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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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INDEX.

NAME INDEX.

Abbot (C. G.), Measures of Solar Radiation made at Mount Wilson and Calama, Chile, in 1918, 160

Abbott (W. J. Lewis), Percussion Figures in Isotropic Solids, 600

Abell (Prof. R. B.), appointed head of the Dept. of Chemistry of the Bradford Technical College, 345

Abraham (H.), E. Bloch, and L. Bloch, The Ultra-rapid Kinematograph, 459

Ackermann (A. S. E.), Power from the Sun, 500

Adames (H. B.), and J. E. Clark, Royal Meteorological Society's Phenological Returns, 437

Adams (Dr. C. E.), Determination of the Position of the Moon by Photography, 518; Photographs on Glass of the Solar Corona, 518; Tables of Mathematical Functions; The Harmonic Analysis of Tidal Observations and the Prediction of Tides, 517

Adams (J.), Presented with the Silver Medal of the Hunterian Society, 319

Adams (Prof. J.), Tests of Intelligence, 513

Adams (W. S.), and A. H. Joy, Stars of High Velocity, 612; and G. Strömberg, Spectroscopic Determination of Stellar Parallax, 511

Aitken (Dr. J.), [death], 318; [obituary article], 337; bequests by, 376

Aldridge (H. E.), Luminous Worms, 174

Alkins (W. E.), Morphogenesis of *Reticularia lineata*, 427

Allbutt (Sir T. Clifford), The New Birth of Medicine, 204

Allen (Dr. E. J.), The Quantitative Study of Plankton, 707

Allen (Dr. H. S.), A Photoelectric Theory of Colour Vision, 174; Physics for Medical Students, 658

Allen (Dr. R. W.), Practical Vaccine-Treatment for the General Practitioner, 466

Allum (Mr.), The Decimalisation of Currency, 579

Amos (A.), Recommended for Appointment to the Lectureship in Agriculture in Cambridge University, 324

Anderson (Prof. A.), The Deflection of Light during a Solar Eclipse, 394; 436; 563; The Displacement of Light Rays Passing near the Sun, 354

Andersson (Prof. J. G.), Request for a Government Grant for Scientific Researches and Collections in China, 178

Andrew, Greenwood, and Green, Defects in the Final Tests of Nickel-chromium Forgings, 485

Andrewes (Dr. F. W.), appointed Harveian Orator of the Royal College of Physicians, 608

Annandale (Dr. N.), A Loom used by the Gaodar Herdsmen of Seistan, 459; Mortality among Snails and the appearance of Blue-bottle Flies, 412; and others, The Aquatic Fauna of Seistan, 453; and others, The Fauna of the Inlé Lake, 176

Anthony (Dr. H. E.), Mammals Collected in Eastern Cuba during 1917, 672

Arber (Agnes), The Vegetative Morphology of Pistia and the Lemnaceæ, 345

Archer (Ellinor), Longevity of Cut Flowers, 619

Armstrong (Dr. E. F.), The Simple Carbohydrates and the Glucosides. Third edition, 526; and T. P. Hilditch, A Study of Catalytic Actions at Solid Surfaces. Part ii., 406

Armstrong (Prof. H. E.), Chemistry in the Making, 219; and others, Method and Substance of Science Teaching, 521

Arnold (Prof. J. O.), A New Alloy Tool-steel, 416; Resignation of the Positions of Dean of the Faculty of Metallurgy and the Professorship of Metallurgy in Sheffield University, 107; career as Professor of Metallurgy and Dean of the Faculty of Metallurgy in Sheffield University, 127

Ashworth (Dr. J. H.), appointed Professor of Zoology in Edinburgh University, 425; Zoology at the British Association, 456

Aston (Dr. F. W.), Neon, 334; The Constitution of the Elements, 393; The Mass Spectra of the Chemical Elements, 714

Atack (F. W.), assisted by L. Whinyates, The Chemists' Year Book, 1918–19, 2 vols., 112

Auric (M.), The Cycle of Eclipses, 459

Aurousseau (M.), An Interesting Form of Sub-surface Drainage, 587

Babcock (Dr. H. L.), The Turtles of New England, 23

Bacon (Major J. E.), New Sources of Aluminium, 277

Baden-Powell (Lt.-Gen. Sir Robert), The Need of Out-of-School Training and Environment as Auxiliary to Education, 522

Bahl (Karm Narayan), The Excretory System of *Pheretima posthuma*, 359

Bailey (A. M.), The Hawaian Island Reservation, 117

Baillaud (B.), Return of the Finlay Comet, 367

Bainbridge (Prof. F. A.), The Physiology of Muscular Exercise, 590

Bairstow (L.), Position and Prospects of Aviation, 246; The Scientific Development of Aviation during the War, 486; R. H. Fowler, and D. R. Hartree, Pressure Distribution on the Head of a Shell Moving at High Velocities, 618

Baker (Prof. H. F.), Mathematical Notes, 714

Baker (Commdr. T. Y.), and Prof. L. N. G. Filon, A Theory of the Second Order Longitudinal Spherical Aberration for a Symmetrical Optical System, 713

Baldit (A.), Effect produced by the Electricity of Rain on an Insulated Wire, 387

Balfour (Mr.), to be nominated as Chancellor of Cambridge University, 67; nomination for the Chancellorship of Cambridge University, 96; elected Chancellor of the University of Cambridge, 146; inaugurated Chancellor of Cambridge University, 266; The National Need for Scientific Research, 399

Ball (Dr. J.), Determination of Positions in the Libyan Desert, 574

Ballard (Dr. P. B.), The Development of Mental Tests, 513; The Measurement of Practical Ability, 513

Balls (Dr. W. Lawrence), The Equipment of Research Laboratories, 399

Bamford (Capt. A. J.), Some Observations of the Upper Air over Palestine, 366

Barbellion (W. N. P.), Enjoying Life: and other Literary Remains of, 529

Barber (Dr. C. A.), Indian Sugar-canes, 14; 578

Barcroft (J.), Time Relations in a Dream, 154
Barker (Capt. D. Wilson), Use of a Prismatic Binocular for Viewing near Objects, 532
Barlow (the late G. T.), assisted by J. W. Meares. Compiled by J. W. Meares. Hydro-electric Survey of India. Preliminary Report on the Water-power Resources of India, 363
Barnard (Edith E.), A Memorial Fellowship to, in Chicago University, 67
Barnard (J. E.), Construction and Use of Microscopes, 546
Barnes (Rev. Dr. E. W.), Address on James Watt, 75
Barnes and Morris's "Algebraic Cube," 79
Barnett (E. de Barry), appointed Lecturer in Organic Chemistry at the Sir John Cass Technical Institute, 186
Barrell (Prof. J.), [obituary], 444; The Nature and Bearings of Isostasy; The Status of the Theory of Isostasy, 645
Barrett (Sir J. W.), A Vision of the Possible: What the R.A.M.C. Might Become. An Account of some of the Medical Work in Egypt, together with a Constructive Criticism of the R.A.M.C., 21; The War Work of the Y.M.C.A. in Egypt, 560; and Lt. P. E. Deane, The Australian Army Medical Corps in Egypt, 560
Barrow (G.), Some Future Work for the Geologists' Association, 510
Barrs (C. E.), Fibroferrite from Cyprus, 649
Barter (E. G.), Radiation Pressure, 188
Bartholomew (Dr. J. G.), The *Times* Survey Atlas of the World. Part i., 658
Barus (Prof. C.), Report on Achromatic Interferometry, 677
Bateson (Prof. W.), Linkage in the Silkworm: a Correction, 315; The Progress of Mendelism, 214; and Caroline Pellew, Genetics of "Rogues" among Culinary Peas, 649
Baudouin (M.), The Fibula of a Newly-born Infant of the Polished Stone Period, and Consequences in Anatomical Philosophy, 459
Baume (G.), and M. Robert, Some Properties of Pure Nitrous Anhydride and of its Solution in Nitrogen Peroxide, 407
Bausor (H. W.), Senior Practical Chemistry, 497
Baxendell (J.), Meteorological Observations made at the Fernley Observatory, 1918, 477
Baxter and Fargher, Arsenic Compounds for Direct Intravenous Injection in Simple Aqueous Solution, 342
Bayeux (R.), The Ozogenic Power of the Solar Radiation at the Altitude of the Mont Blanc Observatory, 407
Bayliss (Prof. W. M.), awarded the Copley Medal of the Royal Society, 295: 362; An Introduction to General Physiology: With Practical Exercises, 654; Cross-Circulation as a Physiological Method, 479; Intravenous Injections of Gum Solutions in Cholera, 73; Physiology and Medicine, 389
Bazile (G.), New Methods for the Destruction of Acridians, 168
Beale (Sir William P.), re-elected President of the Mineralogical Society, 296
Beaver (W. N.), Unexplored New Guinea, 663
Bedford (the Duke of), and S. Pickering, Science and Fruit-growing: Being an Account of the Results obtained at the Woburn Experimental Fruit Farm since its Foundation in 1894, 558
Bedson (Prof. P. P.), Presidential Address to the Chemistry Section of the British Association, 37: 59
Beebe (C. W.), awarded the Elliot Medal of the U.S. National Academy of Sciences, 376
Bell (A. Graham), The Magnetic Storm of August 11–12, 1919, 7*
Bell (F. Jeffrey), Retirement from the Natural History Museum, 157
Bell (Sir Hugh), Presidential Address to the Economic Science and Statistics Section of the British Association, 37: 162
Bell (L.), The Albedo of Saturn's Rings, 138
Bell (Dr. R. J. T.), appointed Professor of Pure and Applied Mathematics in the University of Otago, 146
Bellay (G. du), and M. Houdard, The Chemical Properties of Humus and their Utilisation for the Protection of Combatants against Asphyxiating Gases, 683
Belot (E.), Vulcanicity, Natural and Artificial, 575
Benedicks (C.), The Thermo-electricity of Liquid Mercury Demonstrated by means of the Galvanometer, 187
Benedict (F. G.), W. R. Miles, P. Roth, and H. M. Smith, Human Vitality and Efficiency under Prolonged Restricted Diet, 644
Bennett (G. M.), and E. E. Turner, Organo-metallic Derivatives of Chromium, Tungsten, and Iron, 148
Benson (W. A. S.), Rudiments of Handicraft, 72
Bent (A. C.), Nearctic Diving Birds of the Order Pygopodes, 320
Bergstrand (Dr.), The Group of Helium Stars in Orion, 299
Berry (Dr. E. W.), Cretaceous Plant-remains from Tennessee, etc., 542
Bertrand (G.), Brocq-Rousseu, and Dassonville, Comparative Action of Chloropicrin on the Weevil and on Tribolium, 619; Influence of Temperature and other Physical Agents on the Insecticidal Power of Chloropicrin, 459; The Destruction of Bed-lice by Chloropicrin, 68; and M. Dassonville, Treatment of Scab in Horses by the Vapours of Chloropicrin, 88
Bertrand (L.), and A. Lanquine, Relations between Chemical Composition, Microscopic Structure, and the Ceramic Qualities of Clays, 523
Besson (L.), Diminution of the Transparency of the Air at Paris, 651
Beuzeville (W. A. W. de), Determination of the Increment of Trees by Stem Analysis: *Eucalyptus viminalis*, 587
Bichet (A.), A System of Aiming at Objects in the Air, 307
Bierry (H.), Carnivora and the Three Classes of Food, 387
Biesbroeck (G. van), Relative Masses of Binary Stars, 643
Biles (H. J. R.), awarded the Cammell Laird Scholarship by the Institution of Naval Architects, 186
Bilham (E. G.), Barometric Pressure and Underground Water-level, 366
Bintner (J.), The Symptoms and Distribution of Silver-leaf Disease, 359
Bird (W. B. M.), Work of the Salters' Institute of Industrial Chemistry, 398
Birmingham (the Bishop of), and others, The Declining Birth-rate, 157
Bissell (Dr. W. G.), [death], 357
Bjerknes (Prof. V.), Structure of the Atmosphere when Rain is Falling, 346
Black (F. A.), Planetary Rotation Periods and Group Ratios, 370
Blair (K. G.), The Australian Genus Cestrinus, Er. (fam. Tenebrionidæ), and Some Allied Genera, 407
Blair (Sir Robert), Continuation Schools, 522
Bland-Sutton (Sir John), elected First President of the Association of Surgeons of Great Britain and Ireland, 507
Blaringhem (L.), Vigour of Growth, compensating Sterility in the Hybrids of Species of Digitalis, 88
Blatter (Prof. E.), "Flora Arabica," Part i., 609
Blatterman (Capt. A. S.), The Theory and Use of Radio-direction-finding Apparatus, 137
Bliss (Major H. J. W.), Research Associations and Consulting Work and the Collection and Indexing of Information, 399
Bloch (E.), A Spectroscopic Arrangement for the Study of the Extreme Ultra-violet, 683
Bloch (L.), Industrial Applications of Amplifying Electric Valves, 647
Blondel (A.), A Solution of Heterochromatic Photometry permitting of a Physical Measurement of the Luminous Intensity, 367
Blount (B.), and J. H. Sequeira, The Colours of "Blue John" and other Varieties of Fluorite, 65
Bolduan (Dr. C. F.), and J. Koopman, Immune Sera, Fifth edition, 434
Bolton (Dr. C.), Award of the Charles Graham Gold Medal to, 344
Bolton (H.), Report on the Bristol Museum and Art Gallery, 1918–19, 574
Bond (F. B.), The Hill of Vision: A Forecast of the Great War, and of Social Revolution with the Coming of the New Race, 690
Bonde (C. v.), Some Abnormalities in the Cape Crawfish (*Jasus lalandii*), 148

Bonhote (J. L.), The Practice of Bird-liming in Lower Egypt, 444
Bonney (Prof. T. G.), Annals of the Philosophical Club of the Royal Society, written from its Minute Books, 45; The Expansion of Geology, 203
Bonnier (G.), Comparative Culture of Seedlings at High Altitudes and in the Plain, 523
Bordas (F.), Milk Contamination, 523; The Preparation and Conservation of Sera and Vaccines by Drying in an Absolute Vacuum, 307
Bose (Sir J. C.), The Response of Plants to Wireless Stimulation, 172
Boswell (Prof.), Some Recent Problems in Geo-Chemistry, 455
Bothezat (G. de), The General Theory of Blade-screws, 543
Botley (Cicely M.), Mirage Effects, 565
Bottomley (W. B.), Effect of Nitrogen-fixing Organisms and Nucleic Acid Derivatives on Plant-growth, 345
Bougault (J.), and P. Robin, The Oxidation of Benzaldoxime, 20; The Oxidation of the Hydramides, 407
Boule (Prof. M.), Vertebrate Remains in the Caverns of Grimaldi, 581
Boulenger (E. G.), Methods of Rat Destruction, 97
Boulenger (G. A.), An Extraordinary Tortoise, *Testudo Loveridgii*, 715; The Genus Saphæosaurus, 271
Boulin (Ch.), and L. J. Simon, Action of Stannic Chloride on Dimethyl Sulphate, 271
Bower (Prof. F. O.), Botany of the Living Plant, 274; elected President of the Royal Society of Edinburgh, 177; Joseph Dalton Hooker, 561; Prof. J. Graham Kerr, and Dr. W. E. Agar, Lectures on Sex and Heredity, delivered in Glasgow, 1917–18, 351
Bowie (W.), Connection of the Arcs of Primary Triangulation along the Ninety-eighth Meridian in the U.S. and in Mexico, 509
Boycott (Prof. A. E.), Sedimentation of Blood Corpuscles, 532
Boyle (J. S. W.), appointed Lecturer and Assistant in Chemistry in University College, Dundee, 87
Braae and Fischer-Petersen, Comet 1919*b*, 100, 138, 180, 361
Brabrook (Sir E.), The Anthropological Institutes of France and the United Kingdom, 476
Brade-Birks (Hilda K.), and Rev. S. Graham Brade-Birks, Luminous Chilopoda, with special reference to *Geophilus carpophagus*, Leach, 705
Brade-Birks (Rev. S. Graham), appointed Lecturer in Zoology at the South-Eastern Agricultural College, 167; Luminous Worms, 23; 93
Bradlee (F. B. C.), The Maritime History of Newburyport, Mass., 639
Braesco (P.), The Expansion of Copper-antimony Alloys, 651
Bragg (Prof. W. H.), elected President of the Physical Society, 701; to deliver the Juvenile Christmas Lectures at the Royal Institution, 318; to deliver the Silvanus Thompson Memorial Lecture of the Röntgen Society, 670; X-rays in Physical Science, 235
Bragg (Prof. W. L.), Sound-ranging, 187
Branford (B.), A New Chapter in the Science of Government, 494
Brauner (Prof. B.), A Tribute from Prague, 374; Entente Scientific Literature in Central Europe during the War, 600
Breasted (Prof. J. H.), The Origin of Civilisation, with special reference to the Nile Valley, 267
Breton (A. C.), a Remarkable Picture-map from Mexico, 702
Brierley (W. B.), Species in Relation to Fungi, 520; 708
Bright (Sir Charles), Inter-Imperial Communication, through Cable, Wireless, and Air Methods, 137
Britton (N. L.), and J. N. Rose, The Cactaceæ, 41
Brodetsky (Dr. S.), Mathematical Text-books, 109; Mathematics, Particular and General, 390
Broili (Dr. F.), appointed Professor of Geology and Palæontology in the University of Munich, 443
Brooks (C. E. P.), Incidence of Fog in London on January 31, 1918, 675
Brooks (Sir D.), The Proposed James Watt Memorial, 74
Brown (Prof. E. W.), The Secular Acceleration of the Moon, 299
Brown (Dr. R. N. Rudmose), Spitsbergen: An Account of Exploration, Hunting, the Mineral Riches and Future Potentialities of an Arctic Archipelago, 635; The Coal Export Trade from Spitsbergen, 514
Browne (F. Balfour), appointed University Lecturer in Zoology in Cambridge University, 425
Brownlee (Dr. J.), The Periodicity of Influenza Epidemics, 296
Brownlie (D.), The Performance of Colliery Steam Boiler-plants, 120; The Running of Steam-boiler Plants, 611
Brunt (D.), Internal Friction in the Atmosphere, 714; On the Inter-relation of Wind Direction and Cloud Amount at Richmond, 675
Brunton (J. D.), Gift to the Applied Science Department of Sheffield University, 67
Bryan (Prof. G. H.), Aeronautics in Italy, 656; Hodgson's Tri-lingual Artillery Dictionary, 3 vols., 332; President-elect of the Institute of Aeronautical Engineers, 340; The Neglected Study of Probabilities, 464; The Sound Emitted by Air-screws, 486; Improvement of the Efficiency of Radiators in the Heating of Rooms, 487
Bryant (Major V. S.), Science in Preparatory Schools, 514
Buchanan (J. Y.), Accounts Rendered of Work Done and Things Seen, 686
Buckman (S. S.), Jurassic Chronology: I., Lias. Supplement I., West England Strata, 586
Bugnon (P.), Use of Commercial Inks in Plant Histology, 459
Buller (Prof. A. H. R.), elected President of the Canadian Branch of the Phytopathological Society of the United States, 541
Bulloch (Prof. W.), appointed Professor of Bacteriology in London University, tenable at the London Hospital Medical College, 425
Burchall (P. R.), Elementary Survey of the Present Position of Aerial Photogrammetry, 379
Burchnall (Capt. L. L.), appointed Lecturer in Mathematics in Durham University, 385
Burd (J. S.), Experiments in the Cultivation of Barley, 446
Burley (G. W.), The Cutting Power of Lathe-turning Tools, 478
Burrows (G. J.), Volume Changes in the Process of Solution, 147
Burstall (Prof. F. W.), The Rise of Engineering Manufacture, 74
Bury (E.), Production of Alcohol from Ethylene, 416
Butler (Prof. G. M.), Handbook of Mineralogy, Blowpipe Analysis, and Geometrical Crystallography, 434
Butterfield (K. L.), The Farmer and the New Day, 592
Butterworth (S.), The Self-inductance of Single-layer Flat Coils, 366
Buxton (L. H. D.), Measurements of Skulls in Cyprus, 487

Caie (J. M.), Food Production in Scotland, 553
Calder (Prof. W. M.), Geography and History in the Mediterranean, 650
Calman (Dr. W. T.), appointed Secretary of the Ray Society, 158
Calvert (A. F.), Salt and the Salt Industry, 497
Cambage (R. H.), Acacia Seedlings. Part v., 555
Campbell (Prof. E. D.), The Solution Theory of Steel, etc., 523
Campbell (J. M. H.), C. G. Douglas, and F. G. Hobson, The Respiratory Exchange of Man during and after Muscular Exercise, 427
Campbell (Dr. Norman R.), National Representation upon International Councils, 72
Campbell (Dr. W. W.), elected an Honorary Member of the Royal Institution, 358
Camsell (C.), and W. Malcolm, The Mackenzie River Basin, 640
Cantrill (T. C.), Dr. R. L. Sherlock, and H. Dewey, Iron Ores: Sundry Unbedded Ores of Durham, East Cumberland, North Wales, Derbyshire, the Isle of Man, Bristol District and Somerset, Devon and Cornwall, 429
Caporn (A. St. Clair), Early and Late Ripening in an Oat-cross, etc., 81
Cardot (J.), Proposal to Purchase the Herbarium of Mosses of, 572
Cargill (J. T.), Gift to Glasgow University, 325

Carleton (H. M.), The Cajal Formalin-silver Nitrate Impregnation Method for the Golgi Apparatus, 406
Carothers (S. D.), Plane Strain: The Direct Determination of Stress, 617
Carpenter (Prof. G. H.), Heredity and Evolution, 81
Carpenter (Prof. H. C. H.), A New Copper-refining Industry in Great Britain, 666; The Trend of Modern Metallurgy, 243
Carpentier (Gen. H. W.), Bequests by, 167
Carpentier (J.), Colour Kinematographs of the Gaumont Establishment, 387
Carr (F. H.), elected a Director of the British Drug Houses, Ltd., 638
Carroll (Dr. R. S.), The Mastery of Nervousness based upon Self-Re-education. Third revised edition, 687
Casanowicz (I. M.), Catalogue of Examples of Ecclesiastical Art in the U.S. National Museum, 40
Cashmore (M.), Fermat's Last Theorem: Three Proofs by Elementary Algebra. Revised edition, 171
Casson (S.), Discoveries in the Balkans during the War, 487; Western Turkestan, 335
Castelnuovo (Prof. G.), Calcolo delle Probabilità, 464
Cater (G.), The Nature of Inference, 407
Cave (Capt. C. J. P.), Quotations from the Diary of Samuel Pepys on the Weather, 458; The Audibility of Thunder, 132; The Deflection of Light during a Solar Eclipse, 413; The Status of a Meteorological Office and its Relation to the State and to the Public, 705
Cave-Browne-Cave (Wing-Commdr.), Airships, 486
Chadwyck-Healey (Sir Charles), [obituary], 136
Chalmers (S. D.), [obituary], 318
Chamberlain (Austen), The Government and University Education, 75
Chamberlain (Prof. C. J.). The Living Cycads, 410
Chapman (Capt. E. H.), On the Use of the Normal Curve of Errors in Classifying Observations in Meteorology, 675; The Study of the Weather, 312; The Variation of Wind Velocity with Height, 675
Chapman (F.), An Ostracod and Shell-marl of Pleistocene Age from Boneo Swamp, Victoria, 108; Tertiary Fossils from the Ooldea Soak, South Australia, 347; Tertiary Fossils from Ooldea: Additional Note, 619
Chapman (R. H.), [obituary], 608
Chapman (Prof. R. W.), The Elements of Astronomy for Surveyors, 499
Chapman (Prof. S. J.), The Appointment of, to the Joint Permanent Secretaryship of the Board of Trade, 135
Chardonnet (M. de), The Use of Autochrome Plates instead of Hand-paintings for Clouds, 307
Charlier (C. L.), The Spiral Nebulæ, 68
Charoy (G.), and J. Durand, A Cause of Rupture of Steel Rails, and a Means of Suppressing it, 271
Chatterjee (N.), The Upper Limit of Unpleasant Beats, 708
Chatterjee (N. N.), The Nationalisation of Algebraic Equations, 187
Chavanne (G.), L. P. Clerc, and L. J. Simon, Analyses of German Aviation Petrols, 307
Cheel (E.), Three New Species of Leptospermum, 168
Cheeseman (T. F.), The Vascular Flora of Macquarie Island, 101
Chelle (L.), Detection and Estimation of Traces of Hydrocyanic and Thiocyanic Acids in a Complex Medium, 407; Detection of Hydrocyanic Acid in a Case of Poisoning, 367; Transformation of Hydrocyanic Acid into Thiocyanic Acid in the Course of Cadaveric Putrefactions, 327
Cheshire (Prof. F.), The Outlook of British Technical Optics, 530
Chevenard (P.), The Viscosity of Steels at High Temperatures, 326
Chilton (Prof. C.), A New Isopodan Genus (fam. Oniscidæ) from Lake Corangamite, Victoria, 555; Destructive Boring Crustacea in New Zealand, 78; *Orchestia tucuranna* in New Zealand, 41
Chinnery (Lieut. E. W. P.), "Dengora baiari" Initiation Ceremony of the Binandere Tribe, 386; People of the Hilly Country of New Guinea; Stonework and Goldfields in New Guinea, 488
Chofardet (P.), Observations of Borrelly's Comet, 87; Observations of Finlay's Comet made at the Besançon Observatory, 387
Chree (Dr. C.), awarded the Hughes Medal of the Royal Society, 295, 363; A Magnetic Storm Recorded at Kew Observatory, 120; The Magnetic Storm of August 11-12, 1919, 468
Christmas (W. D.), Exceptional Dryness of October, 1919, 278
Church (Major A. G.), appointed Secretary of the National Union of Scientific Workers, 444; Scientific Workers and a National Federation, 693
Church (Sir Arthur H.), The Collection of Precious Stones of the late, in the Natural History Museum, 357
Church (A. H.), Thalassiophyta and the Sub-aerial Transmigration, 624; The Building of an Autotrophic Flagellate, 594
Clark (W. B.), The Geography of Maryland, 703
Clarke (I. M.), The New Gaspé Bird Sanctuaries in Canada, 117
Claude (G.), Advantages of the Synthesis of Ammonia at very High Pressures, 683; The Industrial Employment of Extremely High Pressures, 307; The Synthesis of Ammonia at very High Pressures, 459
Clay (Prof. A. T.), American Scholars and Research Work in Asia, 64
Clements (A. J.), The Trade in Musk, 97
Clifford (F. W.), The Library of the Chemical Society: A Record of a Recent Attempt at Co-operation, 298
Clowes (Prof. F.), and J. B. Coleman, A Treatise on Qualitative Analysis: Adapted for Use in the Laboratories of Colleges and Technical Institutes, Ninth edition, 688; Elementary Practical Chemistry, Part i., General Chemistry, Seventh edition, 688
Coblentz (W. W.), and H. Kahler, Change in the Electrical Resistance of the Sulphide of Silver and of Bismuth, 478
Cockayne (Dr. L.), The Aims and Aspirations of the New Zealand Institute, 516; The Papers Presented to the New Zealand Science Congress, 516
Cockerell (Prof. T. D. A.), Sugar-beet Seed, 661
Cohn (Prof.), A Sixth Member of the Trojan Group of Planets, 100; Minor Planets, 511
Coker (Prof. E. G.), and K. C. Chakko, The Stress-strain Properties of Nitro-cellulose and the Law of its Optical Behaviour, 617
Coker (R. E.), The Habits and Economic Relations of the Guano Birds of Peru, 378
Coldstream (Lt.-Col. W. M.), The Survey of India Maps and the Modern Development of Indian Cartography, 574
Cole (Prof. G. A. J.), elected President of the Irish Geographical Association, 554; Ireland: The Outpost, 411; On Lecturing with the Lantern, 457
Cole (Dr. L. J.), and Dr. W. A. Lippincott, Relation of Plumage to Ovarian Condition, 81
Colin (H.), and Mlle. A. Chaudin, The Diastatic Inversion of Saccharose, 367
Connell (A.), appointed Professor of Surgery in Sheffield University, 385
Conrady (Prof. A. E.), Microscopical Optics, 548
Conyngham (Col. L.), Exploration in Tibet and Neighbouring Regions, 1865-79, 570
Cooper (W. R.), Retirement from the Editorship of the *Electrician*, 266
Cope (J. L.), A British Imperial Antarctic Expedition, 93
Coriat (Dr. I. H.). What is Psychoanalysis?, 22
Coronas (Rev. J.), The "Quantico" Typhoon, 79
Cortie (Rev. A. L.), A New Astronomical Model, 343; A Solar Eruption in a Giant Star, and Spectral Changes, 454
Cosserat (E.), Some Stars Possessing a Total Annual Proper Motion of more than 0.5", 68
Couch (Sir A. Quiller), The Teaching of English, 521
Coulter (Prof. J. M.), The Evolution of Botanical Research, 581
Coupin (H.), The Causes of the Elongation of the Stem of Etiolated Plants, 683
Courmont (P.), and A. Rochaix, The Bacterial Flora of Sewage Effluents Purified by *Boues activées*, 650
Cowdray (Lord), Donations to the University of London, 344, 586

Crabtree (J. H.), British Ferns and how to Identify Them, 410
Cramp (Dr. W.), appointed Professor of Electrical Engineering in Birmingham University, 489
Crawford (H. S.), The Mural Paintings and Inscriptions at Knockmoy Abbey, 475
Crawford (Prof.), and Misses Fairfield and Cummings, The Orbit of Finlay's Comet 1919d, 380
Crawfurd (Dr. R.), to Deliver the Harveian Oration, 135
Cremieu (V.), and A. Lepape, The Separation by Solidification of Pure Carbon Dioxide from a Gaseous Mixture, 307
Crestani (Prof. G.), Meteorologia Aeronautica, 656
Crommelin (Dr. A. C. D.), Results of the Total Solar Eclipse of May 29 and the Relativity Theory, 280; Einstein's Theory, 514; The Belgian Royal Observatory, 676; The Deflection of Light during a Solar Eclipse, 372; The Einstein Theory and Spectral Displacement, 532; The Theory of Relativity, 631
Crooke (Dr. W.), Cults of the Mother Goddesses in India, 608
Crossland (Dr. C.), Comfort and Health in the Tropics, 573
Crossley (Prof. A. W.), appointed Director of Research to the British Cotton Industry Research Association, 296; The Appointment of, as Director of Research by the British Cotton Industry Research Association, 319
Crowley (Dr. J. F.), The Use of Electricity in Agriculture, 268
Crowther (Dr. J. A.), A Manual of Physics, 658
Crozier (Col. C. D.), The Manufacture of High Explosives during the War, 455
Cruickshank (Dr. J.), appointed Georgina McRobert Lecturer in Pathology in Aberdeen University, 385
Cummings (B. F.), [obituary], 177; Enjoying Life: and other Literary Remains of W. N. P. Barbellion, 529
Cunningham (Dr. Brysson), Hydro-electric Development Works, 161; Irrigation in Egypt and the Sudan, 67: The Chippawa-Queenston Hydro-electric Development Scheme, 483: The Hydro-electric Survey of India, 363; The Reduction of Wave Action in Harbours, 614; The Sudan Irrigation Works, 120; Water in Action—Controlled and Free, 70
Cunningham (E.), Einstein's Relativity Theory of Gravitation, 354, 374, 394; Einstein's Theory and a Map Analogue, 437; The Theory of Relativity, 632
Curtis (R.), The "Grillo" Plant for making Sulphuric Acid, 341
Cutler (D. W.), The Spermatogenesis of Infertile Hybrids between Pheasant and Gold Campine Fowl, 81
Czaplicka (Miss M. A.), Relation of History and Ethnology, with special reference to North Central Asia, 487; The Turks of Central Asia in History and at the Present Day, 273

Dakin (Prof.), Vitalism, 578
Dale (Dr. H. H.), and others, The *Rôle* of Capillaries in the Regulation of the Blood-flow, 519
Dall (Dr. W. H.), New Species of Molluscs of the Family Turritidæ from the West Coast of America and Adjacent Regions, 98
Dallas (W. L.), [obituary], 63
Daly (Prof. R. A.), "Glacial-control" Theory of the Growth of Coral Reefs, 360
Danden (Lieut. M. M.), Dizionario Internazionale di Aeronavigazione e Costruzioni Aeronautiche. Italiano, Francese, Inglese, Tedesco, 656
Daniel (L.), The Causes of the Immersion of the Leaves of the Water-Lily, 407
Daniell (G. F.), Selection of Elementary Children for Higher Forms of Education, 513
Darling (C. R.), to deliver a course of Lectures on the Commerical Applications of Physics, 386
Darrow (F. L.), The Boys' Own Book of Great Inventions, 152
Dautriche (P.), The Field of Application for Aerophotography, 99
Davenport (Dr. C. B.), and M. T. Scudder, Naval Officers: Their Heredity and Development, 396
Davidson (C. R.), The Solar Eclipse of May 29, 1919, 544
Davies (T. J. C. Fraser), The Sociological Society, 662
Davis (Dr. A. P.), and H. M. Wilson, Irrigation Engineering. Seventh edition, 70
Davis (J. J.), The Natural Enemies of Phyllophaga, 40
Davis and Jordan, The Orifice as a Means of Measuring the Flow of Water through a Pipe, 647
Debenham (F.), elected a Fellow of Gonville and Caius College, Cambridge, 616
Deecke (Prof. W.), Articles on Petrographic Subjects, 673
Deeley (R. M.), and others, Lubrication, 451
Delage (Y.), Integrating Pitot Tube for measuring the average Velocity of Variable Currents, 683
Delaporte (P.), Proposed Reform of the Calendar, 415
Deller (Dr. E.), appointed Assistant Secretary to the Royal Society, 572
Dellinger (J. H.), Radio-Transmission and Reception, 543
Delpech (J.), Flameless Powders, 167; The Flashes Produced by the Fire of Artillery, 187; The Pure "B" Powders, 68
Demenitroux (M.), Methods Used in France for the Production of Radium Bromide, 419
Dendy (Prof. A.), Animal Life and Human Progress, 21
Denham (H. J.), Gossypium in Pre-Linnæan Literature, 10
Densmore (F.), Teton Sioux Music, 437; The Sun Dance of the Teton Sioux, 437
Desch (Prof. C. H.), appointed Professor of Metallurgy in Sheffield University, 405; The Metallurgical Position in this Country and the Central Empires, 455
Descombes (P.), The Use of Trees in Extracting Water from the Atmosphere, 491
Deslandres (Dr. H.), Sir Norman Lockyer, 191; The Constitution of the Atom and the Properties of Band Spectra, 271, 347
Dewar (W.), Proposals for a Plumage Bill, 564
Dewsnup (Prof. E. R.), appointed Professor of Railway Administration in Liverpool University, 385
Dhar (N. R.), and G. Urbain, The Polarisation Electromotive Forces of Iron in Solutions of Complex Salts, 618
Dickson (A. A. C.), The Mica Miner's and Prospector's Guide, 276
Dickson (Prof. L. E.), History of the Theory of Numbers. Vol. I., Divisibility and Primality, 4
Dines (W. H.), Atmospheric and Terrestrial Radiation, 714: Progress of Meteorology, 247: The Characteristics of the Free Atmosphere, 505; The Deflection of Light during a Solar Eclipse, 393; Wind and Barometric Gradient, 525
Dixey (Dr. F. A.), Presidential Address to the Zoology Section of the British Association, 39, 121
Dixon (Prof. H. B.), and H. Stephen, The Discovery of Chemical Elements since 1869, 221
Dixon (Prof. H. H.), and T. G. Mason, A Cryoscopic Method for the Estimation of Sucrose, 555; and H. H. Poole, Photo-synthesis and the Electronic Theory, 682
Dixon (R. B.), and A. L. Krœber, Regrouping the Dialects of California, 541
Dobbin (Dr. L.), Formic Acid and the Stinging Hairs of the Common Nettle, 64
Dobell (Prof. C.), The Amœbæ Living in Man, 369
Dobson (G. M. B.), Winds and Temperature-gradients in the Stratosphere, 458
Domville-Fife (C.), Submarines and Sea Power, 433
Doncaster (Prof. L.), Mendelism, 655
Donnan (Prof. F. G.), Heat of Reaction and Gravitational Field, 392
Doodson (A. T.), R. M. Carey, and R. Baldwin, Theoretical Determination of the Longitudinal Seiches of Lake Geneva, 714
Douglas (Capt. C. K. M.), The Formation of Haloes, 641
Douglas (J. A.), Geological Sections through the Andes of Peru and Bolivia, II., 681
Douvillé (H.), The Annular Foraminiferæ (Cyclostègnes) of Orbigny, 523
Dowling (J. J.), An Apparatus for the Production of High Electrostatic Potentials, 428
Downing (E. R.), A Source Book of Biological Nature Study, 465
Doxford (A. E.), The Economic Position of the Country, 268

Druce (Dr. G. C.), Occurrence in Britain as Native Plants of *Ajuga genevensis* and *Centaurium scilloides*, Druce, var. *portense* (Brot.), 406
Druce (H. H.), Collection of Lycænidæ and Hesperidæ in the Hill Museum, Witley, 77
Duchemin (R. P.), General Position of Chemical Industries, especially in France, 268
Duerden (Prof. J. E.), Breeding Experiments with Ostriches, 155; Phylogenetic Degeneration in the Ostrich, 609; Promotion of a Plumage Bill, 499; Results of the Crossing of the Northern and Southern Forms of African Ostrich, 81
Duffield (Prof. W. G.), Relativity and the Displacement of Fraunhofer Lines, 659
Dufrénoy (J.), Experimental Bacterial Tumours in Pines, 168
Duncan (F. Martin), Insect Pests and Plant Diseases in the Vegetable and Fruit Garden, 467; Photographs showing the Actinic Quality of the Light from a Living Pyrophorus Beetle, 345
Dunkerley (J. S.), appointed a Ray Lankester Investigator at the Marine Biological Laboratory, Plymouth, 701
Dunlop (Sir Nathaniel), [obituary], 340
Dykes (W. R.), nominated as Secretary of the Royal Horticultural Society, 377
Dyson (Sir F. W.), The Theory of Relativity, 631; and Mr. Melotte, Open Stellar Clusters, 576

Easterfield (Prof. T. H.), appointed Director of the Cawthorn Research Institute, 442
Eccles (Prof. W. H.), Special Arrangements of Three-electrode Valves, 487; Triode Valves as Electric Amplifiers, 501; and others, Thermionic Valves, 454; and J. H. Vincent, The Variations of Wave-length of the Oscillations Generated by Three-electrode Thermionic Tubes, etc., 617
Eddington (Prof. A. S.), Einstein's Theory, 377; Observations of the Solar Eclipse at Principe, 454; Relativity, 400; The Deflection of Light during a Solar Eclipse, 372; The Predicted Shift of the Fraunhofer Lines, 598; The Sources of Stellar Energy, 269; The Theory of Relativity, 385, 631; and others, Relativity, 454
Edwards (F. W.), Descriptions and Illustrations of Dipera, 64
Eggar (W. D.), Presentation to, on Retirement from the Presidency of the Eton College Scientific Society, 444; The Teaching of English in Relation to School Science, 521
Einstein (Prof.), Interview with, 541; Relativity, 360
Ekblaw (K. J. T.), Farm Concrete, 495
Elgie (J. H.), The Stars Night by Night: Being the Journal of a Star-Gazer, 467
Elliot (H.), Modern Science and Materialism, 625
Elliott (S.), Bequest to Edinburgh University, 425
Ellis (C.), The Hydrogenation of Oils: Catalysers and Catalysis and the Generation of Hydrogen and Oxygen, Second edition, 494
Eötvös (Baron R. von), [obituary], 319
Etheridge (Robert), [obituary article], 700
Evans (D. A. E.), British Iron-ores, 565
Evans (E. V.), The Present Position of the Chemical Industry of Germany, 484
Evans (Dr. J. W.), elected President of the National Union of Scientific Workers, 297; Presidential Address to the Geology Section of the British Association, 38, 102
Evershed (J.), Is Venus Cloud-covered?, 675; The Magnetic Storm of August 11–12, 1919, 436
Ewart (A. J.), The Synthesis of Sugar from Formaldehyde and its Polymers, etc., 555; and J. R. Tovey, Contributions to the Flora of Australia, No. 28, 347
Ewart (Prof. J. Cossar), A Search for Fine Wool, 153; Telegony, 216
d'Eyncourt (Sir E. H. Tennyson), The British Tanks Used in the War, 486

Fabaro (Dr. L.), Oscillations in the Luminosity of Incandescent Electric Lamps illuminated by Alternating Currents, 542
Farmer (Prof. J. B.), awarded a Royal Medal of the Royal Society, 295, 363
Farr (C. C.), The Porosity of Porcelain, 517; and D. B. Macleod, The Viscosity of Sulphur, 712
Farrer (R.), The English Rock-garden, 2 vols., 664
Fawdry (R. C.), Dynamics, Part ii., 109
Fawsitt (Prof. C. E.), The Uniformities of Nature, 586; and C. H. Fischer, The Miscibility of Liquids, 555
Fayet (G.), and A. Schaumasse, Next Return of the Periodic Comet 1911 VII. (Schaumasse), 19; Return of the Periodic Comet 1911 VII. (Schaumasse), 347
Fedden (R.), Golden Days from the Fishing Log of a Painter in Brittany, 391
Ferguson (E. W.), and Marguerite Henry, Tabanidæ from Camden Haven District, N.S.W., 587
Ferry (E. S.), G. A. Shook, and J. R. Collins, Practical Pyrometry: The Theory, Calibration, and Use of Instruments for the Measurement of High Temperatures, 47
Fewkes (Dr. J. W.), A Remarkable Carved Wooden Object from Santo Domingo, 378; Field-work on the Mesa Verde National Park, Colorado, 359
Fisher (Prof. E. F.), Resources and Industries of the United States, 131
Fisher (H. A. L.), to Address the Annual Conference of Educational Associations, 365
Fisk (Prof. W. W.), The Book of Cheese, 528
Fitzsimons (F. W.), The Natural History of South African Mammals, 4 vols., 469
Flack (Dr. M.), appointed Milroy Lecturer of the Royal College of Physicians, 608
Flamand (G. B. M.), The Discovery of a Lens of Coal at Port-Gueydon, 307
Flamsteed (J.), The Bicentenary of the Death of, 417
Fleck (Dr. A.), The Separation of Isotopes, 565
Fleming (A. P. M.), Industrial Research, 470; and others, Works Schools, 522
Fleming (Prof. J. A.), Progress of Electrical Invention, 239; Speaking across the Atlantic by Wireless Telephony, 179; The Thermionic Valve and its Developments in Radiotelegraphy and Telephony, 462
Fletcher (Prof. S. W.), Strawberry-growing, 592
Fleure (Prof. H. J.), The Survival in Remote Parts of Wales of a Primitive Type, 487
Flint (Rev. Dr. W.), Race Consciousness, 118
Flower (Major S.), The Destruction of Birds in Lower Egypt, 444
Forbes (Dr. H. O.), The Audibility of Thunder, 315
Forster (Sir Ralph), The Organic Department of the Chemical Laboratories of University College, London, to be named after, 344
Fortescue (Prof.), Application of the Three-electrode Thermionic Valve, 487
Fotheringham (Dr. J. K.), The Motion of the Moon, 612
Fouché (Ed.), Search for a Characteristic Equation Applicable to Atmospheric Air, 491
Fowler (Prof. A.), awarded a Gold Medal by the National Academy of Sciences, Washington, 296; elected President of the Royal Astronomical Society, 671; Spectroscopic Astronomy, 234; The Centenary of the Royal Astronomical Society, 674; The Theory of Relativity, 632
Fowler (Sir Henry), elected President of the Institution of Automobile Engineers, 638
Fox (H. M.), elected a Fellow of Gonville and Caius College, Cambridge, 616
Fox (Dr. R. H.), Dr. John Fothergill and his Friends: Chapters in Eighteenth-century Life, 1
Frankland (Prof. P. F.), awarded the Davy Medal of the Royal Society, 295; 363
Franklin (Capt. T. B.), The Cooling of the Soil at Night, 450; 458
Fraser (D. C.), Newton's Interpolation Formulas, 42
Fraser (Sir Thomas R.), [death], 474; [obituary article], 505
Freedman (P.), Tungsten Arc ("Pointolite") Lamps, 358
Freeman (Dr. W. E.), British Botanic Gardens and Stations, 469
Frémont (C.), A New Method for Testing the Fragility of Metallic Tubes, 347
French (J. W.), Percussion Figures in Isotropic Solids, 312; The Surface Layer of an Optical Polishing Tool, 682

Frick (H. C.), Bequests by the late, 386
Friend (Rev. H.), A New British Enchytræid Worm, 174; British Well-worms, 5; Luminous Worms, 334
Frink (R. L.), appointed Director of Research by the Glass Research Association, 572
Froggatt (W. W.), A New Species of Wax Scale from New Guinea, 271
Frohawk (F. W.), Birds Beneficial to Agriculture, 72
Frood and Hall, The Deposits of Saltpetre near Prieska and Hay, Cape Province, 477
Fuller (C.), The Wing Venation and Respiratory System of Certain South African Termites, 78; 639

G. (W.), Euclid, Newton, and Einstein, 627
Galippe (V.), Micro-organisms Living in Paper, 347; Resistance of Living Intra-cellular Agents to the Action of Certain Chemical Substances, 128
Gamble (W.), Penrose's Annual, 690
Gardiner (J. H.), The Rarer Elements, 310
Gardiner (Prof. J. Stanley), "The White Water," 563
Gardiner (L.), Proposals for a Plumage Bill, 564
Gardner (A.), appointed Demonstrator in Anatomy in Manchester University, 19
Gardner (J. A.), and F. W. Fox, The Distillation of Chloropicrin, 419
Garelli (Prof.), Experiments for the Extraction of Nitrate of Ammonia from Surplus Stocks of Explosives, 447
Garner (R. L.), [obituary], 573
Garner (W. E.), An Electronic Theory of Isomerism, 661
Garrad (Mr.), Work of the Tractor on the Farm, 98
Garstang (Prof. J.), Provisionally appointed Director of the Projected British School of Archæology at Jerusalem, 398
Garstang (Prof. W.), Sea-fishery Investigations and the Balance of Life, 48
Garuffa (Dr. E.), L'Aviazione. Aeroplani, Idrovolanti, Eliche. Seconda edizione, 656
Gatenby (J. B.), Identification of Intra-cellular Structures, 97; The Germ-cells and Early Development of *Grantia compressa*, 427
Gates (Dr. Ruggles), Mutational *v.* Recapitulatory Characters, 521; The Existence of Two Fundamentally Different Types of Characters in Organisms, 713
Gauthier (Mlle. M.), The "Trypanosome" of the Trout, 650
Gehrs (Prof. J. H.), Productive Agriculture, 495
Geikie (Sir Archibald), Retrospect and Prospect, 195; Science and Sociality, 45
Gemmill (Dr. J. F.), appointed Professor of Natural History at University College, Dundee, 67; Zoology and Human Welfare, 21
George (D. Lloyd), The Place of the University in the General Field of Education, 167
Getman (Dr. F. H.), Outlines of Theoretical Chemistry. Second edition, 3
Geyl (Dr. P.), Holland and International Rivers, 332
Ghambashidze (D.), Mineral Resources of Georgia and Caucasia: Manganese Industry of Georgia, 171
Gheury (Sgt. M. E. J.), A Simple and Rapid Method of Tide Prediction (including Diurnal Time and Height Inequalities), 171
Ghose (S. L.), The Myxophyceæ, or Blue-green Algæ of Lahore, 297
Giacobini (M.), Observations of Finlay's Comet made at the Paris Observatory, 387
Gibson (K. S.). Photo-electric Spectrophotometry by the Null Method, 478
Giglioli (Prof. I.), Vertical-pipe Irrigation for Orchards and Market-gardens in Arid Climates, 276
Gilchrist (Prof. J. D. F.), The Marine Biological Report of the Cape of Good Hope, 615
Giles (Dr. P.), elected Vice-Chancellor of Cambridge University, 126
Gill (A.), Experiments with Horse-chestnuts, 575
Gillespie (T. H.), The Breeding of the King Penguin, 314
Giolitti (Dr. F.), presented with the Bessemer Medal of the Iron and Steel Institute, 77
Glazebrook (Sir Richard), appointed Professor of Aviation in London University, tenable at the Imperial College of Science and Technology, 425; Recent Progress in Aviation, 397; Retirement from the Directorship of the National Physical Laboratory, 8; 77
Godard (H.), Observation of Finlay's Periodic Comet (1919*e*), made at the Bordeaux Observatory, 459
Godchot (M.), and F. Taboury, Some New Bicyclic Ketones, 523
Godfrey (C.), The Modern Teaching of Geometry in Schools, 550
Godfrey (Col.), The Orchids of Hants and Dorset, 520
Godman (F. Du Cane), Lord Walsingham, 40
Gold (Lt.-Col. E.), Meteorology in Three Dimensions, 505; Relation of Meteorology to Aviation, 641
Goldschmidt (Prof. V. M.), Om Aluminiumfremstilling av Norske Raastoffer, 161
Golgi (Prof. C.), Retirement from the Professorship of General Pathology and Histology in the University of Pavia, 19
Gomme (A.), appointed Librarian of the Patent Office, 585
Goodchild (W. H.), awarded the Consolidated Gold Fields of South Africa, Ltd., Gold Medal by the Institution of Mining and Metallurgy, 573
Goodrich (E. S.), constituted Professor of Comparative Embryology in the University of Oxford, 616; Phagocytosis and Protozoa, 456
Goris (A.), and Ch. Vischniac, Characters and Composition of Primeverose, 367
Gould (H. P.), Peach-growing, 495
Gowen (J. W.), A Biometrical Study of Crossing-over, 541
Goyen (P.), Elementary Mensuration, Constructive Plane Geometry, and Numerical Trigonometry, 390
Grabham (Dr. M. C.), Bird Migration, 334; *Iridomermyx humilis* in Madeira, 456
Graff (K.). Barnard's Proper-motion Star, 420
Graham (Dr. J.). appointed Professor of Anatomy in the Anderson College of Medicine, Glasgow, 19
Gramont (A. de), The Direct Arc-spectra of Metals of Low Melting Point, 650
Grard (M.), Thermal Treatment of Aluminium Alloys, 187
Gray (Prof. A.), Presidential Address to the Mathematics and Physical Science Section of the British Association, 39; 52
Gray (J.), Effects of Some Ions on Spermatozoa; Effects of Ions on Ciliary Movement (Gills of *Mytilus edulis*), 366; The Relation of Spermatozoa to Certain Electrolytes (II.), 427
Gray (Dr. R. Whytlaw), elected President of the Eton College Scientific Society, 444
Gray (W. D.), The Reported Dinosaurian Reptile in the Congo Region, 701
Greaves (R. H.), The "Temper Brittleness" of a Nickel Chromium Steel, 480
Green (H. H.). Estimation of Small Quantities of Arsenic by Micro-titration with Iodine, 477
Greenish (Prof. H. G.), to Receive the Diploma of Docteur *honoris causa* from the University of Paris, 397
Greenwood (Dr. H. C.), [obituary], 443; Industrial Gases, 622
Greenwood (M.), The Incidence of Industrial Accidents upon Individuals, with Special Reference to Multiple Accidents, 158
Gregory (Prof. J. W.), The African Rift Valley, 518; The Flight from Cairo to the Cape. Scientific Aspects of the Route, 633; The *Times* African Flight: Discovery of a New Volcanic Field, 667
Gregory (Sir Richard), Educational Value of the Kinema, 522; The Divorce of Laboratory and Class-room Courses, 514; The Promotion of Research, 259
Greig-Smith (Dr. R.), The Germicidal Activity of the Eucalyptus Oils. Part ii., 20
Grierson (Sir George), The Linguistic Survey of India and the Census of 1911, 267
Griffith-Boscawen (Sir A.), appointed Deputy Chairman of the President's Administrative Council of the Board of Agriculture and Fisheries, 342; The State and Agriculture, 181
Griffiths (Mrs. C. H.), Diffraction Patterns in the Presence of Spherical Aberrations, 682
Grignard (V.), G. Rivat, and Ed. Urbain, The Chlorination of Methyl Formate and Methyl Chloroformate, 491

Grindley (Dr. J. H.), appointed Principal of the Dudley Technical College, 306
Grout (F. F.), and T. M. Broderick, Structures in the Huronian Iron-bearing Strata of the Mesabie Range in Minnesota, 360
Groves (C. E.), [death], 608; [obituary], 637
Gude (G. K.), elected President of the Malacological Society of London, 671
Guérin (T. W. M. de), A Sculptured Human Figure Discovered on the Dolmen of Déhus, Guernsey, 487; The Megaliths in Guernsey, 117
Guillaume (J.), Observations of the Sun made at the Lyons Observatory, 491
Guillet (L.), The Transformation undergone by Certain Aluminium Alloys, 459; J. Durand, and J. Galibourg, The Tempering of Certain Aluminium Alloys, 128
Guthrie (D.), The Birds of South Uist, 136
Guyot (J.), and L. J. Simon, Action of Hydrates, Oxides, and Carbonates of the Alkaline Earths on Dimethyl Sulphate, 167; Action of Sulphuric Anhydride and of Oleum on Methyl Alcohol, 247
Gwynne (Comdr.), Submarine Mining, 487

Haber (Prof. F.), awarded the Nobel Prize of 1918 for Chemistry, 318
Hadfield (Sir Robert), Appreciation of the Work of the Department of Scientific and Industrial Research, 670; History of the Microscope and its Applications in Metallurgy, 545; History of Microscopical Invention, 535; The Labour Situation in the Country, 159; The Work of Faraday and the Faraday Society, 539; and T. G. Elliot, The Study of Highly Magnified Metal Sections, 537
Hadwen (Dr. S.), and Dr. A. E. Cameron, Horse Bot-flies, 64
Hahn (O.), and L. Meitner, The Genesis of Actinium, 575
Haines (H. H.), Shrubs belonging to the Genus Carissa, 159
Haldane (Viscount), What is Truth?, 405
Hale (A. J.), The Manufacture of Chemicals by Electrolysis, 529
Hall (Sir A. D.), appointed Vice-Chairman of the President's Administrative Council of the Board of Agriculture and Fisheries, 342; elected a Member of the Athenæum Club, 608
Hall (H. R.), Prof. L. W. King, 27
Halliburton (Prof. W. D.), "Traube" Waves, 418; and others, Accessory Food Substances, 520; J. C. Drummond and R. K. Cannan, The Food Value of a Synthetic Product Prepared from Olive Oil and Mannitol, 419
Hallimond (A. F.), Torbernite, 650
Hallmann (E. F.), New Genera of Monaxonid Sponges Related to the Genus Clathria, 555
Halm (Dr.), Comet 1919g, 612
Hammerton (J. A.), Harmsworth's Universal Encyclopedia No. 1, 659
Hampshire (C. H.), Volumetric Analysis for Students of Pharmaceutical and General Chemistry. Second edition, 497
Hansen (Miss V.), and Fischer Petersen; Prof. Wolf; M. Ebell, Comets, 66; Metcalf's Comet, 12
Harcourt (A. G. Vernon), [obituary article], 49
Hardy (G. H.), appointed Savilian Professor of Geometry in the University of Oxford, 398
Harmer (Dr. S. F.), Antarctic Whaling, 377; Progress of the Natural History Museum, 353
Harris (Prof. D. Fraser), The Medical and Allied Professions as a State Service, 508
Harris (J. A.), and F. G. Benedict, A Biometric Study of Basal Metabolism in Man, 644
Harris (Prof. T. S.), The Sugar-beet in America, 592
Harris (Sir William Snow), The Work of, 417
Harrison (H. T.), A New Form of Photometer, 358
Harrison (Dr. J. W. H.), Peculiar Sex-relationships in Inter-generic Hybrids of Bistoninæ, 574; Effect of Alcohol on *Selenia bilunaria*, 609
Harrison (R.), Resignation of the Assistant Secretaryship of the Royal Society, 361
Harrison (W. J.), appointed University Lecturer in Mathematics in Cambridge University, 425
Hartley (Brig.-Gen.), The Development of Chemical Warfare, 455
Hasse (Adelaide R.), Index of Economic Material in Documents of the States of the U.S., 704
Hatch (Dr. F. H.), The Iron and Steel Industry of the United Kingdom under War Conditions, 111
Hatzidakis (J.), Excavations in Crete, 356
Haverfield (Prof. F. J.), [obituary], 117; Bequest by, to the University of Oxford, 266
Haviland (Miss M. D.), Preliminary Note on the Life-history of a Proctotrypid (Lycocerus sp.) Hyper-parasite of Aphidius, 366
Hawkes (Commdr. C.), appointed Professor of Engineering at Armstrong College, 616
Hawkes (L.), New Sources of Aluminium in Norway, 160
Hawksley (the family of the late C.), Gift to University College, London, 586
Hawtrey (R. G.), Restoration of the Gold Standard, 486
Haynes (Miss D.), and Miss H. M. Judd, Experiments with Pressed Apples, 379
Hazen (Dr. J. V.), [death], 357
Head (Dr.), Sensation and the Cerebral Cortex, 267
Headley (F. W.), [obituary], 358
Heath (Prof. R. S.), Solid Geometry, including the Mensuration of Surfaces and Solids. Fourth edition, 109
Hedrick (Dr. H. B.), Interpolation Tables or Multiplication Tables of Decimal Fractions, 152
Heilbron (Dr. I. M.), appointed Professor of Organic Chemistry at the Glasgow Technical College, 19
Hele-Shaw (Prof.), James Watt and Invention, 75
Hemsalech (G. A.), Origin of Luminous Radiations emitted by Vapours in an Electrical Resistance Tube Furnace, 491
Hemsley (Dr. W. B.), The Flora of Aldabra, etc., 118
Hendy (F. J. R.), The Universities and the Training of Teachers, 681
Henrici (Major E. O.), Precise Levelling, 445
Henry (Prof. A.), Afforestation of Water-catchment Areas, 520; 554; and Miss M. G. Flood, The Douglas Firs: A Botanical and Sylvicultural Description of the Various Species of Pseudotsuga, 682
Herdman (Prof. W. A.), Abundance of Marine Animals and a Quantitative Survey of their Occurrence, 427; President-elect of the British Association, 52; Thirty-third Annual Report of the Liverpool Marine Biology Committee, 677
Heron-Allen (E.), and Mr. Earland, Modifications of Growth in the Life-history of Foraminifera, 456
Herring (Prof. P. T.), St. Andrews Institute for Clinical Research, 615
Hess (F. L.), Proposal of the Term "Tactite," 574
Heywood (H. B.), Mathematics at the University of Strasbourg, 74
Hicks (Prof. W. M.), A Helium Series in the Extreme Ultra-Violet, 393
Hickson (Prof. S. J.), Biological Science in Secondary Schools, 693
Hildebrandsson (Prof. H. H.), awarded the Symons Memorial Gold Medal by the Royal Meteorological Society, 340; Presented with the Symons Gold Medal of the Royal Meteorological Society, 573
Hill (Dr. A.), Aspects of Science at Universities, 255; Resignation of the Principalship of University College, Southampton, 306
Hill (A. V.), appointed Professor of Physiology in Manchester University, 585
Hill (G. F.), Australian Stratiomyidæ (Diptera), with Description of New Species, 271
Hill (H.), National Hydro-electric Schemes for New Zealand, 517
Hillman (H.), Mirage Effects, 630
Hindle (Dr. E.), elected Professor of Biology in the School of Medicine, Cairo, 127; The History of Isolated Pairs of Body-lice and of their Offspring, 456
Hinks (A. R.), Boundary Delimitation in Europe, 445
Hinton (M. A. C.), A New Species of Field-mouse from Foula, 418
Hitchcock (Prof. C. H.), [obituary], 358

Hoagland (D. R.), Experiments in the Cultivation of Barley, 446
Hodgson (E. S.), Trilingual Artillery Dictionary. 3 vols. Vol. i., English—French—Italian, 332
Hodsman (H. J.), and Prof. Cobb, Tests of the Expansions of Refractory Materials, 379
Hogben (L. T.), Nuclear Phenomena in the Oocytes of Neuroterus, a Gall-fly, 346; Studies in Synapsis, I., 649; 674
Hogg (H. R.), Some Australian Opiliones, 713
Holmes (T. V.), Warren's Pre-History in Essex, 112
Holtedahl (Dr. O.), Forthcoming Exploring Expedition to Novaya Zemlya, 357; Suess's "Sal" and "Sima" Magmas, 574
Hooker (R. H.), elected President of the Royal Meteorological Society, 573
Hopkins (Dr. Cyril G.), [obituary article], 442
Horton (F.), and Ann C. Davies, An Experimental Determination of the Critical Electron Velocities for the Production of Radiation and Ionisation on Collision with Argon Atoms, 406; Effects of Electron Collisions with Platinum and with Hydrogen, 618; The Ionisation by Electron Collisions in Argon and Helium, 454; and Miss D. Bailey, The Luminosity Produced in Helium, 454
Hosmer (Prof. G. L.), Text-book on Practical Astronomy. Second edition, 3
Houstoun (Dr. R. A.), Elements of Physics, 658
Howard (A. L.), The Timbers of India, 159
Howard (Dr. L. O.), elected President of the American Association, 613
Howchin (W.), The Geology of South Australia. In two Divisions, 91
Howorth (Sir Henry H.), The Turks of Central Asia, 273
Hrdlička (Dr. A.), The Population of Russia, 341
Hughes (T. S.), Bequest to the University of London, 344
Hull (Rev. J. E.), "Gynandry" among Spiders, 81
Hull (L. M.), Method of Rating Thermionic-valve Generators, 510
Hulme (E. W.), Presentation to, on Vacating the Librarianship of the Patent Office, 585
Humbert (P.), The Calculations of G. H. Darwin on the Stability of the Pyriform Figure, 650
Humphreys (Prof. W. J.), The Factors Controlling Climate, 610
Humphry (R. H.), appointed Lecturer in Physics at the Sir John Cass Technical Institute, 186
Hutchins (D. E.), The Economic Value of the Forests of New Zealand, 159
Hutton (J. H.), Leopard-men in the Naga Hills, 427
Huxley (J.), The Courtship of the Dabchick, 359; Metamorphoses of Axolotl caused by Thyroid-feeding, 435

Ilford, Ltd., A Hardening Solution for Gelatine Negatives, 11
Inge (Dean), appointed Romanes Lecturer for 1920, 266
Inglis (Prof.), Portable Military Bridges, 486
Innes (R. T. A.), The Blink Microscope, 66
Izat (A.), [obituary], 540

Jackson (Rt. Hon. F. Huth), The National Alliance of Employers and Employed, 485
Jackson (Sir John), [obituary], 398
Jackson (V. H.), and A. T. Mukerjee, Improvements in Measurements with Quadrant Electrometers. Part ii., 459; The Utility of Desiccants in Electrostatic Measurements, 459
James (A. V. E.), The Physiography and Geography of the Bulla-Sydenham Area, 610
James (R. W.), The Antarctic: Shackleton's Expedition of 1914-17, 554
Jardine (Dr. F. E.), appointed Lecturer on Applied Anatomy in Edinburgh University, 425
Jayaram (B.), The Manganese Ores of the Shimoga and Adjacent Districts, 137
Jeans (J. H.), awarded a Royal Medal of the Royal Society, 295; 363; Relativity, 400; 631
Jeffreys (Dr. H.), Relativity, 401; The National Union of Scientific Workers and Research, 23
Jekhowsky (B.), Orbit of the Metcalf Comet 1919*b*, 68
Jespersen (P.), The North Atlantic Halibut Fishery, 158
Joad (C. E. M.), Essays in Common-sense Philosophy, 352
Johansen (A. C.), The Biometrics of the Spring-spawning Herrings, 158
Johnson (Prof. D. W.), Shore Processes and Shore-line Development, 70
Johnston (Sir Harry H.), A Comparative Study of the Bantu and Semi-Bantu Languages, 129; The Flight from Cairo to the Cape: Aviation and Exploration, 632; The Prehistory of South Africa, 315
Johnston (R. M.), Proposed Memorial to the late, 117
Johnston (W. J.), A Linear Associative Algebra Suitable for Electro-magnetic Relations and the Theory of Relativity, 365
Johnstone (Prof. J.), The Extension of Territorial Waters in Relation to Deep-sea Fishing, 135
Jolibois (P.), A New Method of Physico-chemical Analysis of Precipitates, 523
Joly (Prof. J.), A Photoelectric Theory of Colour Vision, 74; Relativity and Radio-activity, 468; Scientific Signalling and Safety at Sea, 41; and J. H. J. Poole, Reversed Pleochroic Haloes, 92
Jones (Prof. Bryner), Results of Breaking Up Grassland in 1918, 98
Jones (B. M.), elected Professor of Chemistry in the University College of Wales, Aberystwyth, 186; elected to the Francis Mond Professorship of Aeronautical Engineering in Cambridge University, 107
Jones (Chapman), Progress of Photography, 251
Jones (Dr. D. W. Carmalt), appointed Professor of Systematic Medicine in Otago University, 490
Jordan (Dr. A. C.), X-rays in Medical Science, 237
Jourdain (P. E. B.), [obituary], 117
Jutson (J. T.) Dust-whirls in Sub-arid Western Australia, 619; Rock Expansion by Temperature Variation in Sub-arid Western Australia, 108; The "Clawing" Action of Rain in Sub-arid Western Australia, 108
Jutson and Simpson, The Geology of Albany, 579

Kaye (G. R.), Ancient Hindu Spherical Astronomy, 119
Kaye (Dr. G. W. C.), Industrial and Medical Radiology, 696
Keeble (Dr. F. W.), elected Sherardian Professor of Botany in Oxford University, 426
Keeling (Lt.-Col. B. F. E.), [obituary article], 317
Keen (B. A.), Forecasting Frosts, 450
Keilin (Dr. D.), The Larval Structure and Life-history of *Melinda cognata*, Meig., 399
Keith (Prof. A.), Life and Work of Sir Francis Galton, 670; Menders of the Maimed: The Anatomical and Physiological Principles underlying the Treatment of Injuries to Muscles, Nerves, Bones, and Joints, 493; Nationality and Race from an Anthropologist's Point of View, 476; Presidential Address to the Anthropology Section of the British Association, 36; 301; Race and Nationality from an Anthropological Point of View, 344; Race and Personality, 311
Keltie (Sir John Scott), Progress of Geography, 249; and Dr. M. Epstein, The Statesman's Year Book, 1919, 152
Kennelly (Prof. A. E.), and E. Velander, A New Form of Rectangular Component Alternating-current Potentiometer, 42
Kenoyer (L. A.), The Dimorphic Female Flower of *Acalypha indica*, 297
Kerr (Prof. J. Graham), Text-book of Embryology. Vol. ii., Vertebrata with the Exception of Mammalia, 309
Kerr (W.), appointed Research Assistant in Mechanical Engineering at the Glasgow Technical College, 19
Kidston (Dr. R.), and Prof. W. H. Lang, Old Red Sandstone Plants showing Structure from the Rhynie Chert Bed, Aberdeenshire. Part iii., 458; The Petrified Plants from the Silicified Peat-bed in the Old Red Sandstone of Rhynie, 641
King (Prof. L. W.), H. R. Hall, 27
King (W. B. R.), appointed Assistant to the Professor of Geology in Cambridge University, 364; Geological Work on the Western Front, 476
Kingzett (C. T.), Suggestion for the Analysis of Air obtained at High Altitudes, 540

Kitson (A. E.), Discovery of Diamonds in the Gold Coast, 485
Kling (A.), and D. Florentin, The Production of Carbon Monoxide in Flames of Different Gases, 618; A. Lassieur, and R. Schmutz, The Preparation of Chloromethylchloroformates, 459; and E. Jacob, The Properties of the Chlorinated Methyl Carbonates, 683
Knibbs (G. H.), The Organisation of Imperial Statistics, 551
Knott (Dr. C. G.), elected President of the Scottish Meteorological Society, 444; The Propagation of Earthquake-waves through the Body of the Earth, 477; and Miss Dallas, Magnetic Strains in Nickel-steel Tubes, 715
Kohn-Abrest (E.), Aluminium Spontaneously Oxidisable in the Air, 618
Kopaczewski (W.), and Mme. Z. Gruzewska, Seric Toxicity and the Physical Properties of Colloidal Gels, 651
Koppen (W.), Proposed Alterations in the Classification of Climates, 418
Kunz (Dr. G. F.), The Production of Precious Stones in 1919, 610
Kustner (Prof.), Barnard's Proper-motion Star, 420
Kuwada (Y.), The Origin of Maize, 639

Lacroix (A.), Mineralogical and Chemical Constitution of the Volcanic Lavas of Tibesti, 68
Laing (Miss M. E.), appointed Research Assistant in Physical Chemistry at Bristol University, 306
Laird (T. P.), appointed Professor of Accounting and Business Method in Edinburgh University, 425
Lake (P.), appointed Reader in Geography in Cambridge University, 364
Laman (Dr. K. E.), Return from the Congo with Ethnographical Material, 177
Lang (Prof. W. H.), *Hornea Lignieri*, 367
Lankester (Sir E. Ray), Completion of Fifty Years' Editorship of the *Quarterly Journal of Microscopical Science*, 295; International Relations in Science, 172; Parasitic Amœbæ and Disease, 369; The Foundation of Biological Sciences, 198
Lapicque (L.), Seasonal Variation in the Chemical Composition of Marine Algæ, 618
La Porte (F.), Atmospheric Observations at Gâvre by Means of Free Rubber Balloons, 715
Lapsley (Dr. G.), and others, The America of To-day. Being Lectures delivered at the Local Lectures Summer Meeting of the University of Cambridge, 1918, 151
Lapworth (Prof. A.), and L. K. Pearson, The Direct Replacement of Glycerol in Fats by Higher Polyhydric Alcohols, 399
Larmor (Sir Joseph), Determination of the Strengths of the Sources of a Disturbance Propagated into a Medium, 419; Generalised Relativity, in connection with Mr. W. J. Johnston's Symbolic Calculus, 365; Gravitation and Light, 412; 530
Lartigne (A.), A New Form for the Formulæ of Line Spectra, 387
Lauder (Prof. A.), Agriculture at the British Association, 553
Laufer (Dr. B.), The "Flying Gallop" in Art, 114
Launay (L. de), The Mineral Resources of Alsace-Lorraine, 640
Laurie (Dr. R. D.), Eugenics Education in the Training College, and Eugenics Education in the School, 513
Law (Bonar), and others, Gift to Glasgow University, 325
Lawrence (Col. T. E.), elected to a Research Fellowship at All Souls College, Oxford, 306
Lawson (R. W.), Displacement of Spectral Lines, 565; Entente Scientific Literature in Central Europe during the War, 436; The Doubly Refracting Structure of Silica Glass, 335
Layard (Nina F.), Remains of a Fossil Lion in Ipswich, 413
Lea (A. M.), New Species of Australian Coleoptera. Part xv., 555
Learmonth (Rear-Admiral F. C.), appointed Hydrographer of the Navy, 77
Lebour (Dr. Marie), The Food of Larval and Post-larval Fishes, 457
Lecat (Dr. M.), Pensées sur la Science, la Guerre et sur des Sujets très Variés, 689
Le Chatelier (H.), and B. Bogitch, Refractory Properties of Aluminous Materials, 128
Ledoux-Lebard and Dauvillier, The Fundamental Constants of the Spectrometry of the X-rays, 347
Lees (Prof. C. H.), The Liquefaction of Gases, 247; The Temperature of the Earth's Interior, 713
Lees (Dr. D.), appointed Lecturer on Venereal Diseases in Edinburgh University, 425
Lefroy (Prof. H. Maxwell), and E. C. Ansorge. Report on an Inquiry into the Silk Industry in India. Three vols., 471
Legendre (J.), The Food of *Eleotris Legendrei*, 347
Leiper (Prof. R. T.), awarded the Straits Settlement Gold Medal, 540; Work of, 572
Leishman (Major-Gen. Sir W.), Protective Inoculation against Influenza in the Army, 703
Lelean (Lt.-Col. P. S.), Defensive Science in Gas Warfare, 646
Lemoigne (M.), A Specific Reaction of 2:3-Butyleneglycol and of Acetyl-methylcarbinol, 651
Lenney (C. W.), Bequest by, to Boston University, 167
Le Souef (Dr. W. H. D.), The More Important Indigenous Mammals of Australia, 297
Lester-Garland (L. V.), A Revision of the Genus Baphia, Afzel, 346
Leupp (F. E.), George Westinghouse: His Life and Achievements, 592
Leuschner (Prof.), Metcalf's Comet, 12
Lever Bros. (Ltd.), Cattle Food Calendar, 119
Lewis (Dr. T.), awarded the W. J. Mickle Fellowship of London University, 426
Lewis (Prof. W. C. McC.), Physical Chemistry, 3
Lightfoot (G.), Engineering Standardisation, 447
Lincoln (Prof. A. T.), Text-book of Physical Chemistry, 3
Lindemann (Prof. A. F.), Relativity, 401; 632
Lippincott (Dr. W. A.), The Blue Andalusian Fowl, 81
Lister (G.), The Mycetozoa: A Short History of their Study in Britain; an Account of their Habitats Generally, and a List of Species Recorded from Essex, 332
Lister (Lord), Proposed Memorial to, in Edinburgh, 507; Unveiling of Tablets at University College in Memory of, 322
Little (A. D.), The Paper-making Qualities of Hawaian Bagasse, 341
Lloyd (Dr. L. L.), appointed Head of the Department of Dyeing of the Bradford Technical College, 345
Lock (C. N. H.), elected a Fellow of Gonville and Caius College, Cambridge, 616
Lockyer (Sir Norman), Valedictory Memories, 189; (Dr. H. Deslandres), 191
Lodge (Sir Oliver J.), Æther and Matter: Being Remarks on Inertia and on Radiation, and on the Possible Structure of Atoms, 15; Æther and Matter, 82; Æther, The, *versus* Relativity, 543; A Photoelectric Theory of Colour Vision, 92; Atomic Energy, 435; Einstein's Theory, 377; Gravitation and Light, 334; 354; 372; Relativity, 339; 400; Retirement of, 483; Sources of Power Known and Unknown, 397; Sources of Energy, The Need of Encouragement of Scientific Research, 75; The Theory of Vision, 454; The Utilisation of Atomic Energy, 420
Loeb (Prof. J.), Amphoteric Colloids, 15; elected an Honorary Member of the Royal Institution, 358; The Sex of Frogs Developed from Parthenogenetic Eggs, 81
Loisel (P.), The Radio-activity of the Water from the Large Spring at Bagnoles-de-l'Orne and its Variations, 347
Loisy (E. de), The Synthetic Production of Alcohol or Ether, Starting with Coal-gas, 650
Lomas (E. K.), The Educational Aspects of Geography, 517
Longo (Carlotta), The Elementary Electrostatic Law according to Einstein's Theory, 552
Lossky (Prof. N. O.), The Intuitive Basis of Knowledge, Translated by N. A. Duddington, 110
Louis (Prof. H.), British Iron Ores, 429; 565
Loveday (Prof. T.), appointed Principal of Southampton University College, 585
Lovell (J. H.), The Flower and the Bee; Plant Life and Pollination, 132

Low (Capt. J. W.), appointed Assistant in the Natural History Department, University College, Dundee, 712
Lowe (E. E.), The Taking over of Local Museums by the Board of Education, 703
Lowe (Capt. P. R.), appointed Assistant in Charge of the Bird Room of the Natural History Museum, 340
Lowe (W.), Zoological Mission to the West Coast of Africa, 507
Lubs (H. A.), The Preparation of *p*-Aminocarvacrol and its Use as a Developing Agent in Photography, 79
Lucas (Sir C. P.), Islands as Centres of Preservation of Human Diversities, etc., 514
Lumière and Seyewetz, A Simplified Method for the Development of Autochrome Plates, 137
Lundahl (C. F.), Distances of the Stars of Type F, 479
Lyde (Prof. L. W.), Holland and International Rivers, 332; Presidential Address to the Geography Section of the British Association, 38; 141
Lydekker (R.), Wild Life of the World: A Descriptive Survey of the Geographical Distribution of Animals. Three vols., 69
Lyell of Kinnordy (Lord), Gift of Books on Geology to the Geology Department of Edinburgh University, 425
Lyman (Prof. T.), A Helium Series in the Extreme Ultra-Violet, 314; 565
Lynes (Capt. H.), Zoological Expedition to Darfur, 507
Lyons (Col. H. G.), Lt.-Col. B. F. E. Keeling, 317
Lyster (Dr. C. R. C.), Retirement from the Position of Head of the Electro-therapeutic Department of the Middlesex Hospital, 358; [obituary], 572

Macalister (Prof. A.) [death], 8; [obituary article], 26
Macassey (Sir L.), The Economic Future of Women in Industry, 9
Macfadyen (Lt. W. A.), An Aspect of Electrolytic Iron Deposition, 523
Macfarlane (A.), Lectures on Ten British Physicists of the Nineteenth Century, 561
Macfarlane (Prof. J. M.), The Causes and Course of Organic Evolution: A Study in Bioenergics, 149
Mackenzie (K. J. J.), re-appointed Reader in Agriculture in Cambridge University, 425
Mackie (Miss), Discovery of a Faint Nova, 119; Nova in Lyra, 704
Mackintosh (J.), The Outlook in Dairying, 554
Macleod (Prof. J. J. R.), assisted by Dr. R. G. Pearce and by others, Physiology and Biochemistry in Modern Medicine, 389
Macloskie (Prof. G.), [obituary], 540
Macmillan (George A.), Retirement of, from the Honorary Secretaryship of the Society for the Promotion of Hellenic Studies, 319
Macmurray (J.), appointed Lecturer in Philosophy in Manchester University, 19
Macpherson (Rev. H.), Herschel, 561
MacBride (Prof. E. W.), The Artificial Production of Echinus Larvæ with a Double Hydrocœle, 456
MacMahon (Major P. A.), awarded the Sylvester Medal of the Royal Society, 295; 363
McBain (Capt. J. W.), appointed Professor of Physical Chemistry in the University of Bristol, 167; and C. S. Salmon, Colloidal Electrolytes, Soap Solutions and their Constitution, 712
McCarrison (Lt.-Col. R.), Genesis of Œdema in Beri-beri, 345
McCaughey (Sir Samuel), Bequests by, 107 127
McClelland (J. A.), and A. Gilmour, The Electric Charge on Rain, 682
McCollum (Prof. E. V.), The Newer Knowledge of Nutrition: The Use of Food for the Preservation of Vitality and Health, 527
McDougall (Dr. W.), elected President of the Society for Psychical Research, 608; appointed Professor of Psychology in Harvard University, 186
McIntosh (Prof. W. C.), Sea-fishery Investigations and the Balance of Life, 49
McKay (R. F.), The Paravane or Otter, 487
McKelvy (E. C.), [obituary], 507
McKendrick (Major A. G.), Statistics of Valour and Service, 660
McLachlan (Dr. N. W.), An Experimental Method of Determining the Primary Current at Break in a Magneto, 366; Effect of Pressure and Temperature on a Meter for Measuring the Rate of Flow of a Gas, 325
McLean (Prof. R. C.), Sex and Soma, 407
McLennan (E.), The Endyphytic Fungus of Lolium, 619
McLennan (Prof. J. C.), Resignation of the Post of Scientific Adviser to the Board of Admiralty, 340
McMichael (L.), elected Hon. Secretary of the Wireless Society of London, 8
Maiden (J. H.), Notes on Acacias. No. iv., 587; The Coloration of the Young Foliage of Eucalyptus, 555; Two New Western Australian Species of Eucalyptus, 168
Maitland (Gibb), The Nullagine Formation, 579
Makower (Dr. W.), and Dr. H. Geiger, Traduit de l'Anglais par E. Philippi, Mesures Pratiques en Radioactivité, 626
Mallock (A.), Temperature in the Sun, 113
Mann (E. A.), and T. N. Kirton, Inertness in Industrial Explosives, 647
Maquenne (L.), and E. Demoussy, Distribution and Migration of Copper in the Tissues of Green Plants, 65; The Richness in Copper of Cultivated Soils, 407
Marbonne (E. de), The Geographical Unity of Syria, 97
Marconi (Mr.), Mysterious Interruptions in Wireless Operations, 571
Marett (Dr. R. R.), Recent Excavations in Jersey, 487
Margerie (E. de), appointed Director of the Geological Survey of Alsace and Lorraine, 157
Marr (Prof. J. E.), The Pleistocene Deposits Around Cambridge, 386
Marsh (S.), Alternating-current Electrolysis, 617
Marshall (Rev. E. S.), [obituary], 377
Marshall (Dr. F. H. A.), appointed Reader in Agricultural Physiology in Cambridge University, 364
Marshall (J.), An Unnoticed Point in the Theory of Newton's Rings, 714
Martin (Dr. C. J.), Preventive Medicine since 1869, 210
Martin (E. A.), Antiquity of the Genus Dolium, 446
Martin (L. C.), A New Form of "Daylight" or Colour-matching Lamp, 358; and others, Colour-matching by Natural and Artificial Light, 610
Marvin (F. S.), The Century of Hope. A Sketch of Western Progress from 1815 to the Great War, 130
Masó (Rev. M. S.), Catalogue of Philippine Earthquakes for 1918, 98; Eruptions of the Bulusan Volcano in 1916, 1918-19, 99
Mason (T. G.), Electrolytes in the Leaf-sap of *Syringa vulgaris*, 427
Massingham (H. J.), Promotion of a Plumage Bill, 413
Massy (Miss Anne L.), The Holothurioidea of the Coasts of Ireland, 555
Masters (F. H.), appointed Editor of the *Electrician*, 266
Mathews (R. H.), Dyer-va-val Initiation Ceremony amongst the Birdhawal Tribe, 40
Matignon (C.), and Mlle. G. Marchal, Some Properties of Sodium Nitrite, 683; and E. Monnet, The Reversible Oxidation of Sodium Nitrite, 683
Matthews (Prof. E. R.), Studies in the Construction of Dams: Earthen and Masonry, 434
Matthews (R. B.), The Aviation Pocket-book for 1919–20. Seventh edition, 562
Mauguin (Ch.), and L. J. Simon, Cyanogen Chloride, 88; Preparation of Cyanogen Chloride by Held's Method, 44
Maurain (Ch.), The Wind Velocity in the Stratosphere, 618
Mavor (G.), appointed Lecturer in Mechanical Engineering at the Loughborough Technical College, 67
Maxwell (Sir Herbert), Change of Colour in Captive Birds, 693; The Hibernation of the House-fly, 435
Mazé (P.), M. Vila, and M. Lemoigne, Action of Cyanamide and Dicyanodiamide on the Development of Maize, 347; The Transformation of Cyanamide into Urea by the Micro-organisms of the Soil, 387
Meadowcroft (L. V.), The Theorems of Lambert and Adams on Motion in Elliptic and Hyperbolic Orbits, 427
Meares (J. W.), Hydro-electric Survey of India. Preliminary Report on the Water-power Resources of India, 363; The General Principles of the Development and Storage of Water for Electrical Purposes, 161

Medley (Mrs. M. L.), Bequest to the University of Oxford, 325
Meek (C. F. U.), A Further Study of Chromosome Dimensions, 426
Meigh (E.), The Glass Research Association, 299
Mellor (Dr. E. T.), awarded the Consolidated Gold Fields of South Africa, Ltd., Premium by the Institution of Mining and Metallurgy, 573
Melvin (Dr. G. S.), appointed Professor of Physiology in Queen's University, Kingston, Ontario, 19
Mercier (Dr. C.), A Manual of the Electro-Chemical Treatment of Seeds, 562; [death], 8; [obituary article], 50
Merrill (Prof. E. D.), Identity of *Polypodium spinulosum*, Burm. f., 20
Merton (Dr. T. R.), The Secondary Spectrum of Hydrogen; The Spectra of Isotopes, 406; The Spectra of Isotopes, 93
Mesnager (M.), Method of Determination of the Internal Strains Existing in a Circular Cylinder, 618
Metcalf (M. M.), The Salpidæ, 40
Miall (Dr. S.), Plotting the Atomic Weights of the Elements against their Atomic Numbers, 704
Michelson (Dr. A. A.), and H. G. Gale, The Rigidity of the Earth, 114; Tides in Pipes, 705
Michkovitch (M.), Observation of Finlay's Periodic Comet made at the Marseilles Observatory, 387
Micklethwait (Miss F. M. G.), appointed Principal of Swanley Horticultural College, 490
Middleton (Sir Thomas), Food Production in England, 553
Miers (Sir Henry A.), appointed a Member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, 178; elected President of the Manchester Literary and Philosophical Society, 340; The Future of the Manchester Literary and Philosophical Society, 326; Variation of Refractive Indices, 334
Mill (Dr. H. R.), and M. de Carle S. Salter, British Rainfall, 1918, 411
Millar (H.), Change of Colour in Plumage of Captive "Sunbirds," or "Honey-suckers," 600
Miller (Dr.), The Pre-Cambrian Rocks of Central Canada, 485
Miller (H. W.), Descriptive Geometry. Fourth edition, 169
Miller (Dr. I. E.), Education for the Needs of Life: A Text-book in the Principles of Education, 169
Miller (J. M.), Connection between the Input Impedance of the Valve and the Load in the Plate Circuit, 510
Millikan (Dr. R. A.), elected an Honorary Member of the Royal Institution, 358
Mills (J.), The Realities of Modern Science, 625
Milne (R. M.), Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, and Papers in Elementary Engineering for Naval Cadetships for the years 1909–18, 626
Milne (Prof. W. P.), The Mathematical Association, 550; and G. J. B. Westcott, A First Course in the Calculus. Part i., Powers of X, 109
Milsum (J. N.), Fruit Culture in Malaya, 78
Mirande (R.), Alum Carmine and its Use, Combined with Iodine Green in Plant Histology, 683
Mitchell (J.), Two New Trilobites from Bowning, N.S.W., 271; Some Additional Trilobites from N.S.W., 587
Mitchell (Dr. P. Chalmers), Passenger and Observer on the Aeroplane Flying from Cairo to Cape Town, 607
Moir (J.), Colour and Chemical Constitution. Part ix., 491
Moir (J. Reid), Humanly Fashioned Flints in the Middle Glacial Gravel at Ipswich, 508; The Antiquity of Man, 335; and others, Pre-History of Man in Britain. Flint Implements from the Chalky Boulder Clay of Suffolk, 706
Molteno (P. A.), Gift for an Institute of Parasitology at Cambridge University, 305
Monaco (Prince of), Stray Mines in the North Atlantic, 187; The Oceanographic Study of the Mediterranean, 450
Moncton (H. W.), The Flora of the District of the London Clay, 520
Mond (R.), Gift to the Royal Institution, 296
Mond (R. L.), and C. Heberlein, Chemistry of "Burgundy Mixture," 82
Montgomery (Mr.), The Plateau of Western Australia, 579
Moore (Prof. B.), Colloid and Saline in Shock and Cholera, 131
Moore (Dr. G. E.), External and Internal Relations, 490
Moore (H.), Future Supplies of Motor Fuel, 554
Moreno (Dr. F. P.), [obituary], 508
Morgan (Prof. C. Lloyd), Eugenics and Environment, 351
Morgan (Prof. G. T.), Applied Chemistry in Relation to University Training, 147; to deliver the Streatfeild Memorial Lecture, 78
Morgan (Sir Herbert E.), and others, Need of the Country for Educated Men in directing Business Affairs, 522
Morgan (J. D.), Principles of Electric Spark Ignition in Internal-combustion Engines, 372
Morgan (P. G.), The Organisation and Functions of a State Geological Survey, 517
Morgan (Prof. T. H.), The Secondary Sexual Characters of Poultry, 159
Morris (Sir Daniel), Presidential Address to the Botany Section of the British Association, 37, 381
Mortensen (Dr. Th.), The Use of the Word "Anlage," 357; To Lead an Expedition to Celebes and other Places, 78
Moseley (H. G. J.), Scientific Work of the late, 444
Moureu (C.), and C. Dufraisse, The Stabilisation of Acrolein, 307; P. Robin, and J. Pougnet, The Stabilisation of Acrolein, 650; and A. Lepape. The Stabilisation of Acrolein, 326, 387; and G. Mignonac, The Dehydrogenation of the Primary and Secondary Alcohols by Catalytic Oxidation, 715
Moulton (H. Fletcher), The Einstein Theory and Spectral Displacement, 532
Moulton (Rt. Hon. Lord), Science and War: The Rede Lecture, 1919, 352
Murray (Prof. Gilbert). An Amendment to the Responsions Statute moved by, in Congregation of Oxford University and Lost, 364
Murray (J. Alan), The Classification of Cattle Foods, 553
Muscio (B.), Lectures on Industrial Psychology. Second edition, revised, 687
Mustawfī (Hamd-Allāh), The Geographical Part of the Nuzhat-Al-Qulūb, translated by G. Le Strange, 112
Mutch (Dr. N.), The Isolation of a Single Bacterial Cell, 446
Myers (F. W. H.), Human Personality and its Survival of Bodily Death. Edited and abridged by S. B. and L. H. M., 595
Myres (Prof. J. L.), elected General Secretary of the British Association, 52; Excavations on Sites in Cyprus in 1913, 487

Naser (Dr. V.), Proposals for an Exchange of Students between Denmark and Great Britain, 522
Nathan (Col. Sir Frederic), appointed Power Alcohol Investigation Officer under the Fuel Research Board, 540
Nathan (R.), promoted to K.C.S.I., 443
Nethersole (Sir Michael) [obituary], 607
Newell (R. L.), appointed Demonstrator in Anatomy in Manchester University, 19
Newnham (E. V.), Examples of Katabatic Wind in the Valley of the Upper Thames at the Aerological Observatory at Benson, Oxon., 675
Newsholme (Sir Arthur), and others, Influenza, 275
Newton (Dr. A. P.), appointed Professor of Imperial History in London University, tenable at King's College, 425
Nicholas (T. C.), appointed Demonstrator in Geology in Cambridge University, 364
Nichols (Prof. E. L.), elected General Secretary of the American Association, 613
Nichols (Dr. W. H.), Research and its Application, 262
Nicholson (Prof. J. W.), The Lateral Vibrations of Sharply Pointed Bars, 713
Nicholson (S. B.), The Sun-spot Curve, 160
Nicolardot (P.), The Action of Reagents upon Glass-powder, 20
Nicoll (Prof. M.), appointed Harben Lecturer of the Royal Institute of Public Health, 376
Nicolle (M.), E. Debains, and E. Césari, The Mutual Precipitation of Toxins and their Antitoxins, 619

Nierenstein (Dr. M.), The Colouring Matter of the "Red-pea Gall," 707
Niven (Prof. W.), Stone and Terra-cotta Remains found in the Neighbourhood of the City of Mexico, 9
Normand (Lieut. C. W. B.), Effect of High Temperature, Humidity, and Wind on the Human Body, 366
Norris-Rogers (L. N.), Mirage Effects, 630
North (F. J.), Syringothyris, Winchell, and certain Carboniferous Brachiopoda referred to Spiriferina, D'Orbigny, 586
Noyes, jun. (W. A.), Polarisation in Iron Solutions, 683; The Potential Necessary for Electrolysing Solutions of Iron, 407
Nuttall (Prof. G. H. F.), Lice and their Relation to Disease, 456

Oakesmith (Dr. J.), Race and Personality: An Inquiry into the Origin and Growth of Patriotism, 311
Ogilvie (A. G.), appointed Reader in Geography in Manchester University, 19
Ogilvie (Dr. F. G.), The Use of the Science Museum, South Kensington, 397
Okada (Prof. T.), Weather Forecasting in Japan, 509
Olivier (C. P.), and Van Maanen and Sanford, The Parallax of Nova Aquilæ, 1918, 160
Olsen (Dr. O), to Conduct an Expedition to Siberia, 158
O'Neill (J. J.), Platinum in Canada, 574
Onslow (H.), A Periodic Structure in many Insect Scales, and the Cause of their Iridescent Colours, 649
Oppermann (A.), Premiers Eléments d'une Théorie du Quadrilatère Complet, 169
Ormerod (Miss Eleanor Anne), A Memorial Tablet to, at St. Albans, 638
Orton (Dr. J. H.), Sex-phenomena in the Common Limpet (*Patella vulgata*), 373
Osborne (Prof. H. F.), Portrait of, presented to the Sedgwick Museum, Cambridge University, 385
Osler (Sir William), [death], 443; [obituary article], 472
Owen (J. H.), The Nesting Habits of the Sparrow Hawk, 178
Owen (M. N.), A Fungus Disease of Potato-tubers, 341
Owen (W. D.), Guide to the Study of the Ionic Valve: Showing its Development and Application to Wireless Telegraphy and Telephony, 332
Oye (Dr. P. van), The Chætognatha found in Plankton taken off the North Coast of Java, 446

Page (L.), Gravitational Deflection of High-speed Particles, 692
Pairman (E.), Tables of the Digamma and Trigamma Functions, 341
Palatini (Dr. A.) La Teoria di Relatività nel suo sviluppo storico, 552; Traiettorie dinamiche dei sestemi olonomi con tre gradi di libertà, 552
Palmer (Capt. A. R.), "The White Water," 563
Palmer (G. W.), [obituary], 136
Paneth (Dr. F.), appointed Professor of Chemistry in Hamburg University, 426
Parkinson (T. W. F.), Plea for the Encouragement of Geography in the Higher Forms of Secondary Schools, 514
Parmelee (Dr. M.), Criminology, 687
Parmentier (P.), Irrigation in Syria and Palestine, 44
Parry (E.), The Interference of Power Circuits with Telephone Circuits, 517
Parry (Rear-Admiral Sir John F.), Retirement of, as Hydrographer of the Navy, 77
Parsons (Hon. Sir Charles A.), Presidential Address to the British Association, 28; Researches at High Temperatures and Pressures, 677; 700
Parsons (Prof. F. G.), Racial Characters of the Modern Briton, 487; Results of an Anthropological Examination of German Prisoners of War, 475
Paton (Prof. D. Noël), Presidential Address to the Physiology Section of the British Association, 39, 322
Peake (H.), Origin and Relation of the Nordic and Mongoloid Elements in the Finnic Population, 487
Pear (Prof. T. H.), The Elimination of Wasteful Effort in Industry, 387
Pearce (R.), Donation to the Royal Institution, 296
Pearl (Prof. Raymond), Analysis of the Mortality Statistics of the American Influenza Epidemic of 1918, 509
Pearson (Prof. Karl), A Method of Generalising Tchebycheff's First Theorem, 580
Peary (Rear-Admiral R. E.), [obituary article], 699
Pease (F. G.), Lunar Photography with the 100-in. Reflector, 511
Peddie (Prof. W.), The Adequacy of the Young-Helmholtz Theory of Colour-vision and Colour-blindness, 715; The Quaternionic System as the Algebra of the Relations of Physics and Relativity, 715; The Atomic Space Lattice in Magnetite, 714
Peel (T.), Examples in Heat and Heat Engines, 690
Peet (T. E.), appointed Professor of Egyptology in Liverpool University, 425
Péringuey (Dr. L.), Bushmen Engravings, 44
Perrett (W.), Some Questions of Phonetic Theory, Chap. v., The Perception of Sound, 591
Perrine (C. D.), Aphelia of Planets and Comets, 343
Perry (Sir Cooper), appointed Principal Officer of the University of London, 344
Perry (W. J.), The Historical Process, 490
Petavel (Prof. J. E.), appointed Director of the National Physical Laboratory, 8; Presidential Address to the Engineering Section of the British Association, 38, 181
Peters (Prof. C. A.), The Preparation of Substances Important in Agriculture. Third edition, 497
Pézard (A.), Alimentary Castration in Cocks submitted to an exclusively Carnivorous Diet, 523
Philip (A.), Some Laboratory Tests on Mineral Oils, 298
Philip (Prof. J. C.), Physical Chemistry—Past and Present, 223
Phillips (Dr. H. B.), Differential and Integral Calculus, 109
Picart (L.), and F. Courty, Observations of the Metcalf and Borrelly Comets, 128
Pickard (Dr. R. H.), appointed Principal of Battersea Polytechnic, 325
Pickering (S.), Mirage Effects, 630; Radiation Temperatures, 153; The Explosion at Bailleul, 5
Pickering (Prof. W. H.), Lunar Studies, 544; The Birth of the Moon, 479; The Harvard Observatory at Mandeville, Jamaica, 138; The Orion Nebula, 448
Pictet and Potok, The Distillation of Sodium Stearate and Sodium Oleate, 360
Pilcher (R. B.), The Profession of Chemistry, 409
Pirsson (Prof. L. V.) [obituary], 443
Plimmer (Dr. R. H. A.), appointed Head of the Biochemical Department of Craibstone Animal Nutrition Research Institute, 127
Planck (Prof. M.), awarded the Nobel Prize of 1918 for Physics, 318
Playfair (G. I.), Peridineæ of N.S.W., 587
Poincaré (L.), Speech at the Opening of the British Bureau of the Office National des Universités et Ecoles Françaises, 712
Poincaré (President), installed as Rector of Glasgow University; the Honorary Degree of LL.D. conferred upon, by Glasgow University, 324; Gift to Glasgow University, 325; Welcome to London, 295
Pole-Evans (Dr. I. B.), appointed Director of the Botanical Survey of the Territories included in the Union of South Africa, 607
Pope (Sir William J.), The Photography of Coloured Objects, 346; The Position of Chemistry in Germany and this Country as a Result of the War, 455
Porter (Prof. A. W.), The Vapour Pressure of Binary Mixtures, 523
Porter (Mrs. L.), Floral Development in *Tricuspidaria lanceolata*, 346
Portevin (M.), Influence of various Factors on the Creation of Internal Longitudinal Strains during the Rapid Cooling of Steel Cylinders, 407
Prain (Sir David), elected President of the Association of Economic Biologists, 417
Preston (H.), Cost of Laboratory Apparatus, 514
Priestley (Prof.), The Phenomenon of Root-pressure, 521

Prior (Dr. G. T.), The Classification of Meteorites, 649
Proudman (Dr. J.), appointed Professor of Applied Mathematics in Liverpool University, 344
Punnett (Prof. R. C.), Mendelism. Fifth edition, 655
Purcell (Prof. P.), appointed Peat Investigation Officer under the Fuel Research Board, 540

Quilter (G. F.), Photographs of Appearances of Mirage at Ingatestone, 458

Race (J.), The Examination of Milk for Public Health Purposes, 467
Rai (Hashmat), Note on Nitrogen, 187; and H. B. Dunnicliff, The Purification of Indian Sesame ("Til") Oil, 187
Raman (Prof. C. V.), Percussion Figures in Isotropic Solids, 113; and Sivakali Kumar, Musical Drums with Harmonic Overtones, 500
Ramsay (the late Sir William), Unveiling of a Medallion Portrait of, in the University of Glasgow, 397
Ramsbottom (E. N.), elected to a Research Fellowship in Manchester University, 19
Ranken (Dr. C.), Industrial Chemistry, 497
Rankine (Prof. A. O.), Telephoning by Light, 604
Rasmussen (K.), Exploration of Northern Greenland, 453
Rawlins (F. I. G.), Report on the Collection of Metallurgical Specimens presented to the Royal Microscopical Society by Sir Robert Hadfield, 406
Rawlley (R. C.), The Silk Industry and Trade, 591
Raworth (B. A.) [obituary], 135
Rawson (Col. H. E.), Plant-sports produced at will, 346
Ray (S. H.), Australian Signposts, 643; Unexplored Papua, 663
Rayleigh (Lord), Polarisation of Light Scattered by Helium Atoms, 412; Scattering of Light by Resonating Molecules, 276; The Doubly Refracting Structure of Silica Glass, 153
Read (Sir C. Hercules), An Ancient Chinese Bronze, 574
Reader (T. W.), awarded the Foulerton Award of the Geologists' Association, 397
Redmayne (Sir Richard), Resignation of the Chief Inspectorship of Mines, 376
Reed (W. G.), Frost and the Growing Season, 95
Regan (C. Tate), and others, The Distribution of Freshwater Fishes, 456
Reid (J. H.), The Charters Towers Goldfield, 515
Reisner (Prof. G. A.), Discovery in the Nile Valley of a Horse Cemetery, 702
Rendle (Dr. A. B.), Organisation of Scientific Work, 691
Rey (J.), The Characteristic of a Lighthouse at the Horizon, 271
Reynolds (Prof. J. Emerson) [death], 701
Reynolds (J. H.), Fifty Years of Technical Education, 257
Riccò (Prof. A.), Heliographic Latitudes of the Solar Protuberances (1880–1918), 187; [obituary], 378
Rice (J.), The Predicted Shift of the Fraunhofer Lines, 598
Richards (Prof. T. W.), elected President of the American Academy of Arts and Sciences, 116
Richardson (L. F.), The Deflection of Light during a Solar Eclipse, 393
Richet (Prof. C.), Injections of Gum or of Plasma after Bleeding, 491; La Sélection Humaine, 351
Rideal (E. K.), Conferment of Doctorate upon, by the University of London, 185; and Prof. H. S. Taylor, Catalysis in Theory and Practice, 463
Ridewood (Dr. W. G.), Cephalodiscus, 481
Ridgeway (Sir William), A Remarkable Irish Bronze Axe, 445; The Colours of Racehorses, 334
Rigg (T.), appointed Agricultural Chemist at the Cawthorn Research Institute, 442
Rintoul and Baxter (The Misses), Report on Scottish Ornithology for 1918, 10
Roaf (Dr. H. E.), appointed Professor of Physiology at the London Hospital Medical College, 616; Pathology of Pellagra, 520
Robb (Dr. A. A.), The Straight Path, 509
Robbins (Prof. W. W.), The Botany of Crop Plants, 46
Roberts (Prof. M. M.), and Prof. J. T. Colpitts, Analytic Geometry, 390
Robertson (C. Grant), appointed Principal of Birmingham University, 425; Welcomed as Principal of Birmingham University, 615
Robertson (Dr. G. M.), appointed Professor of Psychiatry in Edinburgh University, 425
Robin (P.), The Peroxide of Benzaldoxime, 307
Robinson (Capt. J.), Directive Wireless Telegraphy as Applied to Aircraft, 487; Wireless Navigation for Aircraft, 24
Robinson (W.), Microscopical Features of Mechanical Strains in Timber, etc., 345
Robson (F.), The Seashore: Its Inhabitants and How to Know Them, 132
Rockefeller (J. D.), Gift to the General Education Board, 158; Further Gift to the Rockefeller Institute, 267; Large Gift for Education and Science, 457
Rogers (Sir Leonard), Intravenous Injections of Gum Solutions in Cholera, 73
Rohlfs (R.), A High Aeroplane Altitude, 63; A Record Aeroplane Ascent, 77
Rohr (Prof. von), Optical Systems and the Graphical Methods of Determining Images, 704
Rolleston (Dr.), The Epidemiology, Symptoms, and Treatment of Cerebro-spinal Fever, 359
Rolleston (Sir Humphry Davy), Gifts to the Royal Institution, 296
Ross (E.), The Climate of Liberia and its Effect on Man, 136
Ross (Sir E. Denison), Report of the Calcutta University Commission, 537
Ross (Prof.), National Scientific Organisation and Education, 578
Ross (Sir Ronald), Work for the National Union of Scientific Workers, 297
Ross (R.), Mirage Effects, 662
Roubaud (E.), Antagonism of Cattle and Man in the Blood Nutrition of *Anopheles maculipennis*, 88
Round (Capt. H. J.), Radio Direction and Position Finding, 576
Roussy (G.), J. Boisseau, and M. d'Œlsnitz, Traitement des Psychonévroses de Guerre, 22
Roux (Prof. E.), awarded the Oliver Sharpey Prize by the Royal College of Physicians, 608
Roux (Dr. P. B. E.), elected an Honorary Member of the Royal Institution, 358
Runner (G. H.), The Tobacco Beetle: An Important Pest in Tobacco Products, 301
Running (Prof. T. R.), Empirical Formulas, 109
Russ (Dr. S.), elected President of the Röntgen Society, 96
Russell (A.), Occurrence of Phenakite and Scheelite at Wheal Cock, St. Just, 326
Russell (Capt. A. S.), to Edit *Discovery*, 186
Russell (Dr. E. J.), Dr. Cyril G. Hopkins, 442; Farming in the New Era, 592; The Ithaca Agricultural Experimental Station, 482; War-time and Post-war Problems of Food Production, 553
Russell (Hon. G. W.), Plea for Government Support for Science in New Zealand, 516
Russell (Prof.), The Sources of Stellar Energy, 269
Rutherford (Sir Ernest), Radium and the Electron, 226; and Dr. A. H. Compton, Radio-activity and Gravitation, 412

Sabatier (Dr. P.), elected an Honorary Member of the Royal Institution, 358; and A. Mailhe, The Catalytic Reduction of the Halogen Acetic Esters, 347
Sachs (E. O.) [obituary], 63
Saha (Megh Nad), Radiation Pressure, 448
Saillard (E.), The Nitrogen Balance in Sugar Manufacture, 651
Salter (Carle), and F. J. W. Whipple, Editors of the *Meteorological Magazine* (hitherto *Symons's Meteorological Magazine*), 608
Sampson (Prof. R. A.), Newton's Views on Gravitation, etc.; The Theory of Einstein and its Observational Tests, 458
Sanford (Prof. F.), The *ignis fatuus*, 267

Sankey (G. S.), made a K.B.E., 443
Saunders (Miss), A Graded Series of Forms in Matthiola, 521
Saunders (J. T.), Hydrogen-ion Concentration and Photosynthesis, 366
Savile (Sir Henry), The Tercentenary of the Foundation of the University Chairs of Geometry and Astronomy by, 398
Schafer (Sir E. Sharpey), Developments of Physiology, 207; The Fatal Result of Section of Both Vagus Nerves, 418
Schaumasse (A.), Observations of Finlay's Comet made at the Nice Observatory, 387
Schlesinger (Dr. F.), elected Director of the Yale Observatory, 417; Two Stars with Large Parallaxes, 342
Schnittger (Dr. B.), A Large Neolithic Graveyard found by, at Gestilren, 77
Schoeller (Dr. W. R.), and A. R. Powell, The Analysis of Minerals and Ores of the Rarer Elements for Analytical Chemists, Metallurgists, and Advanced Students, 310; Villamaninite, a New Mineral, 326
Scholes (G. E.), appointed Professor of Engineering-thermodynamics of Heat Engines, 648
Schorr (Dr.), Holmes's Comet, 704
Schott (G. A.), The Scattering of X- and Y-rays by Rings of Electrons, 365
Schuchert (Dr. C.), The Stratigraphical Position of the American Morrison and the East African Tendaguru Formations, 672
Schuster (Sir Arthur), The Deflection of Light during a Solar Eclipse, 468; The Influence of Small Changes of Temperature on Atmospheric Refraction, 714
Schwarz (Prof. E. H. L.), The Kalahari Lake Scheme, 158
Scott (Dr.), Relation of the Seed-plants to the Higher Cryptogams, 521
Seares (F. H.), Absolute Magnitude as a Function of Colour, 479
Searles (E. F.), Gift to the University of California, 67
Sebileau (Dr.), appointed Professor of Laryngology in the University of Paris, 107
Senderens (J. B.), The Catalytic Hydrogenation of Lactose, 650
Senter (Dr.), and others, The Present Position of the Theory of Ionisation in Solution, 707
Sexton (Mrs. E. W.), appointed a Ray Lankester Investigator at the Marine Biological Laboratory, Plymouth, 701
Shackleton (Sir Ernest), South: The Story of Shackleton's Last Expedition, 1914–17, 602
Shah (Ikbal Ali), The Folk-life of Afghanistan, 573
Shand (Prof. S. J.), A Rift-valley in Western Persia, 490
Shannon (Jean), The Structure of *Megascolex Fletcheri*, sp. nov., 619
Shapley (Dr.), A Nova discovered by Prof. Wolf and Prof. Barnard, 160; Open Stellar Clusters, 576; and Mrs., Stellar Clusters, 119
Sharp (H.), Seventh Quinquennial Review of the Progress of Education in India, 156
Shastri (M. H.), The Contributions of Bengal to Hindu Civilisation, 418
Shaw and Mather, The Oilfields of Allen County, Kentucky, 672
Shaw (D. M.), The Forward Protrusion and Obliquity in the Upper Incisors, etc., 136
Shaw (Dr. J. B.), Lectures on the Philosophy of Mathematics, 390
Shaw (Sir Napier), Manual of Meteorology. Part IV.: The Relation of the Wind to the Distribution of Barometric Pressure, 525; Pioneers in the Science of the Weather, 613; Presidential Address to the Educational Science Section of the British Association, 38, 401
Shaxby (Capt. J. H.), A Cheap and Simple Microbalance, 325
Sheather (A. L.), A Malaria-like Parasite found in the Blood of an Indian Buffalo, 445
Sheldon (Prof. S.), and Prof. E. Hausmann, Physical Laboratory Experiments for Engineering Students. Part I.: Mechanics, Sound, Heat, and Light, 4
Shelford (Dr. V. E.), Waste Involved in the Discharge of Domestic and Industrial Sewage into the Sea and Rivers, 78
Sheppard (S. E.), and G. Meyer, Experiments with Photographic Plates, 642
Sheppard (T.), Dane's Dyke, 445; The Hull Whaling Trade, 609
Sherrington (Prof. C. S.), Mammalian Physiology, 71
Shipley (Dr. A. E.), Resignation of the Vice-Chancellorship of Cambridge University, 126
Shipley (J. W.), The Nature of the Katmai Volcanic Gases and Encrustations, 595
Shufeldt (Dr. R. W.), Certain Cranial Sutures in the Primates, 44
Sibly (Dr. T. F.), appointed Principal of Swansea University College, 616; Iron Ores: The Hæmatites of the Forest of Dean and South Wales, 429
Sibree (E.), The Stanton Drew Stones, 445
Silberstein (Dr. L.), Italian Papers on Relativity, 552; Relativity, 400
Simmonds (C.), Alcohol: Its Production, Properties, Chemistry, and Industrial Applications, with Chapters on Methyl Alcohol, Fusel Oil, and Spirituous Beverages, 431
Simmonds (W. G.), awarded the Parsons Scholarship by the Institution of Naval Architects, 186
Simpson (Dr. E. S.), Gearksutite at Gingin, Western Australia, 649
Skinner (J. J.), awarded the Edward Longstreth Medal of the Franklin Institute, 8
Skinner (S.), Radiation Temperature: Dew, 277
Slade (Dr. R. E.), and F. C. Toy, A New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide, 713; and G. I. Higson, Causes of the Shape of the Characteristic Curve of a Photographic Plate, 510
Slipher (Prof.), Spectrum of Comet Brorsen-Metcalf, 576
Smiles (Dr. S.), appointed Daniell Professor of Chemistry at King's College, London, 616
Smith (A. Malins), appointed Head of the Department of Biology of the Bradford Technical College, 345
Smith (B.), Iron Ores: Hæmatites of West Cumberland, Lancashire, and the Lake District, 429
Smith (Prof. D. E.), Number Stories of Long Ago; Number Puzzles before the Log Fire, 42
Smith (F. G.), A Ray Plotter, 682
Smith (Prof. G. Elliot), The Evolution of the Dragon, 350
Smith (Dr. G. F. H.), A Curious Crystal from the Binnental, 326
Smith (H. G.), The Essential Oil of *Boronia pinnata*, Smith, and the Presence of Elemicin, 108
Smith (Prof. J. A.), The Philosophy of Giovanni Gentile, 586
Smith (Capt. Ross), Aeroplane Flight to Australia, 397
Smith (R. T.), The Electrification of Railways, 320
Smith (Dr. V. A.) [obituary], 671
Smith (W. Campbell), Volcanic Rocks in Northern Kordofan, Sudan, 693
Smyth (L. B.), The Carboniferous Coast Section at Malahide, 427
Snell (H. J.), and W. H. Tams, The Natural History of Rodrigues, 366
Soddy (Prof. F.), Aspects of Modern Science, 625; Atoms and Molecules, 230; Organisation of Scientific Work, 691; The Waste of Youth, 89
Sola (C.), Discovery of a New Comet (1920*a*), 576
Somerville (Prof. W.), Presidential Address to the Agriculture Section of the British Association, 36, 421
Soreau (R.), Experimental Laws of the Variations of Barometric Pressure and of the Specific Gravity of Air with Altitude, 459
Spencer (Dr. J. F.), The Metals of the Rare Earths, 310
Spencer (L. J.), New Crystal-forms on Pyrites, Calcite, and Epidote, 326
Srinivasan (K. C.), The Manufacture of Glue in the Tropics, 611
Stacey (Lt. W. F.), Upper-air Temperatures at Martlesham Heath, February, 1917, to January, 1918, 675
Stamp (Dr. J. C.), The Taxation of Profits of Businesses, 486
Stanley (Major R.), appointed Principal of the Belfast Municipal Technical Institute, and Director of Technical Instruction for Belfast, 186; Text-book on Wireless Telegraphy. New edition in two vols., 462

Stapfer and Moleski, Snowfalls, 618
Starck (H. P.), appointed Lecturer in Chemistry at the Bradford Technical College, 345
Stark (E. E.), The Effect of Low Power-factor from the Viewpoint of Electric Power Station Operators, 517
Stark (Prof. H.), awarded the Nobel Prize of 1919 for Physics, 318
Stead (Dr. J. E.), Investigations on Some Ternary Alloys of Tin, Antimony, and Arsenic, 448; nominated as President of the Iron and Steel Institute, 340
Steel (T.), Water from the Roots of the Red Mallee, 20
Steenwijk (J. E. de Vos Van), The Transit Circle, 80
Stefansson (V.). Living off the Country, 118
Step (E.), Insect Artizans and their Work, 132
Stephen (H.), and Prof. H. B. Dixon, The Discovery of Chemical Elements since 1869, 221
Stephens (J. G.), A New Method of Measuring Molecular Weights, 555
Sterling (J. W.), Bequest to Yale University, 67
Stewart (Dr. J. G.), appointed Lecturer in Engineering at University College, London, 107
Stewart (J. S.), The Rocky Mountain Belt in Alberta, 672
Stirling (the late Sir Edward), and E. R. Waite, Description of Toas, or Australian Aboriginal Direction Signs, 643
Stoddart (Dr. W. H. B.), Mind and its Disorders. Third edition, 624
Stokes (Dr. A. C.), Aquatic Microscopy for Beginners; or, Common Objects from the Ponds and Ditches. Fourth edition, 498
Straehling (C.), The Radio-activity of Uranium, 459
Strassmaier (Father J. N.), [death], 506; [obituary], 540
Strathcona (Lord), Legacy of, to Yale University, 146; (Exors. of the late), Gift to the Institute of Parasitology, Cambridge University, 364
Stratton (Mr.), Types of Spectra occurring in the History of Nova Geminorum, 454
Stromeyer (C. E.) Memorandum for 1918–19 on Steam Boilers and Economisers, 675; The Study of Nationalities, 490
Stroobant (Prof.). Nova Aquilæ, 676; The Constitution of the Ring of Minor Planets, 676
Stuart (Prof. H. W.), College Studies, 490
Stuart (Dr. M.), The Deposits of Potash Salts in the Punjab Salt Range and Kohat, 268
Stuart (Dr. T.), appointed Lecturer in Mathematics at the Loughborough Technical College, 67
Suffern (C.). The Migration of Birds over the Mediterranean Sea, 418
Sulman (H. L.), awarded the Gold Medal of the Institution of Mining and Metallurgy, 573; The Study of Flotation, 401
Sunier (Dr. A. L. J.), Stomatopoda in the Fishery Station and the Museum at Buitenzorg, 446
Sussmilch (C. A.), and Prof. T. W. Edgeworth David, Sequence and Correlation of the Permo-Carboniferous and Carboniferous Rocks of N.S.W. Part i., 587
Swann (H. Kirke), A Synoptical List of the Accipitres (Diurnal Birds of Prey). Parts i. and ii., 529
Swinton (A. A. Campbell), Power from the Sun, 392, 532
Sykes (Major-Gen. Sir F. H.), Imperial Air Routes, 634

Tanret (G.), The *Miellée* of the Poplar, 367
Tansley (A. G.), appointed University Lecturer in Botany in Cambridge University, 425
Tarazona (I.), Observation of the Solar Eclipse of November 22, 1919, at Valencia, 491
Tarde (A. de), Work of the French in Morocco, 298
Tarn (A.), Mirage Effects, 662
Tarrant (A. G.), The Measurement of Physical Properties at High Temperatures, 523
Taylor (F.), Australian Phlebotomic Diptera, New Culicidæ and Tabanidæ, and Synonymy, 555
Taylor (Griffith), The Possibilities of Settlement in Tropical Australia, 648
Taylor (Dr. Hugh S.), Catalysis in Chemical Industry, 94
Taylor (J. R.), appointed Director of Humanistic Studies in the Huddersfield Technical College, 127
Teale (E. O.), The Diabase and Associated Rocks of the Howqua River, near Mansfield, Victoria, 108
Thaysen (Dr. A. C.), Different Aspects of Bacteriology outside Medicine, 455
Theal (Dr. G. McCall), Ethnography and Condition of South Africa before A.D. 1505. Second edition, 315
Thomas (Major E. R.), The Work of an Ammunition Chemist in the Field, 455
Thomas (Capt. H. Hamshaw), Some Features in the Topography and Geological History of Palestine, 345; The Desert Flora of Western Egypt, 520
Thompson (Prof. D'Arcy W.), International Relations in Science, 154; The Birth of Oceanography, 686
Thompson (H.), Modern Engineering Workshop Practice, 352
Thompson (Dr. McLean), Nature and Origin of the Pith and Inner Endodermis in Medullated Ferns, 521
Thomson (Dr. G. H.), awarded the Prize for a Paper on the Availability of Pearson's Formulæ for Psychophysics, 608
Thomson (Dr. J. Allan), The Geology and Palæontology of the Palliser Bay District, 517
Thomson (Prof. J. Arthur), Heredity. Third edition, 92; Secrets of Animal Life, 172
Thomson (Sir J. J.), Presidential Address to the Royal Society, 361; Recommended for Re-election as President of the Royal Society, 295; The Influence of Investigations on the Electrical Properties of Gases on Our Conceptions of the Structure of Matter, 224
Thorburn (A.), A Naturalist's Sketch Book, 432
Thornton (Dr.), Ignition of Gases by Hot Wires, 487
Thornton (Prof.), The Thermal Conductivity and the Velocity of Sound in Insulating Materials, 487
Thorp (Major G.), appointed Chief Instructor in Electricity at the School of Military Engineering, Chatham, 186
Thorpe (Sir Edward), Progress of Chemistry, 217
Thrum (T. G.), The Formation of the Hawaiian Islands, etc., 508
Tilden (Sir William A.), Progress in Science Teaching, 253
Tilho (Col. J.), Discoveries in the Sahara, 610; The Raw Materials and Railways of Tropical Africa North of the Equator, 68
Tillyard (Dr. R. J.), Australian Neuroptera. No. 8. Revision of the Family Ithonidæ, 147; Mesozoic Insects of Queensland. No. 6, 147; No. 7, 587; The Panorpoid Complex. Part iii., The Wing-venation, 408
Tizard (Col.). Reduction of Engine Performance at a Great Height to a Standard Pressure, Density, and Temperature, 486
Tolkowsky (M.), Conferment of the Degree of D.Sc. upon, by the University of London, 616
Tolmatcheff (Dr.), Conditions in Petrograd, 443
Torporley (N.), The Career of, 297
Torricelli, Opere di Evangelista, Edite da Gino Loria e Giuseppe Vassura. Three vols., 557
Townsend (Prof. J. S.), Ionisation of Gases, 233
Trail (Prof. J. W. H.), [obituary article], 76
Travers (Dr. M. W.), The Control of Scientific and Industrial Research, 597; The Position of the Glass Trade after the War, 455
Trelease (Prof. W.). The Flora of Central America and the Antilles and Former Land Connections, 476
Trotter (A. P.), Lambert and Photometry, 358
Troup (R. S.), elected Professor of Forestry in Oxford University, 186
Trowbridge (S. B. P.), and others, Zoological Sculpture in Art and Architecture, 117
Turner (Dr. A. J.), Revision of Australian Lepidoptera. Part vi., 20; 147
Turner (Prof. H.), Long-Period Variables, 643
Turner (H. G.), [obituary], 702
Tutton (Dr. A. E. H.), Crystallographic Properties of Monoclinic Double Selenates of the Cobalt Group, etc., 447
Tweedy (Sir John), The Surgical Tradition (The Thomas Vicary Lecture), 418
Twenhofel (W. H.), Pre-Cambrian and Carboniferous Algal Deposits, 640
Twyman (F.), Variations of Refractive Index, 315

Uljanin (Prof. W.), Reduction of the Measurement of the Horizontal Component of the Earth's Magnetic Field to that of an Electric Current, 510

Ungemach (H.), A Remarkable Deposit of Chalcostibite in Morocco, 387
Unwin (Dr. W. C.), Developments of Mechanical Science, 241; Results of Notched-bar Tests, 79

Van der Goot (P.), The Aphides of Java, 648
Vanderlinden (H.), Observations of Borrelly's Comet, 1919c, 326; Orbit of Comet 1919c, 80
Van Dyke (F. C.), Works Management, 543
Vaughan (W. W.), The Importance of Science as Part of a Liberal Education, 514
Vernon (Dr. H. M.), The Influence of Hours of Work and of Ventilation on Output in Tinplate Manufacture, 136; and others, The Influence of the Six-hour Day on Industrial Efficiency and Fatigue, 519
Véronnet (A.), Time and Temperature of Formation of a Star, 367
Victorian, Popular Science, 630
Vigneron (H.), Les Applications de la Physique pendant la Guerre, 2
Villey (J.), Explosion Motors for Rarefied Atmospheres, 683
Vincent (Prof. T. Swale), appointed Professor of Physiology at the Middlesex Hospital Medical School, 616
Vines (Prof. S. H.), Impending Retirement of, from the Sherardian Professorship of Botany in the University of Oxford, 167
Vinter-Hansen (Miss), and Mr. Fischer-Petersen, A New Comet, 43
Volmat (J.), Application of Aerial Photography to Hydrographic Surveys, 326
Vonwiller (Prof. O. U.), The Elastic Properties of Selenium, 347
Vredenburg (E. W.), Shells of the Family Doliidæ, 78
Vries (Prof. H. de), The Present Position of the Mutation Theory, 213

Wade (Sir Charles G.), Australia: Problems and Prospects, 130; Prices and Government Control, 485
Wadia (D. N.), Geology of India for Students, 502
Wales (Prince of), Admission as Fellow of the Royal Society, 571; Conferment of Degree upon, 19; Consent to Become an Honorary Member of the Iron and Steel Institute, 77
Walker (Emery), Reproduction of Illustrations, 1869–1919, 252
Walker (Prof. J.), Organic Chemistry for Students of Medicine. Second edition, 499
Walker (R. J.), The Development of Geared Turbines for the Propulsion of Ships, 486
Walker (W.), appointed Chief Inspector of Mines, 397
Walker-Tisdale (C. W.), and T. R. Robinson, Practical Butter-making. Fourth revision, 528
Wall (Dr. R. C.), appointed Bradshaw Lecturer of the Royal College of Physicians, 608
Wallace (R. F.), [obituary], 573
Waller (Prof. A. D.), Decrease in Electrical Resistance, 520; The Energy Output of Dock Labourers during Heavy Work. Part i., 427
Walmsley (Lieut. L.), The Use of the Aeroplane in African Exploration, 379
Walpole (Dr. G. S.), The Present Position of the Chemical Industry of Germany, 484
Walsh (J. W. T.), The Resolution of a Curve into a Number of Exponential Components, 325
Walsingham (Lord), A Tribute to the late F. DuCane Godman, 40; [obituary article], 376
Walton (Prof. L. B.), Factors of Organic Evolution, 81
Warburton (C.), The Solitary Wasp, *Crabro cephalotes*, 366
Ward (Prof. H. B.), and Prof. G. C. Whipple, Fresh-water Biology, 498
Ward (Prof. J.), In the Beginning . . ., 325
Ward (Prof. R. De C.), Some Characteristics of the Rainfall of the United States, 483
Wardlaw (Dr. H. S. H.), The Venous Oxygen Content of the Alkaline Reserve of the Blood in Pneumonic Influenza, 407
Warre (Rev. Dr. E.), [obituary], 572
Warren (S. H.), A Stone-axe Factory at Graig-lwyd, Penmaenmawr, 346; Pre-History in Essex, 112
Watkins (J. R.), Tests on Wood for Spars of Aeroplane Wings, 42
Watson and Sons, Ltd., Catalogue of X-ray and Electromedical Apparatus, 320
Watson (D. M. S.), Palæontology and the Evolution Theory, 485
Watson (Prof. G. N.), Diffraction of Electric Waves, 454
Watson (Sir George), Endowment of a Chair in American History, Literature, and Institutions, 386
Watt (Sir George), Cotton Growing in the British Empire, 694
Watts (F.), appointed Lecturer in Psychology in the University of Manchester, 616; Work as Assistant to the Director of the Department of Industrial Administration in the Manchester College of Technology, 648
Watts (Prof. W. W.), Shropshire: The Geography of the County, 331
Waugh (F. W.), Canadian Aboriginal Canoes, 78
Wayland (E. J.), The Problem of the Stone Ages in Ceylon, 609
Weaver (E. R.), and E. E. Weibel, Instruments for Detecting and Measuring Combustible Gas Present in the Air, 65
Webber (Dr. W. P.), and Prof. L. C. Plant, Introductory Mathematical Analysis, 169
Weber (Sir H.), On Longevity and Means for the Prolongation of Life. Edited by Dr. F. Parkes Weber. Fifth edition, 527
Webster (Dr. A. G.), elected an Honorary Member of the Royal Institution, 358
Wedderburn (Dr. E. M.), Meteorology and Gunners, 641
Weigall (Lt.-Col. A. G.), and C. Wrey, A Large State Farm: A Business and Educational Undertaking, 592
Welldon (Bishop J. E. C.), Political Science, 494; Training in Citizenship, 522
Wells (H. G.), The Outline of History: Being a Plain History of Life and Mankind. Part i., 371
Wells (Dr. S. Russell), elected Vice-Chancellor of London University, 425
Werner (Prof. A.), [death], 376
West (Capt. R.), The Application of Air-brakes to Aeroplanes, 486
Weston (Capt. W. J.), The North Riding of Yorkshire, 4
Wheeler (Dr. Olive), New Views of Human Personality, 513
Wheeler (R. E. M.), Conferment of the Degree of D.Lit. upon, by the University of London, 616
Whiddington (Dr.), A Wireless Method of Measuring e/m, 454; Thermionic Valves on Aircraft, 630
Whipple (F. J. W.), Equal Parallel Cylindrical Conductors in Electrical Problems, 365; The Laws of Approach to the Geostrophic Wind, 458
Whipple (R. S.), elected President of the Optical Society, 671
Whitby, Variation in *Hevea brasiliensis*, 98
White (C. T.), A Revised Account of the Queensland Lecythidaceæ, 587
White (G. F.), Nosema-disease in Bees, 41
Whitehead (Prof. A. N.), Fundamental Principles in Education, 522; The Theory of Relativity, 632
Whitman (Prof. C. O.), Inheritance, Fertility, and the Dominance of Sex and Colour in Hybrids of Wild Species of Pigeons, edited by Dr. O. Riddle, 566; Orthogenetic Evolution in Pigeons, edited by Dr. O. Riddle, 566; The Behavior of Pigeons, edited by Prof. H. A. Carr, 566
Whitmell (C. T.), Surface-tension, 278; [obituary], 398
Whittaker (Prof. E. T.), A Survey of the Numerical Methods of Solving Equations, 550
Whymper (Capt. R.), The Conditions that Govern Staleness in Bread, 99
Wicksteed (J. H.), [obituary], 443
Widal (F.), and P. Vallery-Radot, Anaphylaxy due to Antipyrin after a Long Phase of Sensibilisation, 683
Wieland (Dr. G. R.), Classification of the Cycadophyta, 509
Wiglesworth (Dr. J.), Bequest to Bristol University, 126
Wilks (Rev. W.), Resignation of the Secretaryship of the Royal Horticultural Society, 377

Willcocks (Sir William), The Nile Projects, 120
Williams (J. G.), The Electrolytic Formation of Perchlorate, 523
Williamson (H. B.), A Revision of the Genus Pultenæa, 555
Willis (Dr. J. C.), A Dictionary of the Flowering Plants and Ferns. Fourth edition, 410; Origin of the Flora of New Zealand, 520
Willows (Dr. R. S.), Recent Work on Colloids, 650
Wilson (C. T. R.), elected President of the Cambridge Philosophical Society, 267
Wilson (Dr. F. J.), appointed Professor of Inorganic and Analytical Chemistry at the Glasgow Technical College, 19
Wilson (Dr. J.), [obituary], 539
Wilson (Prof. J.), The Application of the Food-unit Method in the Fattening of Cattle, 682
Wilson (the Ven. Canon J. M.), Science and the Church, 201
Wilson (Dr. W.), An Astronomical Model, 344
Wimperis (Major H. E.), appointed Head of the Air Navigation Research Section of the Air Ministry, 572
Winslow (Prof. C. E. A.), The Untilled Fields of Public Health, 703
Wood (A.), appointed University Lecturer in Experimental Physics in Cambridge University, 425
Wood (Dr. H. B.), Sanitation Practically Applied, 311
Wood (Sir H. Trueman), The Development of our Natural Resources, 339
Wood (Prof. R. W.), Researches on Physical Optics. Part ii. Resonance Radiation and Resonance Spectra, 526
Woods (Miss), Discovery of a Nova, 160
Woodward (Dr. A. Smith), The Antiquity of Man, 212; 335
Wormald (H.), Conferment of Doctorate upon, by the University of London, 185
Wourtzel (E.), Existence of Nitrous Anhydride in the Gaseous State, 651; The Velocity of Oxidation of Nitric Oxide, 683
Wright (R.), Apparatus for Vapour-pressure Determinations, 581
Wright (W. B.), Minor Periodicity in Glacial Retreat, 682

Yapp (Prof. R. H.), appointed Professor of Botany in Birmingham University, 489
Young (J.), appointed an Assistant Lecturer in the Department of Physics of Birmingham University, 615
Young (Prof. S.), Brown's Formula for Distillation, 555
Young (W. J.), A. Breinl, J. J. Harris, and W. A. Osborne, Effects of Exercise and Humid Heat upon the Pulse Rate, etc., 345

Zilva (Dr. S. S.), Effect of Prolonged Dietetic Deficiency, 66
Zimmer (G. F.), The Mechanical Handling of Chemical Materials, 137
Znaniecki (Dr. F.), Cultural Reality, 110

TITLE INDEX.

Aberdeen University: Dr. J. Cruickshank appointed Georgina McRobert Lecturer in Pathology in, 385; Conferment of Honorary Degrees, 712
Aberystwyth, University College of Wales, B. M. Jones elected Professor of Chemistry in the, 186
Absolute Magnitude as a Function of Colour, F. H. Seares, 479
Acacia Seedlings, Part v., R. H. Cambage, 555
Acacias, Notes on, No. iv., J. H. Maiden, 586
Acalypha indica, The Dimorphic Female Flower of, L. A. Kenoyer, 297
Accipitres, A Synoptical List of the (Diurnal Birds of Prey), Parts i. and ii., H. Kirke Swann, 529
Accounts Rendered of Work Done and Things Seen, J. Y. Buchanan, 686
Acridians, New Methods for the Destruction of, G. Bazile, 168
Acrolein: The Stabilisation of, C. Moureu and C. Dufraisse, 307; C. Moureu, C. Dufraisse, P. Robin and J. Pougnet, 650; C. Moureu and A. Lepape, 326, 387
Actinium, The Genesis of, O. Hahn and L. Meitner, 575
Admiralty, Board of, Resignation of Prof. J. C. McLennan of the Post of Scientific Adviser to the, 340
Adult Education: 452; Committee of the Ministry of Reconstruction, Final Report of the, 452
Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, Sir Henry A. Miers appointed a Member of the, 178
Aerial: Photogrammetry, the Present Position of, P. R. Burchall, 379; Photography, Application of, to Hydrographic Surveys, J. Volmat, 326
Aeronavigazione e Costruzioni Aeronautiche, Dizionario Internazionale di, Italiano, Francese, Inglese, Tedesco, Lt. M. M. Dander, 656
Aeronautica, Meteorologia, Prof. G. Crestani, 656
Aeronautical Engineers, Institute of, Foundation of an, Prof. G. H. Bryan President Elect of, 340
Aeronautics: Exhibition at the Science Museum, South Kensington, 397; in Italy, Prof. G. H. Bryan, 656
Aero-Photography, the Field of Application for, P. Dautriche, 99
Aeroplane: Altitude Record, An, R. Rohlfs, 77; Flight from Cairo to Capetown, 607; to Australia, The, Capt Ross Smith, 397; High Altitude, An, R. Rohlfs, 63; Use of the, in African Exploration, Lieut. L. Walmsley, 379
Æther: and Matter: being Remarks on Inertia, and on Radiation, and on the Possible Structure of Atoms, Sir Oliver J. Lodge, 15, 82; The, *versus* Relativity, Sir Oliver J. Lodge, 543
Afforestation of Water-catchment Areas, Prof. A. Henry, 520, 554
Afghanistan, The Folk-life of, Ikbal Ali Shah, 573
Africa, Tropical, Raw Materials and Railways of, North of the Equator, M. Tilho, 68
African Rift Valley, The, Prof. J. W. Gregory, 518
Agar-agar, The Preparation of, in California, 703
Agricultural: and Horticultural Research Station, Long Ashton, Report of the, 418; Experimental Station, Ithaca, New York, Reports of the, for the Years 1914–17, 482; Research, A New Development in, 579
Agriculture: and the State, Sir Arthur Griffith-Boscawen, 181; at the British Association, Prof. A. Lauder, 553; Electricity in, Dr. J. F. Crowley, 268; Frosts and, in the United States, 95; Productive, Prof. J. H. Gehrs, 495; The Preparation of Substances important in, Prof. C. A. Peters. Third edition, 497
Aiming at Objects in the Air, A System of, A. Bichet, 307
Air: -brakes, Application of, to Aeroplanes, Capt. R. West, 486; Diminution of the Transparency of the, at Paris, L. Besson, 651; Navigation Research Section of the Air Ministry, Major H. E. Wimperis appointed Head of the, 572; obtained at High Altitudes, Proposed Analysis of, C. T. Kingzett, 540; Pollution of the, by Smoke, etc., Appointment of a Departmental Committee upon, 701; Routes, Imperial, Major-Gen. Sir F. H. Sykes, 634; -screws, The Sound emitted by, Prof. G. H. Bryan, 486

Aircraft: Research, The Need for, 589; Wireless Navigation for, Capt. J. Robinson, 24
Airships, Wing-Comdr. Cave-Browne-Cave, 486
Ajuga genevensis and *Centaurium scilloides*, Druce, var. *portense* (Brot.), Occurrence in Britain as Native Plants of, Dr. G. C. Druce, 406
Albany, The Geology of, Jutson and Simpson, 579
Alcohol: from Ethylene Gas, E. Bury, 416; its Production, Properties, Chemistry, and Industrial Applications. With Chapters on Methyl Alcohol, Fusel Oil, and Spirituous Beverages, C. Simmonds, 431; or Ether, A Commercial Method for the Synthetic Production of, starting with Coal-gas, E. de Loisy, 650; Power, Investigation Officer, Col. Sir Frederic Nathan appointed, 540
Alcohols, the Primary and Secondary, The Dehydrogenation of, by Catalytic Oxidation, C. Moureu and G. Mignonac, 715
Aldabra, etc., The Flora of, Dr. W. B. Hemsley, 118
Algal Deposits, Pre-Cambrian and Carboniferous, W. H. Twenhofel, 640
Algebra, A Linear Associative, suitable for Electro-magnetic Relations and the Theory of Relativity, W. J. Johnston, 365
Algebraic: Cube, The, 79; Equations, The Rationalisation of, N. N. Chatterjee, 187
Allen County, Kentucky, The Oilfields of, Shaw and Mather, 672
Alloys: Light Aluminium Casting, Tests of, 478; of the Duralumin Type, Heat-treatment of, 510; of Tin, Antimony, and Arsenic, Some Ternary, Dr. J. E. Stead, 448; Spherical Shell Crystals in, 448
Alpine Plants for Rock-gardens, 664
Alsace and Lorraine: Geological Survey of, E. de Margerie appointed Director of the, 157; The Mineral Resources of, L. de Launay, 640
Alternating-current Electrolysis, S. Marsh, 617
Alum Carmine and its Use, combined with Iodine Green in Plant Histology, R. Mirande, 683
Aluminium Alloys: The Tempering of certain, L. Guillet, J. Durand, and J. Galibourg, 128; The Transformation undergone by certain, L. Guillet, 459; Thermal Treatment of, M. Grard, 187; in Norway, New Sources of, L. Hawkes, 160; New Sources of, Major J. E. Bacon, 277; Spontaneously Oxidisable in the Air, E. Kohn-Abrest, 618
Aluminiumfremstilling av Norske Raastoffer, Om, Prof. V. M. Goldschmidt, 161
America of To-day, The, being Lectures delivered at the Local Lectures Summer Meeting of the University of Cambridge, 1918. Edited by Dr. G. Lapsley, 151
American: Academy of Arts and Sciences, Prof. T. W. Richards elected President of the, 116; Agriculture, An Atlas of, 640; Association, The St. Louis Meeting of the, 612; Dr. L. O. Howard appointed President of the Association, and Prof. E. L. Nichols General Secretary, 613; Books on Agriculture, 495; Embassy, Closing of the Office of Scientific Attaché at the, 40; History, Literature, and Institutions, Endowment of a Chair in, Sir George Watson, 386; Meteorological Society, Formation of an, 40; Morrison and the East African Tendaguru Formations, The Stratigraphical Position of the, Dr. C. Schuchert, 672; Scholars and Research Work in Asia, Prof. A. T. Clay, 64; Universities, 151
Americans who have produced Inventions of the First Rank, 11
p-Aminocarvacrol, Preparation of, and its Use as a Developing Agent in Photography, H. A. Lubs, 79
Amœbæ: living in Man, The, Prof. C. Dobell, 369; Parasitic, and Disease, Sir E. Ray Lankester, 369
Ammonia: Advantages of the Synthesis of, at Very High Pressures, G. Claude, 683; Nitrate of, The Extraction of, from Surplus Stocks of Explosives, Prof. Garelli, 447; The Synthesis of, at Very High Pressures, G. Claude, 459
Ammunition Chemist, Work of an, in the Field, Major E. R. Thomas, 455
Amplifying Electric Valves, Applications of, L. Bloch, 647
Anaphylaxy due to Antipyrin after a Long Phase of Sensibilisation, F. Widal and P. Vallery-Radot, 683
Andalusian Fowl, The Blue, Dr. W. A. Lippincott, 81
Anderson College of Medicine, Glasgow, Dr. J. Graham appointed Professor of Anatomy in the, 19
Andes of Peru and Bolivia, Geological Sections through the, ii., J. A. Douglas, 681
Anglo-Saxon Remains at Ravensbury Manor, Mitcham, 474
Animal Life: and Human Progress. Edited by Prof. A. Dendy, 21; Secrets of, Prof. J. Arthur Thomson, 172
"Anlage," A Protest against the Use of the Word, Dr. Th. Mortensen, 357
Anopheles maculipennis, Antagonism of Cattle and Man in the Blood Nutrition of, E. Roubaud, 88
Antarctic Whaling, Dr. S. F. Harmer, 377
Anthropological Institutes of France and the United Kingdom, The, Sir E. Brabrook, 476
Anthropology at the British Association, 487
Apples, Experiments to Ascertain the Composition of Runnings of Pressed, Misses D. Haynes and H. M. Judd, 379
Aquatic Fauna of Seistan, Dr. N. Annandale and others, 453
Aquatic Microscopy for Beginners; or, Common Objects from the Ponds and Ditches, Dr. A. C. Stokes. Fourth edition, 498
Arc-spectra of Metals of Low Melting Point, The Direct, A. de Gramont, 650
Arcs of Primary Triangulation in the U.S. and Mexico, Connection of the, W. Bowie, 509
Aristotelian Society, Proceedings of the. New Series, vol. xix; Supplementary vol. ii., 559
Armstrong College, Comdr. C. Hawkes appointed Professor of Engineering at, 616
Arsenic: Compounds for Direct Intravenous Injection in Simple Aqueous Solution, Baxter and Fargher, 342; Estimation of Small Quantities of, by Micro-titration with Iodine, H. H. Green, 477
Artillery Dictionary, Trilingual, E. S. Hodgson. 3 vols. Vol. i., English-French-Italian, 332
Asset and Obligation, 621
Association of Surgeons of Great Britain and Ireland, Formation of the, Sir John Bland Sutton elected President, 507
Astronomical: Lectures and Essays, 370; Model, A New, Rev. A. L. Cortie, 343; Observatories, Selection of Sites for, 138

ASTRONOMICAL NOTES.

Comets:
Metcalf's Comet, Miss V. Hansen and F. Fischer-Petersen, 12; Comet Notes, 43; Comets, Miss V. Hansen and F. Fischer-Petersen; Prof. Leuschner, Prof. Wolf; M. Ebell, 66; Comets, H. Vanderlinden, 80; Comet 1919*b*, Braae and Fischer-Petersen, 100; Comets, 100; Comet 1919*c*, 119; Ephemeris of Comet 1919*b*, Braae and Fischer-Petersen, 138; Comet 1919*b* (Brorsen-Metcalf), Braae and Fischer-Petersen, 180; Comets, 269; Comets, 321; Comets, Aphelia of Planets and, C. D. Perrine, 343; Comets, 361; Comets, 380; Comets, 448; New Comet 1920*a*, C. Sola, 576; Spectrum of Comet Brorsen-Metcalf, Prof. Slipher, 576; Comets, 612; Holmes's Comet, Dr. Schorr, 704
Instruments:
The Blink Microscope, R. T. A. Innes, 66; Lunar Photography with the 100-in. Reflector, F. G. Pease, 511
Meteors:
The Recent Shower of Perseids, 12; Large Meteors, 179; The Leonid Meteors, 299; Large Fireball, 321; The Leonid Meteoric Shower, 342; The December Meteoric Shower, 400; Fireball of December 25, 448; Large Fireball on January 16, 544, 576; Large Fireball on February 4, 642
Observatories:
The Selection of Sites for Astronomical Observatories, Prof. W. H. Pickering, 138
Planets:
Minor Planets, 100; The Albedo of Saturn's Rings, L. Bell, 138; The Secular Acceleration of the Moon, Prof. E. W. Brown, 299; Aphelia of Planets and

Comets, C. D. Perrine, 343; Heliocentric Grouping of Planets in December, 361; The Birth of the Moon, Prof. W. H. Pickering, 479; Minor Planets, Dr. F. Cohn, 511; Lunar Studies, Prof. W. H. Pickering, 544; The Motion of the Moon, Dr. J. K. Fotheringham, 612; Mercury as an Evening Star, 674; Is Venus Cloud-covered?, J. Evershed, 675; Minor Planet GM, 704

Stars:
A Faint Nova, Miss Mackie, 119; Stellar Clusters, Dr. and Mrs. Shapley, 119; Novæ, Miss Woods; Dr. Shapley; Mr. Joy; C. P. Olivier; Van Maanen and Sanford, 160; The Sources of Stellar Energy, Prof. Russell; Prof. Eddington, 269; The Group of Helium Stars in Orion, Dr. Bergstrand, 299; Two Stars with Large Parallaxes, Prof. F. Schlesinger, 342; Barnard's Proper-motion Star, K. Graff, 420; The Orion Nebula, Prof. W. H. Pickering, 448; Distances of the Stars of Type F, C. F. Lundahl, 479; Absolute Magnitude as a Function of Colour, F. H. Seares, 479; Spectroscopic Determination of Stellar Parallax, W. S. Adams and G. Stromberg, 511; Open Stellar Clusters, Dr. H. Shapley; Sir F. W. Dyson, and Mr. Melotte, 576; Stars of High Velocity, W. S. Adams and A. H. Joy, 612; Relative Masses of Binary Stars, G. van Biesbroeck, 643; Long-period Variables, Prof. Turner, 643; Nova in Lyra, Miss Mackie, 704

Sun:
The Sun-spot Curve, S. B. Nicholson, 160; Solar Radiation, C. G. Abbot, 160; The Great Solar Prominence of Last May, 420; The Solar Eclipse of May 29, 1919, C. R. Davidson, 544

Miscellaneous:
The Future of the Transit Circle, J. E. de Vos Van Steenwijk, 80; The Twenty-four-hour Day, 100; Hindu Spherical Astronomy, G. R. Kaye, 119; Fall of a Meteorite in America, 361; Wireless Time Signals, 380; Leeds Astronomical Society, vol. xxvi. of the Journal, 380; Discussion on Relativity, Prof. Eddington; Dr. Jeans; Sir Oliver Lodge; Dr. Silberstein; Prof. Lindemann; Dr. Jeffreys, 400; Radiation Pressure, Megh Nad Saha, 448; Centenary of the Royal Astronomical Society, Prof. A. Fowler, 674; Tides in Pipes, A. A. Michelson and H. G. Gale, 705

Astronomy: for Surveyors, The Elements of, Prof. R. W. Chapman, 499; Practical, Text-book on, Prof. G. L. Hosmer, Second edition, 3; Spectroscopic, Prof. A. Fowler, 234; The Adolfo Stahl Lectures in, delivered in San Francisco, Cal., in 1916-17 and 1917-18, under the auspices of the Astronomical Society of the Pacific, 370

Athenæum Club, Sir Daniel Hall, elected a member of the, 608

Atmosphere: Free, The Characteristics of the, W. H. Dines, 505; Internal Friction in the, D. Brant, 714; The Structure of the, when Rain is falling, Prof. V. Bjerknes, 346

Atmospheric: Air, Search for a Characteristic Equation Applicable to, Ed. Fouché, 491; and Terrestrial Radiation, W. H. Dines, 714; Refraction, The Influence of small Changes of Temperature on, Sir Arthur Schuster, 714; Observations at Gâvre by means of free Rubber Balloons, F. La Porte, 715

Atom, The Constitution of the, and the Properties of Band Spectra, Dr. H. Deslandres, 271; 347

Atomic: Disintegration and Heat Energy, Sir Oliver Lodge, 420; Energy, Sir Oliver J. Lodge, 435; Weights of the Elements, Plotting the, against their Atomic Numbers, Dr. S. Miall, 704; Weights, &c., problems of, 398

Atoms and Molecules, Prof. F. Soddy, 230

Aurora of October 1, The, Dr. C. Chree, and others, 119

Australia: Problems and Prospects, Sir C. G. Wade, 130; the Flora of, Contributions to, No. 28, A. J. Ewart and J. R. Tovey, 347; Tropical, Future of, G. Taylor, 648

Australian Army Medical Corps in Egypt, the, Lt.-Col. J. W. Barrett and Lt. P. E. Deane, 560; Educational Institutions, Bequests to, by Sir Samuel McCaughey, 127; Lepidoptera, Revision of, Part vi., Dr. A. J. Turner, 20; Lepidoptera, Part vi., Dr. A. J. Turner, 147; Opiliones, Some, H. R. Hogg, 713; Neuroptera, No. 8: Revision of the Family Ithonidæ, Dr. R. J. Tillyard, 147; Phlebotomic Diptera, new Culicidæ and Tabanidæ, and Synonymy, F. Taylor, 555; Rainfall and Wheat Yield, 606; Signposts, S. H. Ray, 643; South, Geology, 91; Stratiomyidæ (Diptera), with Description of New Species, G. F. Hill, 271

Autochrome Plates, a Simplified Method for the Development of, Lumière and Seyewetz, 137; The use of, instead of Hand-paintings for Clouds, M. de Chardonnet, 307

Automobile Engineers, Institution of, Sir Henry Fowler elected President of the, 638

Autotrophic Flagellate, The Building of an, A. H. Church, 594

Autumn Weather, the Abnormal, 417

Aviation: during the War, Progress of the Scientific Development of, L. Bairstow, 486; Pocket-book for 1919-20, The, R. B. Matthews, Seventh edition. 562; Position and Prospects of, L. Bairstow, 246; Recent Progress in, Sir Richard Glazebrook, 397

Awards for Medical Discovery, Suggested, 671

Axolotl, Metamorphosis of, caused by Thyroid-feeding, J. S. Huxley, 435

Bacterial Cell, a Single, the Isolation of, Dr. N. Mutch, 446

Bacteriology outside Medicine, Different Aspects of, Dr. A. C. Thaysen, 455

Bailleul, The Explosion at, S. Pickering, 5

Balkans, Discoveries made in the, during the War, S. Casson, 487

Bantu Languages, a Comparative Study of the Bantu and Semi-, Sir Harry H. Johnston, 129

Baphia, Afzel, A revision of the Genus, L. V. Lester-Garland, 346

Barnard College, Bequest to, by Genl. H. W. Carpentier, 167

Barnard's Proper-motion Star, K. Graff: Prof. Kustner, 420

Barometric Pressure and Underground Water-level, E. G. Bilham, 366; Variations of, and of the Specific Gravity of Air with Altitude, R. Soreau, 459

Battersea Polytechnic, courses at, 43; Dr. R. H. Pickard appointed Principal of, 325

Beats, Unpleasant, The Upper Limit of, N. Chatterjee, 708

Bedford College for Women, Decision to Extend the, 306

Bed-lice, Destruction of, by Chloropicrin, G. Bertrand, Brocq-Rousseau and Dassonville, 68

Beginning . . . . , In the, Prof. J. Ward, 325

Belfast Municipal Technical Institute, Major R. Stanley appointed Principal of the, 186

Belgian Royal Observatory, Dr. A. C. D. Crommelin, 676

Belgique, Annuaire de l'Observatoire Royal de, 1920, 158

Belgium, Gifts for Education in, 67

Benzaldoxime, Oxidation of, J. Bougault and P. Robin, 20; The Peroxide of, P. Robin, 307

Beri-beri, The Genesis of Œdema in, Lt.-Col. A. McCarrison, 345

Biological Nature-Study, A Source Book of, E. R. Downing, 465; Problems, 90; Science in Secondary Schools, Prof. S. J. Hickson, 693; Sciences, The Foundations of, Sir E. Ray Lankester, 198

Biologists, Economic, Association of, General Meeting of the, Sir David Prain elected President, 417

Biology, Fresh-water, Profs. H. B. Ward and G. C. Whipple, 498

Biometrika, Vol. xii.; Pts. iii. and iv., 579

Bird-Liming in Lower Egypt, J. L. Bonhote, 444; Migration, Dr. M. C. Grabham, 334

Birds: and the Destruction of Insect Pests, Major S. Flower, 444; Beneficial to Agriculture, F. W. Frohawk, 72; of South Uist, D. Guthrie, 136; The Migration of, over the Mediterranean Sea, C. Suffern, 418

Birkbeck College, Celebration of Founder's Day, 405; Courses at, 87

Birmingham: University, C. Grant Robertson appointed Principal of, 425; C. Grant Robertson welcomed as

Principal; J. Young appointed an Asst. Lecturer in the Department of Physics, 615; Gift to, for the Endowment of the Adrian Brown chair of Brewing; Gift to, for a Lectureship in honour of Prof. J. H. Muirhead, 648; Prof. R. H. Yapp appointed Professor of Botany, Dr. W. Cramp, Professor of Electrical Engineering in, 489
Birth-rate, The declining, The Bishop of Birmingham, and others, 157
Bistoninæ, Peculiar Sex-relationships in Inter-generic Hybrids of, Dr. J. W. H. Harrison, 574
Blade-screws, The General Theory of, G. de Bothezat, 543
Blink Microscope, The, R. T. A. Innes, 66
Blood Corpuscles, Sedimentation of, Prof. A. E. Boycott, 532
Blow-flow, The *Rôle* of Capillaries in the Regulation of the, Dr. H. H. Dale, 519
"Blue John" and other varieties of Fluorite, Cause of the Colours of, B. Blount and J. H. Sequeira, 65
Board of Agriculture and Fisheries, Reorganisation of the, and Appointments under, 319; Sir A. Griffith-Boscawen appointed Deputy Chairman, and Sir A. D. Hall Vice-Chairman of the President's Administrative Council of the, 342
Board of Trade, the appointment of Prof. S. J. Chapman as Joint Permanent Secretary of the, 135
Body-lice, History of Isolated Pairs of, and of their Offspring, Dr. E. Hindle, 456
Boiler Plants, Colliery, D. Brownlie, 120
Boronia pinnata, Smith, The Essential Oil of, and the Presence of Elemicin, H. G. Smith, 108
Borrelly's Comet, Observations of, P. Chofardet, 87; H. Vanderlinden, 326
Boston: Society of Natural History, Memoirs of the, Vol. viii., No 3, The Turtles of New England, Dr. H. L. Babcock, 23; University, Bequest to, by C. W. Lenney, 167
Botanic Gardens and Stations, British, 263
Botanical: Research, The Evolution of, Prof. J. M. Coulter, 581; Teaching, Elementary, Reconstruction of, 64
Botany at the British Association, 520
Boys' Own Book of Great Inventions, The, F. L. Darrow, 152
Bradford Technical College, Appointments at the, 345
Bread, Staleness in, The Conditions that Govern, Capt. R. Whymper, 99
Brisbane University, Bequest to, by Sir Samuel McCaughey, 108
Bristol: Museum and Art Gallery, Report of the, H. Bolton, 574; University, Appointment of Capt. J. W. McBain to the Chair of Physical Chemistry in, 167; Bequest to, by Dr. J. Wiglesworth, 126; Miss M. E. Laing appointed Research Assistant in Physical Chemistry in, 306
British: and Belgium Universities, Proposed Exchange of Teachers and Students between, 345; Antarctic (*Terra Nova*) Expedition, 1910. Cephalodiscus, Dr. W. G. Ridewood, 481; Association, The Bournemouth Meeting of the, 7; Inaugural Address of the President, the Hon. Sir Charles A. Parsons, 28; Summaries of Addresses of Presidents of Sections, 36; to be Held at Cardiff in 1920, and at Edinburgh in 1921, 52; Bournemouth, The, 51; Presidential Address to the Mathematical and Physical Science Section, Prof. A. Gray, 52; Presidential Address to the Chemistry Section, Prof. P. P. Bedson, 59; Presidential Address to the Geology Section, Dr. J. W. Evans, 102; Presidential Address to the Zoology Section, Dr. F. A. Dixey, 121; Resolutions on the Need of Grants from the Government for Research, 135; at Bournemouth, The, Presidential Address to the Geography Section, Prof. L. W. Lyde, 141; Proposed History of the, 158; Presidential Address to the Economic Science and Statistics Section, Sir Hugh Bell, 162; Presidential Address to the Engineering Section, Prof. J. E. Petavel, 181; Presidential Address to the Anthropology Section, Prof. A. Keith, 301; Presidential Address to the Physiology Section, Prof. D. Noël Paton, 312; The, and Scientific Research, 337; Presidential Address to the Botany Section, Sir Daniel Morris, 381; Presidential Address to the Educational Science Section, Sir Napier Shaw, 401; Presidential Address to the Agriculture Section, Prof. W. Somerville, 421; Physics at the, 454; Chemistry at the, 455; Zoology at the, Prof. J. H. Ashworth, 456; Geology at the, 484; Economics at the, 485; Engineering at the, 486; Anthropology at the, 487; Physiology at the, 519; Botany at the, 520; Education at the, 521; Agriculture at the, Prof. A. Lauder, 353; of Research for the Cocoa, Chocolate, Sugar, Confectionery, and Jam Trades, Formation of a, 117; Botanic Gardens and Stations, 263; Dr. W. E. Freeman; The Writer of the Article, 469; Bureau of the Office National des Universités et Ecoles Françaises, L. Poincaré at the Opening of the, 712; Cotton Industry Research Association, Prof. A. W. Crossley appointed Director of Research to the, 296; The Appointment of Prof. A. W. Crossley as Director of Research of the, 319; Chemists during the War, Services of, 8; Empire, Cotton-growing in the, Sir George Watt, 694; Enchytræid Worm, A New, Rev. H. Friend, 174; Ferns and How to Identify Them, J. H. Crabtree, 410; Fisheries Guild, Proposed Foundation of the, 638; Imperial Antarctic Expedition, A, J. L. Cope, 93; Iron Ores, Prof. H. Louis, 429; D. A. E. Evans; Prof. H. Louis, 565; Launderers' Industry, The Research Association for the, Approved, 507; Medical Association, Forthcoming Annual Meeting of the, at Cambridge, 474; Physicists, Lectures on Ten, of the Nineteenth Century, A. Macfarlane, 561; Rainfall, 1918, Dr. H. R. Mill and M. de Carle S. Salter, 411; Rubber and Tyre Manufacturers' Research Association, Establishment of the, 158; Science Exhibition, Glasgow, 343; Science Guild, Journal of the, July, 11, January, 642; Scientific Societies Founded during the Past Fifty Years, 270; Technical Optics, The Outlook of, Prof. F. Cheshire, 530; Well-worms, Rev. H. Friend, 5
Brown's Formula for Distillation, Prof. S. Young, 555
Bryophyllum calycinum, Mechanism of Regeneration in, 15
Budapest University Unable to Resume its Work through Lack of Fuel, 364
Bulla-Sydenham Area, Physiography and Geography of the, A. V. E. James, 619
Bulusan Volcano, Eruptions of the, Rev. M. S. Masò, 99
Bureau International des Poids et Mesures, Travaux et Mémoires du. Tome xvi., 12
"Burgundy Mixture," Chemistry of, R. L. Mond and C. Heberlein, 82
Bushman Engravings, Dr. L. Péringuey, 44
Butter-making: Practical. Fourth revision, C. W. Walker-Tisdale and T. R. Robinson, 528
Butyleneglycol, A Specific Reaction of 2:3-, and of Acetylmethylcarbinol, M. Lemoigne, 651

Cactaceæ, The, N. L. Britton and J. N. Rose, 41
Cairo: School of Medicine, Dr. E. Hindle Appointed Professor of Biology in the, 127; to the Cape, The Flight from, Sir H. H. Johnston, 632; Prof. J. W. Gregory, 633
Cajal formalin-silver Nitrate Impregnation Method for the Golgi Apparatus, The, H. M. Carleton, 406
Calculus; A First Course in the, Part i., Powers of X, Dr. W. P. Milne and G. J. B. Westcott, 109; Differential and Integral, Dr. H. B. Phillips, 109
Calcutta University Commission, Report of the, Sir E. Denison Ross, 537
Calendar, The Reform of the, 415
Calendrier, réforme du, Commission pour la, 415
California University; Bequest to, by General H. W. Carpentier, 167; Gift to, by E. F. Searles, 67
Californian Dialects, R. B. Dixon, and A. L. Kroeber, 541
Cambridge: Forestry Association, Archives of the, 1919, 672; Philosophical Society, Election of Officers, 267; University Press, New Catalogue of the, 639; The Universities of Oxford and, The Royal Commission on, 329; Women at, 265; University, Mr. A. J. Balfour to be Nominated as Chancellor of, 67; The Nomination of Mr. Balfour as Chancellor of, 96;

B. M. Jones Elected to the Francis Mond Professorship of Aeronautical Engineering in, 107; Resignation of the Vice-Chancellorship of, by Dr. A. E. Shipley, Election as Vice-Chancellor of Dr. P. Giles, 126; Mr. A. J. Balfour Elected Chancellor of, 146; Mr. Balfour Inaugurated Chancellor of, 266; Gift by P. A. Molteno for an Institute of Parasitology; Postponement of Special Lectures by Sir J. J. Thomson and Prof. Eddington; Recommendations of the General Board of Studies; Difficulties of Accommodation at, 305; Forthcoming Establishment of a Professorship of Physical Chemistry; Recommendation of A. Amos to the University Lectureship in Agriculture, 324; Appointment of Royal Commissioners to Consider Financial Assistance to, 325; Gift to the Institute of Parasitology, by the Executors of the late Lord Strathcona & Mount Royal; Dr. F. H. A. Marshall Appointed Reader in Agricultural Physiology; P. Lake Appointed Reader in Geography; W. B. R. King Appointed Assistant to the Professor of Geology, and C. Nicholas Appointed Demonstrator in Geology; 364; Lecture on the Theory of Relativity, Prof. Eddington; Presentation of a Portrait of Prof. H. F. Osborn; 385; K. J. J. Mackenzie Re-appointed Reader in Agriculture; W. J. Harrison Appointed University Lecturer in Mathematics, A. Wood, University Lecturer in Experimental Physics, A. G. Tansley, University Lecturer in Botany, and F. Balfour Brown, University Lecturer in Zoology, 425; A John Couch Adams Astronomership in, 615; Offer of an E. G. Fearnsides Scholarship; H. M. Fox, F. Debenham, and C. N. H. Lock Elected Fellows of Gonville & Caius College, 616
Cammellaird-Fullagar Marine Oil-Engine, The, 642
Camphor Cultivation in the West Indies, 98
Canada, the Mineral Production of, for 1918, 673
Canadian Aboriginal Canoes, F. W. Waugh, 78
Cancer Research and Vivisection, 136
Carbohydrates, The Simple, and the Glucosides, Dr. E. F. Armstrong. Third edition, 526
Carbon: Dioxide, Pure, The Separation by Solidification of, from a Gaseous Mixture, V. Cremieu and A. Lepape, 307; Monoxide in Flames of Different Gases, Production of, A. Kling and D. Florentin, 618
Carboniferous Coast Section at Malahide, The, L. B. Smyth, 427
Carnivora and the Three Classes of Food, H. Bierry, 387
Cass, Sir John, Technical Institute, E. de Barry Barnett Appointed Lecturer in Organic Chemistry, and R. H. Humphry Lecturer in Physics at the, 186
Catalysis: in Chemical Industry, Dr. H. S. Taylor, 94; in Theory and Practice, Dr. E. K. Rideal and Prof. H. S. Taylor, 463
Catalytic Actions at Solid Surfaces, Part ii., Dr. E. F. Armstrong and T. P. Hilditch, 406
Cattle: Food Calendar, Lever Bros, 119; Foods, The Classification of, J. Alan Murray, 553; the Fattening of, Application of the Food-unit Method to, Prof. J. Wilson, 682
Cawthorn Research Institute, The, Prof. T. H. Easterfield Appointed Director of; T. Rigg Appointed Agricultural Chemist at, 442
Celebes and Other Places, Dr. Th. Mortensen to Lead an Expedition to, 78
Central: America and the Antilles, The Existing Flora of, Prof. W. Trelease, 476; Canada, The Pre-Cambrian Rocks of, Dr. Miller, 485
Cephalodiscus and the Archichordates, 481
Cerebral Cortex, Sensation and the, Dr. Head, 267
Cerebro-spinal Fever, the Epidemiology, Symptoms, and Treatment of, Dr. Rolleston, 359
Cestrinus, Er. (fam. Tenebrionidæ), and Some Allied Genera, K. G. Blair, 407
Ceylon, the Problem of the Stone Ages in, E. J. Wayland, 609
Chadwick Public Lectures, Forthcoming, 712
Chætognatha in Plankton Taken off the North Coast of Java, Dr. R. van Ove, 446
Chalcostibite, a Remarkable Deposit of, in Morocco, H. Ungemach, 387
Characters in Organisms, The Existence of two Fundamentally Different Types of, Dr. R. R. Gates, 713
Charters Towers Goldfield, The, J. H. Reid, 515
Chatham School of Military Engineering, Major G. Thorp Appointed Chief Instructor in Electricity at the, 186
Cheese: and Butter-making, 528; The Book of, C. Thorn and Prof. W. W. Fisk, 528
Chemical: Dictionary, The Condensed, 622; Elements, The Discovery of, Since, 1869, Prof. H. B. Dixon and H. Stephen, 221; The Mass Spectra of the, F. W. Aston, 714; Industries, General Position of, in the Chief Countries of the World, R. P. Duchemin, 268; The Organisation of, 484; Materials, The Mechanical Handling of, G. F. Zimmer, 137; Society, changes in the Officers and Council of the, 701; Forthcoming Lectures at the, 158; The Library of the, F. W. Clifford, 298; Technology, The, 65; Warfare, The Development of, Brig.-Gen. Hartley, 455
Chemicals, The Manufacture of, by Electrolysis, A. J. Hale, 529
Chemist, the Government, Report of, 575
Chemistry: Annual Reports on the Progress of, for 1918, issued by the Chemical Society, Vol. xv., 91; Applied, in relation to University Training, Prof. G. T. Morgan, 147; at the British Association, 455; Elementary Practical, Part i., General Chemistry, Prof. F. Clowes and J. B. Coleman, Seventh edition, 688; Handbooks of, 497; Industrial, Dr. C. Ranken, 497; Industrial, 622; in the Making, Prof. H. E. Armstrong, 219; Organic, for Students of Medicine, Prof. J. Walker, Second edition, 499; Physical, Past and Present, Prof. J. C. Philip, 223; Text-book of, Prof. A. T. Lincoln, 3; Practical, Senior, H. W. Bansor, 497; Progress of, Sir Edward Thorpe, 217; The Position of, in Germany and this Country as a Result of the War, Sir William Pope, 455; The Profession of, R. B. Pilcher, 409; Theoretical, Outlines of, Dr. F. H. Getman, Second edition, 3
Chemists, the British Association of, the Second Annual Meeting of, 319
Chemists' Year Book, The, 1918-19, Edited by F. W. Atack, assisted by L. Whinyates, 2 vols., 112
Chicago University, foundation of the Edith Barnard Memorial Fellowship in, 67
China, Scientific Researches and Collections in, Proposed Swedish Grant towards, 178
Chinese Bronze, An ancient, Sir C. Hercules Read, 574
Chippawa-Queenston Hydro-electric Development Scheme, The, Dr. B. Cunningham, 483
Chlorinated Methyl Carbonates, The Properties of the, A. Kling, D. Florentin, and E. Jacob, 683
Chlorination of Methyl Formate and Methyl Chloroformate, V. Grignard, G. Rivat, and Ed. Urbain, 491
Chloromethylchloroformates, Preparation of, A. Kling, and others, 459
Chloropicrin: Comparative Action of, on the Weevil and on Tribolium, G. Bertrand, Brocq-Rousseu, and Dassonville, 619; Insecticidal Power of, Influence of Temperature and other Physical Agents on the, G. Bertrand, and others, 459; Production of a Gas in the Distillation of, J. A. Gardner and F. W. Fox, 419
Chromosome Dimensions, A further Study of, C. F. U. Meek, 426
Citizenship, Training in, Bishop Welldon, 522
Civil Engineers, Institution of, Abstracts of Papers of the, 674
Civilisation, The Origin of, with Special Reference to the Nile Valley, Prof. J. H. Breasted, 267
Classics in the Educational System of the United Kingdom, Appointment of a Committee upon, 364
Clays, Relations between Chemical Composition, Microscopic Structure, and the Ceramic Qualities of, L. Bertrand and A. Lanquine, 523
Climate, Factors Controlling, Prof. W. J. Humphreys, 610
Climates, Classification of, Proposed Alterations in the, W. Koppen, 418
Coal at Port-Gueydon, Discovery of a lens of, G. B. M. Flamand, 307
Cobalt Group, $R_2Co\ (SeO_4)_2,\ 6H_2O_1$, Crystallographic properties of the Monoclinic Double Selenates of the, Dr. A. E. H. Tutton, 447
Cocks, Alimentary Castration in, Submitted to an Exclusively Carnivorous Diet, A. Pézard, 523
Cocoa, Production and Consumption of, 10

College Studies, Prof. H. W. Stuart, 490
Colliery Boiler-plants, Performance of, D. Brownlie, 120
Colloid and Saline in Shock and Cholera, Prof. B. Moore, 131
Colloidal: Electrolytes, Soap Solutions and their Constitution, J. W. McBain and C. S. Salmon, 712; gels, Seric Toxicity and the Physical Properties of, W. Kopaczewski and Mme. Z. Gruzewska, 651
Colloids: Amphoteric, Prof. J. Loeb, 15; Recent Work on, Dr. R. S. Willows, 650
Cologne Post, The, 458
Colonial Services, Agricultural Departments in the, Appointment of a Committee to consider the, 325
Colour: and Chemical Constitution, Part ix., J. Moir, 491; Change of, in Captive Birds, Sir Herbert Maxwell, 693; in Plumage, Change of, of Captive "Sun-birds," or "Honey-suckers," H. Millar, 600; Kinematographs of the Gaumont Establishment, J. Charpentier, 387; -Matching by Natural and Artificial Light, L. C. Martin, and others, 610; Vision, A Photo-electric Theory of, Prof. J. Joly, 74; Sir Oliver Lodge, 92; Dr. H. S. Allen, 174
Columbia University, Bequest to, by Gen. H. W. Carpentier, 167
Comet: 1916*c*, Orbit of, H. Vanderlinden, 80, 119; 1919*b*, Ephemeris of, Braae and Fischer-Petersen, 138, 180; Spectrum of, Prof. Slipher, 576; 1919*g*, Dr. Halm, 612; 1920*a*, Discovery of, C. Solá, 576; Notes, 43,
Comets: Miss V. Hansen and F. Petersen; Prof. Wolf; M. Ebell, 66, 100, 269, 321, 361, 380, 448; Metcalf and Borrelly, Observations of the, L. Picart and F. Courty, 128
Common-sense Philosophy, Essays in, C. E. M. Joad, 352
Congo, Return of Dr. K. E. Laman from the, 177
Congress, Librarian of, Report of the, 43
Conquest, No. 1, 321; February, 641
Continuation Schools, Sir Robert Blair, 522
Copper: -antimony Alloys, Expansion of, P. Braesco, 651; in the Tissues of Green Plants, Distribution and Migration of, L. Maquenne and E. Demoussy, 651; -refining Industry, A new, in Great Britain, 666; the Richness in, of Cultivated Soils, L. Maquenne and E. Demoussy, 407
Coral-reefs, the "Glacial-control" Theory of the Growth of, Prof. R. A. Daly, 360

CORRESPONDENCE.

Aluminium, New Sources of, Major J. E. Bacon, 277
Atomic Energy, Sir Oliver J. Lodge, 435
Axolotl, Metamorphosis of, caused by Thyroid-feeding, J. S. Huxley, 435
Biological Science in Secondary Schools, Prof. S. J. Hickson, 693
Bird Migration, Dr. M. C. Grabham, 334
Blood Corpuscles, Sedimentation of, Prof. A. E. Boycott, 532
Blue-bottle Flies, Mortality among Snails and the Appearance of, Dr. N. Annandale, 412
British Botanic Gardens and Stations, Dr. W. E. Freeman; The Writer of the Article, 469
British Imperial Antarctic Expedition, A, J. L. Cope, 93
British Iron-Ores, D. A. E. Evans; Prof. H. Louis, 565
British Technical Optics, The Outlook of, Prof. F. Cheshire, 530
British Well-worms, Rev. H. Friend, 5
Colloid and Saline in Shock and Cholera, Prof. B. Moore, 131
Colour, Change of, in Plumage of Captive "Sun-birds" or Honey-suckers, H. Millar, 600
Colour in Captive Birds, Change of, Sir Herbert Maxwell, 693
Colour Vision, A Photo-electric Theory of, Prof. J. Joly, 74; Sir Oliver Lodge, 92; Dr. H. S. Allen, 174
Earth, The Rigidity of the, Dr. A. A. Michelson and H. G. Gale, 114
Einstein's Theory and a Map Analogue, E. Cunningham, 437
Einstein Theory, The, and Spectral Displacement, H. Fletcher Moulton, Dr. A. C. D. Crommelin, 532
Electronic Theory of Isomerism, An, W. E. Garner, 661
Elements, The Constitution of the, Dr. F. W. Aston, 393
Enchytræid Worm, A New British, Rev. H. Friend, 174
Entente Scientific Literature in Central Europe during the War, R. W. Lawson, 437; Prof. B. Brauner, 600
Euclid, Newton, and Einstein, W. G., 627
Explosion at Bailleul, The, S. Pickering, 5
Fishery Investigations and the Balance of Life, Prof. W. Garstang, 48; Prof. W. C. McIntosh, 49
"Flying Gallop," The, in Art, Dr. B. Laufer, 114
Fraunhofer Lines, The Predicted Shift of the, J. Rice, Prof. A. S. Eddington, 598
Gravitation and Light, Sir Oliver Lodge, 334, 354, 372; Sir Joseph Larmor, 412, 530
Gravitation, Radio-activity and, Sir Ernest Rutherford and Dr. A. H. Compton, 412
Gravitational Deflection of High-speed Particles, L. Page, 692
Holland and International Rivers, Dr. P. Geyl; Prof. L. W. Lyde, 333
House-fly, The Hibernation of the, Sir Herbert Maxwell, 435
International Councils, National Representation upon, Dr. Norman R. Campbell, 72
International Relations in Science, Prof. D'Arcy W. Thompson, 154; Sir E. Ray Lankester, 172
Intravenous Injections of Gum Solutions in Cholera, Sir Leonard Rogers; Prof. W. M. Bayliss, 73
Isotopes, The Separation of, Dr. A. Fleck, 565
Isotopes, The Spectra of, Dr. T. R. Merton, 93
Katmai Volcanic Gases and Encrustations, The Nature of the, J. W. Shipley, 595
King Penguin, The Breeding of the, T. H. Gillespie, 314
Light, Gravitation and, Sir Joseph Larmor, 412, 530
Light, Polarisation of, scattered by Helium Atoms, Lord Rayleigh, 412
Light Rays passing near the Sun, The Displacement of, Prof. A. Anderson, 354
Light, Scattering of, by Resonating Molecules, Lord Rayleigh, 276
Light, The Deflection of, during a Solar Eclipse, Prof. A. S. Eddington; Dr. A. C. D. Crommelin, 372; W. H. Dines; L. F. Richardson, 303; Prof. A. Anderson, 394, 436, 563; Capt. C. J. P. Cave, 413; Sir Arthur Schuster, 468
Limpet, Common, Sex-phenomena in the, Dr. J. H. Orton, 373
Lion, Fossil, Remains of a, in Ipswich, Nina F. Layard, 413
Magnetic Storm of August 11-12, 1919, The, A. Graham Bell, 74; J. Evershed, 436; Dr. C. Chree, 468
Man, The Antiquity of, J. Reid Moir; Dr. A. Smith Woodward, 335
Mirage Effects, Cicely M. Botley, 56-; S. Pickering; L. N. Norris-Rogers; H. Hillman, 630; R. Ross; A. Tarn, 662
Musical Drums with Harmonic Overtones, Prof. C. V. Raman and Sivakali Kumar, 500
National Union of Scientific Workers and Research, The, Dr. H. Jeffreys, 23
Natural History Museum, Progress of the, Dr. S. F. Harmer, 353
Neon, Dr. F. W. Aston, 334
October, 1919, Exceptional Dryness of, W. D. Christmas, 278
Optics, British Technical, The Outlook of, Prof. F. Cheshire, 530
Organisation of Scientific Work, Dr. A. B. Rendle, 691; Prof. F. Soddy, 691
Percussion Figures in Isotropic Solids, Prof. C. V. Raman, 113; J. W. French, 312; W. J. L. Abbott, 600
Pleochroic Haloes, Reversed, Prof. J. Joly and J. H. J. Poole, 92
Plumage Bill, Promotion of a, H. J. Massingham, 413; Prof. J. E. Duerden, 499; Proposals for a, L. Gardiner; W. Dewar, 564
Popular Science, Victorian, 630
Prague, A Tribute from, Prof. B. Brauner, 374
Prismatic Binocular, Use of a, for viewing near Objects, Capt. D. Wilson Barker, 532

Racehorses, The Colours of, Sir William Ridgeway, 334
Radiation Temperatures, S. Pickering, 153; Dew, S. Skinner, 277
Radio-activity and Gravitation, Sir Ernest Rutherford and Dr. A. H. Compton, 412
Radio-activity, Relativity and, Prof. J. Joly, 468
Reaction and Gravitational Field, Heat of, Prof. F. G. Donnan, 392
Refractive Index, Variations of, F. Twyman, 315
Refractive Indices, Variation of, Sir Henry A. Miers, 334
Relativity and Radio-activity, Prof. J. Joly, 468
Relativity and the Displacement of Fraunhofer Lines, Prof. W. G. Duffield, 659
Royal Meteorological Society's Phenological Returns, H. B. Adames and J. E. Clark, 437
Scientific and Industrial Research, The Control of, Dr. W. M. Travers, 597
Scientific Workers and a National Federation, Major A. G. Church, 693
Sex-phenomena in the Common Limpet, Dr. J. H. Orton, 373
Silica Glass, The Doubly Refracting Structure of, Lord Rayleigh, 153; R. W. Lawson, 335
Silkworm, Linkage in the: A Correction, Prof. W. Bateson, 315
Snails, Mortality among, and the Appearance of Blue-bottle Flies, Dr. N. Annandale, 412
Sociological Society, The, T. J. C. Fraser Davies, 662
Spectral Lines, Displacement of, R. W. Lawson, 565
Straight Path, The, Dr. A. A. Robb, 599
Strasbourg, The University of, Mathematics at, H. B. Heywood, 74
Sugar-beet Seed, Prof. T. D. A. Cockerell, 661
Sun, Power from the, A. A. Campbell Swinton, 392, 532; A. S. E. Ackermann, 500
Surface-tension, C. T. Whitmell, 278
Temperature in the Sun, A. Mallock, 113
Thermionic Valves on Aircraft, Prof. R. Whiddington, 630
Thunder, The Audibility of, Capt. C. J. P. Cave, 132; Dr. H. O. Forbes, 315
Time Relations in a Dream, J. Barcroft, 154
Ultra-violet, A Helium Series in the Extreme, Prof. T. Lyman, 314; Prof. W. M. Hicks, 393; Prof. T. Lyman, 565
Valour and Service, Statistics of, Major A. G. McKendrick, 660
Vertical-pipe Irrigation for Orchards and Market-gardens in Arid Climates, Prof. I. Giglioli, 276
Volcanic Rocks in Northern Kordofan, Sudan, W. Campbell Smith, 693
"White Water," The, Capt. A. R. Palmer; Prof. J. Stanley Gardiner, 563
Wireless Stimulation, The Response of Plants to, Sir J. C. Bose, 172
Wool, Fine, A Search for, Prof. J. C. Ewart, 153
Worms, Luminous, Rev. S. Graham Brade-Birks, 23, 93; H. E. Aldridge, 174; Rev. H. Friend, 334

Cotton: Growing in the British Empire, Sir George Watt, 694; Industry, Botanical Research Studentships in Connection with the, 186
Crabro cephalotes, Note on the Solitary Wasp, C. Warburton, 366
Craibstone Animal Nutrition Research Institute, Dr. R. H. A. Plimmer appointed Head of the Department of Bio-Chemistry of, 127
Cretaceous Plant-remains from Tennessee, &c., Dr. E. W. Berry, 542
Criminology: Dr. M. Parmelee, 687; and Nervousness, 687
Crop Plants, The Botany of, Prof. W. W. Robbins, 46
Cross-Circulation as a Physiological Method, Prof. W. M. Bayliss, 479
"Crossing-over," J. W. Gowen, 541
Crystal: A curious, from the Binnental, Dr. G. F. H. Smith, 326; -forms, New, on Pyrites, Calcite, and Epidote, L. J. Spencer, 326
Cuba, Eastern, Mammals Collected During 1917 in, Dr. H. E. Anthony, 672
Cultivated Plants, Botany of, 46
Cultural Reality, Dr. F. Znaniecki, 110
Cyanamide, The Transformation of, into Urea by the Micro-organisms of the Soil, P. Mazé, Vila, and Lemoigne, 387
Cyanogen Chloride, Ch. Mauguin and L. J. Simon, 88; Preparation of, by Held's Method, Ch. Mauguin and L. J. Simon, 44
Cycadophyta, Classification of the, Dr. G. R. Wieland, 509
Cycads, The Living, Prof. C. J. Chamberlain, 410
Cylindrical Conductors, Equal Parallel, in Electrical Problems, F. J. W. Whipple, 365
Cyprus: Excavations in, in 1913, Prof. J. L. Myres, 487; Measurements of Skulls in, L. H. D. Buxton, 487

Dabchick, The Courtship of the, J. Huxley, 359
Dairying, The Outlook in, J. Mackintosh, 554
"Daily Telegraph" Victory Atlas of the World, The. Part i., 276, 419; The Review in NATURE of the, 674
Dalhousie University, Halifax, Nova Scotia, Centenary of, 146
Dams: Studies in the Construction of, Earthern and Masonry, Prof. E. R. Matthews, 434
Danes' Dyke, T. Sheppard, 445
Dartmoor: Hydro-electric Supply Scheme, Abandonment of the, 541; Water-power and, 461
Davy-Faraday Research Laboratory, The, of the Royal Institution, 264
"Daylight," or Colour-matching Lamp, A New Form of, L. C. Martin, 358

DEATHS.

Aitken (Dr. J.), 318, 337
Barrell (Prof. J.), 444
Bissell (Dr. W. G.), 357
Chadwyck-Healey (Sir Charles), 136
Chalmers (S. D.), 318
Chapman (R. H.), 608
Cummings (B. F.), 177
Dallas (W. L.), 63
Dunlop (Sir Nathaniel), 340
Eötvös (Baron R. von), 319
Fraser (Sir Thomas R.), 474, 505
Garner (R. L.), 573
Greenwood (Dr. H. C.), 443
Groves (C. E.), 608, 637
Harcourt (Dr. A. G. Vernon), 49
Haverfield (Prof. F. J.), 117
Hazen (Dr. J. V.), 357
Headley (F. W.), 358
Hitchcock (Prof. C. H.), 358
Hopkins (Dr. G.), 442
Izat (A.), 540
Jackson (Sir John), 398
Jourdain (P. E. B.), 117
Keeling (Lt.-Col. B. F. E.), 317
King (Prof. L. W.), 27
Lyster (Dr. C. R. C.), 572
Macalister (Prof. A.), 8, 26
Macloskie (Prof. G.), 540
McKelvy (E. C.), 507
Marshall (Rev. E. S.), 377
Mercier (Dr. C. A.), 8, 50
Moreno (Dr. F. P.), 508
Nethersole (Sir Michael), 607
Osler (Sir William), 443, 472
Palmer (G. W.), 136
Pirsson (Prof. L. V.), 443
Raworth (B. A.), 135
Reynolds (Prof. J. Emerson), 701
Riccò (Prof. A.), 378
Sachs (E. O.), 63
Smith (Dr. V. A.), 671
Strassmaier (Father J. N.), 506, 540
Trail (Prof. J. W. H.), 76
Turner (H. G.), 702
Wallace (R. F.), 573
Walsingham (Lord), 376
Warre (Rev. Dr. E.), 572
Werner (Prof. A.), 376

Whitmell (C. T.), 398
Wicksteed (J. H.), 443
Wilson (Dr. J.), 539

Decimalisation of Currency, The, Allum, 579
"Dengora baiari" Initiation Ceremony, The, Lieut. E. W. P. Chinnery, 386
Diabase and Associated Rocks of the Howqua River, Victoria, E. O. Teale, 108
Dietetic Deficiency, Effect of, on Immunity to Disease, Dr. S. S. Zilva, 66
Diffraction Patterns in the Presence of Spherical Aberrations, Mrs. C. H. Griffiths, 682
Digamma and Trigamma Functions, Tables of the, E. Pairman, 341
Digitalis, Vigour of Growth, compensating Sterility, in the Hybrids of Species of, L. Blaringhem, 88
Dimethyl Sulphate, Action of Hydrates, Oxides, and Carbonates of the Alkaline Earths on, J. Guyot and L. J. Simon, 167
Dinosaurian Reptile in the Congo Region, Report of a, 396; W. D. Gray, 701
Discovery, Forthcoming Publication of a New Journal entitled, 186; No. 1, 554
Disturbance Propagated into a Medium, The Problem of Finding the Strengths of the Sources of, Sir Joseph Larmor, 419
Dolium, Antiquity of, E. A. Martin, 446
Douglas Firs, The, Prof. A. Henry and Miss M. G. Flood, 682
Dragon: The Evolution of the, Prof. G. Elliot Smith, 350; of Mythology, 350
Drainage, Sub-surface, An Interesting Form of, M. Aurousseau, 587
Dudley Technical College, Dr. J. H. Grindley appointed Principal of the, 306
Dundee: University College, Dr. J. F. Gemmill appointed Professor of Natural History at, 67; J. S. W. Boyle appointed Lecturer and Assistant in Chemistry in, 87; Capt. J. W. Low appointed Assistant in the Natural History Department of, 712
Durham University: Capt. L. L. Burchnall appointed Lecturer in Mathematics in, 385; Forthcoming Definitive Edition of the Roll of Service and Roll of Honour, 425
Dust-whirls in Sub-arid Western Australia, J. T. Jutson, 619
Dyer-va-val Initiation Ceremony, The, R. H. Matthews, 40
Dynamics. Part ii., R. C. Fawdry, 109

Earth, The Rigidity of the, Dr. A. A. Michelson and H. G. Gale, 114
Earthquake: in Mexico, A Violent, 474; Shock in the Region of Monte Amiata, near Siena, 63; Waves through the Body of the Earth, Propagation of, Prof. C. G. Knott, 477
Earthquakes, Destructive, in Mexico, 508
Earth's Interior, The Temperature of the, Prof. C. H. Lees, 713; Magnetic Field, Reducing the measurement of the Horizontal Component of the, Prof. W. Uljanin, 510
East: Africa and Uganda Natural History Society, Journal of the, 10; Indian Seas, Meteorological Conditions of the, 119
Echinus Larvæ, The Artificial Production of, with a Double Hydrocœle, Prof. E. W. MacBride, 456
Eclipses, The Cycle of, M. Auric, 459
Economic Position of the Country, The Present, A. E. Doxford, 268
Economics at the British Association, 485
Edinburgh University: Developments in, 87; Bequest to, by S. Elliott; Projected additional equipment for the Engineering Laboratory, 425; Dr. F. E. Jardine appointed Lecturer on Applied Anatomy, and Dr. D. Lees Lecturer on Venereal Diseases; Presentation of Geology volumes to the Geology Department, by Lord Lyell of Kinnordy, 425; Dr. G. M. Robertson appointed Professor of Psychiatry; Dr. J. H. Ashworth Professor of Zoology, and T. P. Laird Professor of Accounting and Business Method, 425
Educated Men, Need in the country of, for directing Business Affairs, Sir H. E. Morgan, and others, 522
Education: Adult, 452; and Life, 169; and Science, Large Gift for, J. D. Rockefeller, 457; at the British Association, 521; Board of, Appointment of a Departmental Committee of the, on the award of scholarships, and for the provision of free places in secondary schools, 186; for the Needs of Life: A Text-book in the Principles of Education, Dr. I. E. Miller, 169; Fundamental Principles in, Prof. A. N. Whitehead, 522; in British India, 101; in India, Seventh Quinquennial Review of the Progress of, H. Sharp, 156; National, Problems of, Twelve Scottish Educationists, Edited by J. Clarke, 89; Technical, Fifty Years of, J. H. Reynolds, 257
Educational: Associations, Forthcoming Conference of, 365; The Eighth Annual Conference of, 513; Conferences, 513; Grants for ex-Service Officers and Men, 68
Egypt: Irrigation in, Appointment of a Commission on, 580; Western, Desert Flora of, Capt. H. H. Thomas, 520
Eighteenth-Century Physician, An, 1
Einstein, Prof., Interview with, 541
Einstein's Theory of Gravitation, Sir Joseph Larmor, and others, 339; E. Cunningham, 354; 374; Prof. Eddington; Sir Oliver Lodge, 377; E. Cunningham, 394; Prof. A. S. Eddington, and others, 454; Dr. Crommelin, 514; C. Longo, 552; and a Map Analogue, E. Cunningham, 437; and its Observational Tests, Prof. R. A. Sampson, 458; and Spectral Displacement, H. Fletcher Moulton; Dr. A. C. D. Crommelin, 532
Electric: Amplifiers, Triode Valves as, Prof. W. H. Eccles, 501; Charge on Rain, Further Observations of the, J. A. McClelland and A. Gilmour, 682; Spark Ignition, Principles of, in Internal-combustion Engines, J. D. Morgan, 372; Waves, Diffraction of, Prof. G. N. Watson, 454
Electrical: Invention, Progress of, Prof. J. A. Fleming, 239; Properties of Gases, The Influence of Investigations on the, on our Conceptions of the Structure of Matter, Sir J. J. Thomson, 224; Resistance of the Hand, Prof. A. D. Waller, 520
Electrician, Resignation by W. R. Cooper of the Editorship; Appointment of F. H. Masters as Editor, 266
Electricity: (Supply) Bill, The, 338; Read a Second Time in the House of Lords, 376; 416
Electrification of Railways, The, R. T. Smith, 320
Electro-chemical Treatment of Seeds, A Manual of the, Dr. C. Mercier, 562
Electrode Valves, Three, Special Arrangements of. Prof. Eccles, 487
Electron: Collisions with Platinum and with Hydrogen, Effects of, F. Horton and Ann C. Davies, 618; Radium and the, Sir Ernest Rutherford, 226; Velocities for the Production of Radiation and Ionisation on Collision with Argon Atoms, Experimental Determination of the critical, F. Horton and Ann C. Davies, 406
Electrostatic: Measurements, Utility of Desiccants in, V. H. Jackson and A. T. Mukerjee, 459; Potentials, High, An Apparatus for the Production of, J. J. Dowling, 428
Electrotechnical Commission, International, Meeting of the, 177
Elementary Children, The Selection of, for Higher Forms of Education, G. F. Daniell, 513
Elements, The Constitution of the, Dr. F. W. Aston, 393
Eleotris Legendrei, The Food of, J. Legendre, 347
Embryology, Text-book of, Vol. ii., Vertebrata, with the Exception of Mammalia, Prof. J. Graham Kerr, 309
Empirical Formulas, Prof. T. R. Running, 109
Employers and Employed, The National Alliance of, Rt. Hon. F. Huth Jackson, 485
Encephalitis Lethargica, an Obscure Disease, Report of an inquiry into an, 452
Energy: Output of Dock Labourers during Heavy Work. Part i., Dr. A. D. Waller, 427; Sources of, Sir Oliver Lodge, 75
Engine Performance, Reduction of, at a Great Height, Col. Tizard, 486
Engineering: Abstracts, Separate Issue of, by the Institu-

tion of Civil Engineers, 179; at the British Association, 486; Manufacture, The Rise of, Prof. F. W. Burstall, 74; Standardisation, G. Lightfoot, 447; Workshop Practice, Modern, H. Thompson, 352
English: Rock Garden, The, A. Farrer, 2 vols., 664; The Teaching of, Sir A. Quiller-Couch, 521; in Relation to School Science, W. D. Eggar, 521
Entente Scientific Literature in Central Europe during the War, R. W. Lawson, 436; Prof. B. Brauner, 600
Entomologists at the Natural History Museum, The Pay of, 339
Equations, Solving, A Survey of the Numerical Methods of, Prof. E. T. Whittaker, 550
Essex, Pre-History in, as recorded in the Journal of the Essex Field Club, S. H. Warren, 112
Estimates, Tentative Revised, in a "Normal" Year, 177
Ethnography and Condition of South Africa before A.D. 1505, Dr. G. McCall Theal. Second Edition, 315
Etiolated Plants, Causes of the Elongation of the Stem of, H. Coupin, 683
Eton College Scientific Society, a Conversazione of the, Presentation to W. D. Eggar the retiring President; Dr. R. Whytlaw Gray elected President of the, 444
Eucalyptus: Coloration of the Young Foliage of, J. H. Maiden, 555; Oils, The Germicidal Activity of the, Part ii., Dr. R. Greig-Smith, 20; Two new Western Australian Species of, J. H. Maiden, 168; *viminalis*, Determination of the Increment of Trees by Stem Analysis, W. A. W. de Benzeville, 587
Euclid, Newton, and Einstein, W. G., 627
Eugenics: 351; and Environment, Prof. C. Lloyd Morgan, 351; Education in the Training College; Eugenics Education in the School, Dr. R. D. Laurie, 513
Europe, Boundary Delimitation in, A. R. Hinks, 445
Evolution: Facts and Factors of, 149; Heredity and, Prof. G. H. Carpenter, 81; of Ostrich Plumes, 155; Organic, The Causes and Course of, A Study in Bioenergics, Prof. J. M. Macfarlane, 149; The Factors of, Prof. L. B. Walton, 81
Exercise and Humid Heat, Effects of, upon the Pulse-rate, Blood-pressure, Body Temperature, and Blood Concentration, W. J. Young, A. Breinl, J. J. Harris, and W. A. Osborne, 345
Experimental Researches carried out in the Department of Glass Technology, University of Sheffield. Vol. i., 1917-18, 2
Exploration of the Sea, International Council for the, Vol. xxv. of the "Rapports et Procès-Verbaux" of the, 78; Forthcoming Meeting of the, 701
Explosion Motors for Rarefied Atmospheres, J. Villey, 683
Explosives: High, Manufacture of, during the War, Col. C. D. Crozier, 455; Industrial, Development of Inertness in, E. A. Mann and T. N. Kirton, 647
External and Internal Relations, Dr. G. E. Moore, 490

Familiar, The Study of the, 465
Faraday, The Work of, and the Faraday Society, Sir Robert Hadfield, 539
Farm: A Large State, A Business and Educational Undertaking, Lt.-Col. A. G. Weigall and C. Wrey, 592; Concrete, K. J. T. Ekblaw, 495
Farmer, The, and the New Day, K. L. Butterfield, 592
Farming in the New Era, Dr. E. J. Russell, 592
Fauna of the Inlé Lake, The, Dr. N. Annandale and others, 176
Fernley Observatory, Meteorological Observations made at the, in 1918, J. Baxendell, 477
Ferns: British, and How to Identify Them, J. H. Crabtree, 410; Medullated, Nature and Origin of the Pith and Inner Endodermis in, Dr. M. Thompson, 521
Fibroferrite from Cyprus, C. E. Barrs, 649
Fibula of a Newly Born Infant of the Polished Stone Period, The, and Consequences in Anatomical Philosophy, M. Baudouin, 459
Field-mouse, A New Species of, from Foula, M. A. C. Hinton, 418
Finlay Comet: Return of the, B. Baillaud, 367; Prof. Crawford and Misses Fairfield and Cummings, 380; Observations of, M. Michkóvitch, M. Giacobini, P. Chofardet, A. Schaumasse, 387; H. Godard, 459
Finnic Population, Nordic and Mongoloid Elements in the, H. Peake, 487
Fireball: A Large, 321; on December 25, 448; Large, on January 16, 544; of January 16, The, 576; Large, on February 4, 642
Fishery: Investigations, Proposed International Scheme of, 318, International Council for, Report for 1913 of the, 541; in South Africa, Report on, Prof. J. D. F. Gilchrist, 615
Fishes: Fresh-water, Distribution of, C. Tate Regan and others, 456; Larval and Post-larval, Food of, Dr. Marie Lebour, 457
Fishing, Deep-sea, The Extension of Territorial Waters in Relation to, Prof. J. Johnstone, 135; Industry, The Reconstruction of the, 133; -log of a Painter in Brittany, Golden Days from the, R. Fedden, 391
Flamsteed, John, The Bicentenary of the Death of, 417
Flashes Produced by the Fire of Artillery, M. Delpech, 187
Flax Production in Great Britain, Report on, 98
Flies, Bluebottle, Mortality among Snails and the Appearance of, Dr. N. Annandale, 412
Flint Implements from the Chalky Boulder Clay of Suffolk, J. Reid Moir, 706
Flints, Humanly fashioned, in the Middle Glacial Gravel at Ipswich, J. Reid Moir, 508
"Flora Arabica," part i., Prof. E. Blatter, 609
Flora of Macquarie Island, The Vascular, T. F. Cheeseman, 101
Flotation: A Contribution to the Study of, H. L. Sulman, 401; Principles of Ore Extraction, 401; Process, the, 673
Flow of Water through a Pipe, the Orifice as a Means of Measuring the, Davis and Jordan, 647
Flower, The, and the Bee: Plant Life and Pollination, J. H. Lovell, 132
Flowers, Cut, Longevity of, Ellinor Archer, 619
Fluorescence, Researches on, 526
"Flying Gallop," The, in Art, Dr. B. Laufer, 114
Food Production: in England, Sir T. Middleton, 553; in Scotland, J. M. Caie, 553; War-time and Post-war Problems of, Dr. E. J. Russell, 553; Substances, Accessory, Prof. W. D. Halliburton, and others, 520
Fog in London on January 31, 1918, Incidence of, C. E. P. Brooks, 675
Foraminiferæ (Cyclostègnes), The Annular, of Orbigny, H. Douvillé, 523; Hitherto unemphasised Modifications of Growth in the life-history of, E. Heron-Allen and Mr. Earland, 456
Forestry: Act, The Appointment of Commissioners under the, 318; Acts, Appointment of Commissioners under the, 295
Forthcoming Books of Science, 11, 42, 66, 80, 100, 138, 179, 298, 320, 321, 342, 360, 380, 400, 419, 447, 478, 511, 544, 576, 611
Fossils, Japanese Memoir on, 542
Fothergill, Dr. John, and his Friends: Chapters in Eighteenth-century Life, Dr. R. H. Fox, 1
Foulerton award of the Geologists' Association, T. W. Reader selected for the, 397
Fraunhofer Lines, The Predicted Shift of the, J. Rice; Prof. A. S. Eddington, 598
French Ministry of Inventions, The, 99; Republic, Welcome to London of the President of the, 295
Fresh-water Biology, Profs. H. B. Ward and G. C. Whipple, 498
Frost and the Growing Season, W. G. Reed, 95
Frosts: and Agriculture in the United States, 95; Forecasting, B. A. Keen, 450
Fruit: Culture in Malaya, J. N. Milsum, 78; -Grower, Problems of the, 558; The true species complex of, W. B. Brierley, 520
Fungi, The Species Concept among, W. B. Brierley, 708

Galton Lecture of the Eugenics Education Society, The, Prof. A. Keith, 670
Gas: Combustible, Present in the Air, Instruments for Detecting and Measuring, 65; Forthcoming Introduction

of a Bill relating to the Value and Supply of, 296; Warfare, Defensive Science in, Lt.-Col. P. S. Lelean, 646
Gases: Ignition of, by Hot Wires, Dr. Thornton, 487; Industrial, Dr. H. C. Greenwood, 622; Ionisation of, Prof. J. S. Townsend, 233; The Influence of Investigations on the Electrical Properties of, on our Conceptions of the Structure of Matter, Sir J. J. Thomson, 224; The Liquefaction of, Prof. C. H. Lees, 247; The Occlusion of, by Metals: A General Discussion held by the Faraday Society, November, 1918, 690
Gaspé Bird Sanctuaries, The, I. M. Clarke, 117
Gearksutite at Gingin, Western Australia, Dr. E. S. Simpson, 649
Gentile, Giovanni, The Philosophy of, Prof. J. A. Smith, 586
Geo-chemistry, Some Recent Problems in, Prof. Boswell, 455
Geography: Progress of, Sir John Scott Keltie 249; The Educational Aspects of, E. K. Lomas, 517; The Encouragement of, in the higher forms of Secondary Schools, T. W. F. Parkinson, 514
Geological: Society Awards, 507; Survey of Great Britain, Summary of Progress of the, 1918, 477: Work on the Western Front, W. B. R. King, 476
Geologists' Association, Some Future Work for the, G. Barrow, 510
Geology: at the British Association, 484; of India for Students, D. N. Wadia, 502; of South Australia, The. In two Divisions, W. Howchin, 91; of the country around Lichfield, 640; The Expansion of, Prof. T. G. Bonney, 203
Geometry; Analytic, Profs. M. M. Roberts and J. T. Colpitts, 390; Descriptive, H. W. Miller, Fourth Edition, 169; in Schools, Modern Teaching of, C. Godfrey, 550; Solid, including the Mensuration of Surfaces and Solids, Prof. R. S. Heath, Fourth Edition, 109
Georgia and Caucasia, Mineral Resources of, Manganese Industry of Georgia, D. Ghambashidze, 171
Geostrophic Wind, The Laws of Approach to the, F. J. W. Whipple, 458
German: Aviation Petrols, Analyses of, G. Chavanne, L. P. Clerc and L. J. Simon, 307; Prisoners of War in England, Anthropological Examination of, Prof. F. G. Parsons, 475; Technology, The Imperial League for, 65
Germany, Present position of the Chemical Industry of, E. V. Evans, Dr. G. S. Walpole, 484
Girton College, Cambridge, Gift to, 585
Glacial Retreat, Minor Periodicity in, W. B. Wright, 682
Glasgow: Technical College, Appointments at; Gifts to, 19; The British Science Exhibition, 343; University, Appointments in, 126; Installation of President Poincaré as Rector; Conferment of the Honorary Degree of LL.D. upon President Poincaré, 324; Gift to the University of Nancy; Gifts to, 325; Conferment of Honorary Degrees, 344
Glass: Experimental Researches on, 2; Research Association, The. E. Meigh, 299; R. L. Frink appointed Director of Research by the, 572; Trade, The Position of the, after the War, Dr. W. M. Travers, 455; -powder, Action of Reagents upon, P. Nicolardot, 2n
Glue, Manufacture of, in the Tropics, K. C. Srinivasan, 611
Glycerol in Fats, The Direct Replacement of, by higher Polyhydric Alcohols, Prof. A. Lapworth and L. K. Pearson, 399
Godman, the late F. Du Cane, Tribute to, Lord Walsingham, 40
Gold Coast, Discovery of Diamonds in the, A. E. Kitson 485
Gold Standard, Restoration of the, R. G. Hawtrey, 486
Gossypium in Pre-Linnæan Literature, H. J. Denham, 10
Government, the Science of, A new chapter in, B. Branford, 494
Grantia compressa, The Germ-cells and Early Development of, J. B. Gatenby, 427
Grass-land, Breaking up of, in 1918, Prof. B. Jones, 98
Gravitation and Light: Sir Oliver Lodge, 334, 354, 372; Sir Joseph Larmor, 412, 530; Einstein's Relativity, Theory of, E. Cunningham, 354, 374, 394; Radioactivity and, Sir Ernest Rutherford and Dr. A. H. Compton, 412
Gravitational Deflection of High-speed Particles, L. Page, 692
Greenland, Northern, Exploration of, 453
Grimaldi, Les Grottes de, fasc. iv., Tome i., Prof. M. Boule, 581
Guano Birds of Peru, R. E. Coker, 378
Guernsey: A Sculptured Human Figure discovered on the dolmen of Déhus, T. W. M. de Guérin, 487; The Megaliths in, Col. de Guérin, 117
Gum, Injections of, or of Plasma, after Bleeding, C. Richet, 491

Hadfields, Ltd., Essays by Apprentices of, on their Visit to London, 267
Haloes, &c., The Formation of, Capt. C. K. M. Douglas, 641
Halogen Acetic Esters, The Catalytic Reduction of the, P. Sabatier and A. Mailhe, 347
Hamburg University, Dr. F. Paneth appointed Professor of Chemistry in, 426
Handicraft, Rudiments of, W. A. S. Benson, 72
Hardening Solution for Gelatine Negatives, Ilford, Ltd., 11
Harmsworth's Universal Encyclopedia, Edited by J. A. Hammerton, No. i., 659
Harris, Sir William Snow, Work of, 417
Harvard: Observatory, The, at Mandeville, Jamaica, Prof. W. H. Pickering, 138; University, Dr. W. M. McDougall appointed Professor of Psychology in, 186
Harveian Oration, The, to be delivered by Dr. R. Crawfurd, 135
Hawaian: Bagasse, the Paper-making Qualities of, A. D. Little, 341; Island Reservation, The, A. M. Bailey, 117; Islands, &c., The Formation of the, T. G. Thrum, 508
Hazell Annual and Almanack, The New, Dr. T. A. Ingram, 562
Health, Public, The Untilled Fields of, Prof. C. E. A. Winslow, 703
Heat and Heat Engines, Examples in, T. Peel, 690; Energy, Atomic Disintegration and, Sir Oliver Lodge, 420
Helium: Series, A, in the Extreme Ultra-violet, Prof. T. Lyman, 314; Stars in Orion, The Group of, Dr. Bergstrand, 299
Hellenic Studies, the Society for the Promotion of, Retirement of G. A. Macmillan from the honorary secretaryship of, 319
Hell Gate Bridge, New York, 268
Heredity: Prof. J. Arthur Thomson, Third edition, 92; and Evolution, Prof. G. H. Carpenter, 81
Herrings, the Biometrics of the Spring-spawning, A. C. Johansen, 158
Herschel, Rev. H. Macpherson, 561
Heterochromatic Photometry, A solution of, permitting of a physical measurement of the Luminous Intensity, A. Blondel, 367
High: Pressures, Extremely, The Industrial Employment of, G. Claude, 307; Temperature, Humidity, and Wind, Effect of, on the Human Body, Lt. C. W. B. Normand, 366
Hindu: Civilisation, the Contributions of Bengal to, M. H. Shastri, 418; Spherical Astronomy, G. R. Kaye, 119
Historical Process, The, W. J. Perry, 490
History. The Outline of, being a Plain History of Life and Mankind, H. G. Wells, Part i., 371
Holland and International Rivers, Dr. P. Geyl; Prof. L. W. Lyde, 333
Holmes's Comet, Dr. Schorr, 704
Holothurioidea of the Coasts of Ireland, The, Miss Anne L. Massy, 555
Hooker, Joseph Dalton, Prof. F. O. Bower, 561
Hope: Our Legacy of, 130; The Century of, A Sketch of

Western Progress from 1815 to the Great War, F. S. Marvin, 130
Hornea Lignieri, One of the simplest Land-plants, Prof. W. H. Lang, 367
Horse: Bot-flies, Drs. S. Hadwen and A. E. Cameron, 64; Cemetery in the Nile Valley, discovery of a, Prof. G. A. Reisner, 702; -chestnuts, Experiments with, A. Gill, 575
House-fly: The Hibernation of the, Sir Herbert Maxwell, 435; in Winter, 96
Huddersfield Technical College, J. R. Taylor appointed Director of Humanistic Studies in the, 127
Hull: Municipal Museum, The Drake and Bower Geological Collections acquired by the, 9; Whaling Trade, The, T. Sheppard, 609
Human: Metabolism, 644; Personality and its survival of Bodily Death, F. W. H. Myers, Edited and Abridged by S. B. and L. H. M, 595; New Views of, Dr. Olive Wheeler 513; Vitality and Efficiency under prolonged Restricted Diet, F. G. Benedict, W. R. Miles P. Roth, and H. M. Smith, 644
Humus, The Chemical Properties of, and their Utilisation for the protection of Combatants against Asphyxiating Gases, G. du Bellay and M. Houdard, 683
Hunterian Society, Celebration of the Centenary of the, presentation of the Society's silver medal to J. Adams, 319
Huronian Iron-bearing strata of the Mesabie range in Minnesota, Structures in the, due to Algæ, F. F. Grant and T. M. Broderick, 360
Hydramides, The Oxidation of the, J. Bougault and P. Robin, 407
Hydrocyanic: Acid, Detection of, in a Case of Poisoning, L. Chelle, 367; Transformation of, into Thiocyanic Acid in the Course of Cadaveric Putrefactions, M. Chelle, 327; and Thiocyanic Acids in a Complex Medium, The Detection and Estimation of Traces of, L. Chelle, 407
Hydro-electric: Development Scheme, The Chippawa-Queenston, Dr. B. Cunningham, 483; Development Works, Dr. B. Cunningham, 161; Survey of India, The, Dr. B. Cunningham, 363
Hydrogen:-ion Concentration and Photosynthesis, J. T. Saunders, 366; The Secondary Spectrum of, T. R. Merton, 406
Hydrographic Conference, The International, 440

Immune Sera, Dr. C. F. Bolduan and J. Koopman. Fifth edition, 434
Imperial: Air Routes, Major-Gen. Sir F. H. Sykes, 634; Botanical Congress in London, The Proposed. Abandoned, 670; College of Science and Technology, Request for Power to Award Degrees, 426; Statistics, The Organisation of, G. H. Knibbs, 551
Incandescent Electric Lamps, The Luminosity of, Dr. L. Fabaro, 542
India: Cults of the Mother Goddesses in, Dr. W. Crooke, 608; Government of, Appointment by the, of a Committee on the Sugar Industry, 444; Hydro-electric Survey of, Preliminary Report on the Water-power Resources of, Compiled by J. W. Meares, 363; Review of the Mineral Production of, during 1918, 542; Sericulture in, 471; Survey of, General Report of the, for 1917-18, 509; Survey of, Maps and the Modern Development of Indian Cartography, Lt.-Col. W. M. Coldstream, 574; The Organisation of Scientific Work in, 653
Indian: *Botany, Journal of*, No. 1, 297; Geology, 502; Munitions Board, Industrial Handbook, 1919. Revised edition, 413; Museum, Calcutta, Identification of Two Statues in the, 702; Sugar-canes and Their Origin, Some, Dr. C. A. Barber, 14; Studies in, Dr. C. A. Barber, 578
Industrial: Efficiency and Fatigue, The Influence of the Six-hour Day on, Dr. H. M. Vernon, 519; Psychology, Lectures on, B. Muscio. Second edition, Revised, 687; Research, A. P. M. Fleming, 470; Associations, 551; Pamphlet on, 9; Resources of India, 413
Industrialist, A Great, 592
Industry, Elimination of Wasteful Effort in, Prof. T. H. Pear, 387
Inference, The Nature of, G. Cater, 407
Influenza: A Discussion Opened by Sir Arthur Newsholme, 275; Epidemic of 1918-19, The, 509; Epidemics, The Periodicity of, Dr. J. Brownlee, 296; Mortality Statistics in America, Prof. R. Pearl, 509; Protective Inoculation Against, in the Army, Major-Gen. Sir W. Leishman, 703; Pneumonic, The Venous Oxygen Content of the Alkaline Reserve of the Blood in, Dr. H. S. H. Wardlaw, 407; Returns, 638; Threatened Prevalence of, 573
Inks, Commercial, Use of, in Plant Histology, P. Bugnon, 459
Insect: Pests and Plant Diseases in the Vegetable and Fruit Garden, F. Martin Duncan, 467; Scales, A Periodic Structure in Many, and the Cause of Their Iridescent Colours, H. Onslow, 649
Insulating Materials, Relation between the Thermal Conductivity and the Velocity of Sound in, Prof. Thornton, 487
Intelligence, Tests of, Prof. J. Adams, 513
Interferometry, Applications of, Prof. C. Barus, 677
Internal-combustion Engines, Principles of Electric Spark Ignition in, J. D. Morgan, 372
Internal Strains Existing in a Circular Cylinder, Method of Determination of the, M. Mesnager, 618
International: Co-ordination of Scientific Effort and Action, Resolutions Respecting, 506; Hydrographic Conference, The, 440; Organisation in Science under the Peace Treaty, 506; Standardisation, 12
Inventors, Difficulties of, 543
Ionic Valve, Guide to the Study of the, Showing its Development and Application to Wireless Telegraphy and Telephony, W. D. Owen, 332
Ionisation: by Electron Collisions in Argon and Helium, Prof. Horton and Miss A. C. Davies, 454; in Solution, The Present Position of the Theory of, Dr. Senter, and others, 707
Ions: and Ionisation, 707; Effects of, on Ciliary Movement (Gills of *Mytilus edulis*), J. Gray, 366; on Spermatozoa, J. Gray, 366
Ireland: The Outpost, Prof. G. A. J. Cole, 411
Iridomermyx humilis in Madeira, Dr. M. C. Grabham, 456
Irish: Decorated and Socketed Bronze Axe, An, Sir W. Ridgeway, 445; Geographical Association, Prof. G. A. J. Cole elected President of the, 554
Irrigation in Egypt: 580; and the Sudan, Dr. B. Cunningham, 67
Iron: and Steel Institute, Dr. J. E. Stead nominated as President of the, 340; Forthcoming Annual Meeting of the, 474; Deposition, Electrolytic, An Aspect of, Lt. W. A. Macfadyen, 523; Electrolysing Solutions of, The Potential Necessary for, W. A. Noyes, jun., 407; Ores, British, Prof. H. Louis, 429; B. Smith; T. C. Cantrill, Dr. R. L. Sherlock, and H. Dewey; Prof. T. F. Sibly, 429; Solutions, Polarisation in, W. A. Noyes, jun., 683
Islands as Centres of Preservation of Human Diversities, etc., Sir C. P. Lucas, 514
Isomerism, An Electronic Theory of, W. E. Garner, 661
Isopodan Genus, A New (fam. Oniscidæ), from Lake Corangamite, Victoria, Prof. C. Chilton, 555
Isostasy: The Nature and Bearings of, and The Status of the Theory of, Prof. J. Barrell, 645
Isostatic Compensation in the Earth's Crust, 645
Isotopes: The Separation of, Dr. A. Fleck, 565; The Spectra of, Dr. T. R. Merton, 406
Italian Papers on Relativity, Dr. L. Silberstein, 552
Italy, Aeronautics in, Prof. G. H. Bryan, 656
Ithaca Agricultural Experimental Station, The, Dr. E. J. Russell, 482

Jacobi, Mary Putnam, Fellowship of the Women's Medical Association of New York, The, 616
January Weather, 638

Japan, Attempts to Discover a Forecasting Formula for, Prof. T. Okada, 509
Jasus lalandii, Some Abnormalities in the Cape Crawfish, C. v. Bonde, 148
Java, The Aphides of, P. van der Goot, 648
Jersey, Recent Excavations in, Dr. R. R. Marett, 487
Jerusalem, A Projected British School of Archæology at, Prof. J. Garstang provisionally appointed director, 398
Jurassic Chronology: I., Lias. Supplement I., West England Strata, S. S. Buckman, 586

Kalahari Lake Scheme, The, Prof. E. H. L. Schwarz, 158
Karyokynetosis, A. Paillot, 44
Kashmir and Indian Silks, 591
Katabatic Wind in the Valley of the Upper Thames of the Aerological Observatory at Benson, Oxon, Notes on Examples of, E. V. Newnham, 675
Katmai Volcanic Gases and Encrustations, The Nature of the, J. W. Shipley, 595
Ketones, Bicyclic, Some new, M. Godchot and F. Taboury, 523
"Key" Industries: A Bill to safeguard, 338; The Nurture of, 349; The Protection of our, 5
Kinema, The Educational Value of the, Sir Richard Gregory, 522
Kinematograph: in Schools, The, 580; The Ultra-rapid, H. Abraham, E. Bloch, and L. Bloch, 459
King Penguin, The Breeding of the, T. H. Gillespie, 314
King's College, London, Proposed Old Students' Association at, 712
King's Speech at the Opening of Parliament, The, 637
Kloet Volcano, Java, Eruption of the, 63
Knowledge, The Intuitive Basis of, an Epistemological Inquiry, Prof. N. O. Lossky. Translated by N. A. Duddington, 110
Korinchi Peak, Sumatra, Results of a Collecting Expedition to, 64

Laboratory: and Classroom Courses, The Divorce of, Sir Richard Gregory, 514; Management, H. Preston, 514
Labour Situation in the Country, The, Sir Robert Hadfield, 159
Lactose, The Catalytic Hydrogenation of, J. B. Senderens, 650
Lake Geneva, Theoretical Determination of the Longitudinal Seiches of, A. T. Doodson, R. M. Carey, and R. Baldwin, 714
Lambert and Photometry, A. P. Trotter, 358
Lankester, Ray, Investigators at the Marine Biological Laboratory, Plymouth, J. S. Dunkerley, and Mrs. E. W. Sexton appointed, 701
Lathe-turning Tools, Cutting power of, G. W. Burley, 478
Lava Rush in a Cave, A, 640
Laval University, Montreal, destroyed by fire, 344
L'Aviazione Aeroplani, Idrovolanti, Eliche, Dr. E. Garuffa. Seconda edizione, 656
Lecturing with the Lantern, Prof. G. A. J. Cole, 457
Ledebur Method for Oxygen in Steel, Equilibrium Conditions in the System Carbon, Iron Oxide, and Hydrogen in relation to the, 510
Leeds: Astronomical Society, Vol. XXVI. of the Journal of the, 380; University, Conferment of Honorary Degrees, 344
Leonid: Meteoric Shower, The, 342; Meteors, 299
Leopard-men in the Naga Hills, J. H. Hutton, 427
Leptospermum, Three New Species of, E. Cheel, 168
Levelling, Precise, Major E. O. Henrici, 445
Liberia, The Climate of, and its Effect on Man, E. Ross, 136
Libyan Desert, Determination of Latitude and Longitude in the, Dr. J. Ball, 574
Lice and their Relation to Disease, Prof. G. H. F. Nuttall, 456
Liddle Triennial Prize, The, of the London Hospital, 386
Life: and its Maintenance: A Symposium on Biological Problems of the Day, 90; Enjoying, and other Literary Remains of W. N. P. Barbellion (B. F. Cummings), 529
Light: Gravitation and, Sir Joseph Larmor, 412, 530; Polarisation of, scattered by Helium Atoms, Lord Rayleigh, 412; Scattering of, by Resonating Molecules, Lord Rayleigh, 276; Telephoning by, Prof. A. O. Rankine, 604; The Deflection of, during a Solar Eclipse, Prof. A. S. Eddington, Dr. A. C. D. Crommelin, 372; during a Solar Eclipse, W. H. Dines, L. F. Richardson, Prof. A. Anderson, 393; Capt. C. J. P. Cave, 413; Prof. A. Anderson, 436; Sir Arthur Schuster, 468; Prof. A. Anderson, 563; Rays passing near the Sun, The Displacement of, Prof. A. Anderson, 354
Lighthouse at the Horizon, Experimental Predetermination in the Laboratory of the Characteristic of a, J. Rey, 271
Limpet, Common (*Patella vulgata*), Sex Phenomena in the, Dr. J. H. Orton, 373
Line Spectra, A New Form for the Formulæ of, A. Lartigne, 387
Linen Industry Research Association, Establishment of the, 158
Lion, Remains of a Fossil, in Ipswich, Nina F. Layard, 413
Liquefaction of Gases, The, Prof. C. H. Lees, 247
Liquids, The Miscibility of, Prof. C. E. Fawsitt and C. H. Fischer, 555
Lister: Institute of Preventive Medicine, The, 264; Lord, Forthcoming Unveiling of Memorial Tablets to, at University College, London, 266; Unveiling of Tablets to the Memory of, at University College, 296, 312; Proposed Memorial to, in Edinburgh, 507
Liverpool: Marine Biology Committee, Annual Report of the, 677; University, Dr. J. Proudman appointed Professor of Applied Mathematics, 344; Prof. E. R. Dewsnup appointed Professor of Commerce in, 385; T. E. Peet appointed Professor of Egyptology, and Dr. J. S. Jones Professor of Veterinary Anatomy, 425; Appointment of G. E. Scholes as Professor of Engineering—Thermodynamics of Heat Engines, 648
Living off the Country, V. Stefansson, 118
Livingstone College, Annual Report of, 418
Lloyd's: Register of Shipping, Annual Report of, 320; Shipbuilding Returns, 575
Lockyer, Sir Norman, Dr. H. Deslandres, 191
Lolium, The Endophytic Fungus of, E. McLennan, 619
London: Clay, Flora of the District of the, H. W. Monckton, 520; University, Programme of University Extension Lectures, 108; Forthcoming Lectures by Sir Napier Shaw; Informal Meetings for Discussion at the Meteorological Office, Resumption of the Academic Teaching of Military Science, 127; A Bronze Medal received from the University of Paris in commemoration of the services of the universities of the Allied Nations during the war; Grants from the Drapers Company and the L.C.C.; Conferment of Doctorates, 185; Sir Cooper Perry appointed Principal Officer; Gifts to; Conferment of Degree of D.Sc. upon R. C. Rawlley; Dr. C. Bolton awarded the Charles Graham Gold Medal, 344; Dr. S. Russell Wells elected Vice-Chancellor; Sir Richard Glazebrook appointed Professor of Aviation at the Imperial College of Science and Technology; Dr. A. P. Newton appointed Professor of Imperial History at King's College; Prof. W. Bulloch appointed Professor of Bacteriology at the London Hospital Medical College, 425; Conferment of Doctorates; Dr. T. Lewis awarded the W. J. Mickle Fellowship, 426; Dr. S. Smiles appointed Daniell Professor of Chemistry at King's College; Dr. H. E. Roaf Professor of Physiology at the London Hospital Medical College; Prof. T. Swale Vincent Professor of Physiology at the Middlesex Hospital Medical School; Conferment of Doctorates on R. E. M. Wheeler and M. Tolkowsky, 616; Dr. H. L. Eason and Prof. L. N. G. Filon elected on the Senate of, 585; University College: Dr. J. G. Stewart appointed Lecturer in Engineering at, 107
Longevity, Nutrition and, 527; On, and Means for the Prolongation of Life, Sir Hermann Weber. Edited by Dr. F. Parkes Weber. Fifth edition, 527
Longitudinal Spherical Aberration, A Theory of the Second

Order, for a Symmetrical Optical System, Comdr. T. Y. Baker and Prof. L. N. G. Filon, 713
Longstreth, Edward, Medal of the Franklin Institute awarded to J. J. Skinner, 8
Loughborough Technical College, Dr. T. Stuart Appointed Lecturer in Mathematics, and G. Mavor Lecturer in Mechanical Engineering at the, 67
Low Power-factor, Effect of, from the Viewpoint of Electric Power Station Operators, E. E. Stark, 517
Lubrication and Lubricants, R. M. Deeley, and others, 451
Luminosity: in Centipedes, 705; Produced in Helium, Prof. Horton and Miss D. Bailey, 454
Luminous: Chilopoda, with Special Reference to Geophilus carpophagus, Leach, Hilda K. Brade-Birks and Rev. S. Graham Brade-Birks, 705; Radiations, Origin of, Emitted by Vapours, G. A. Hemsalech, 491; Worms, Rev. S. Graham Brade-Birks, 93; H. E. Aldridge, 174
Lunar Photography with the 100in. Reflector, F. G. Pease, 511; Studies, Prof. W. H. Pickering, 544
Lycænidæ and Hesperidæ, The Druce Collection of, at the Hill Museum, Witley, 77
Lyon, Foire de, Bulletin officiel de la, 9

Mackenzie River Basin, The, C. Camsell and W. Malcolm, 640
Macquarie Island, The Vascular Flora of, T. F. Cheeseman, 101
Magnesite Deposits, The, of Bulong, 137
Magnetic Storm of August 11-12, 1919, The, A. Graham Bell, 74; J. Evershed, 436; Dr. C. Chree, 468
Magnetite, The Atomic Space Lattice in, Prof. W. Peddie, 714
Maimed: Menders of the, The Anatomical and Physiological Principles underlying the Treatment of Injuries to Muscles, Nerves, Bones, and Joints, Prof. A. Keith, 493
Maize: the Development of, The Action of Cyanamide and Dicyanodiamide on, P. Mazé, M. Vila, and M. Lemoigne, 347; The Origin of, Y. Kuwada, 639
Malacological Society of London, Election of Officers and Council of the, 671
Malaria-like Parasite in the Blood of an Indian Buffalo, A. A. L. Sheather, 445
Mallee, Red, Water from the Roots of the, T. Steel, 20
Mallet Type of Locomotive, a Development of the, 342
Mammalian Physiology, Prof. C. S. Sherrington, 71
Man: in Britain, Pre-History of, Flint Implements from the Chalky Boulder Clay of Suffolk, J. Reid Moir, 706; The Antiquity of, Dr. A. Smith Woodward, 212; J. Reid Moir; Dr. A. Smith Woodward, 335; The Dominion of, 371
Manchester: Chemical Club Incorporated with the Manchester Literary and Philosophical Society, 178; Literary and Philosophical Society, the Future of the, Sir Henry A. Miers, 326; Sir Henry A. Miers elected President of the, 340; Municipal College of Technology, Appeal for Funds, 405; F. Watts appointed Assistant to the Director of the Department of Industrial Administration, 648; University, Appointments in, 19; An Appeal for Funds, 426; A. V. Hill appointed Professor of Physiology in, 585; F. Watts appointed Lecturer in Psychology, 616
Manganese Ores, The, of the Shimoga and Adjacent Districts, B. Jayaram, 137
Maps, Large-scale, Value of, in War, 509
Marine: Algæ, Seasonal Variation in the Chemical Composition of, L. Lapicque, 618; Animals, The Abundance of, and a Quantitative Survey of their Occurrence, Prof. W. A. Herdman, 427; Biology, Recent English, 707
Maryland: Geological Survey, Volumes of the, for 1916-18, 703; The Geography of, W. B. Clark, 703
Mathematician's Miscellany, A, 689
Mathematics: in the United States, 601; Particular and General, Dr. S. Brodetsky, 390; the Philosophy of, Lectures on, Dr. J. B. Shaw, 390
Mathematical: Analysis, Introductory, Dr. W. P. Webber and Prof. L. C. Plant, 169; Association, Forthcoming Annual Meeting of the, 386; Prof. W. P. Milne, 550; Curriculum of the Secondary Schools in the U.S., Grant for a Study of the, 19; Functions, Tables of, Dr. C. E. Adams, 517; Notes, Prof. H. F. Baker, 714; Papers for Admission into the Royal Military Academy and the Royal Military College and Papers in Elementary Engineering for Naval Cadetships for the years 1909-18, Edited by R. M. Milne, 626; Statistics, 579; Text-books, Dr. S. Brodetsky, 109, 169
Matter, the Structure of, The Influence of Investigations on the Electrical Properties of Gases on our Conceptions of, Sir J. J. Thomson, 224
Matthiola, A Graded Series of Forms in, Miss Saunders, 521
Mauritius, Royal Alfred Observatory, Reports of the, 673
Measurement of Practical Ability, Dr. P. B. Ballard, 513
Mechanical Science, Developments of, Dr. W. C. Unwin, 241
Medical: and Allied Professions, The, as a State Service, Prof. D. Fraser Harris, 508; Social War-work in Egypt, 560; Discovery, Awards for, 296; Rewards for, 488
Medical Science: Abstracts and Reviews, Vol. i., No. 5, 703
Medical: Science, X-rays in, Dr. A. C. Jordan, 237; Services of the Colonies and Dependencies, Appointment of a Committee on the, 297
Medicine: Preventive, since 1869, Dr. C. J. Martin, 210; The New Birth of, Sir T. Clifford Allbutt, 204
Mediterranean: Geography and History in the, Prof. W. M. Calder, 650; The Oceanographic Study of the, Prince of Monaco, 459
Megascolex Fletcheri, sp. nov., Structure of, Jean Shannon, 619
Melbourne Zoological Park, The Mammals in the, Dr. W. H. D. Le Souef, 297
Melinda cognata, Meig., The Larval Structure and Life-history of, Dr. D. Keilin, 399
Mendelism: Prof. R. C. Punnett, Fifth Edition, Prof. L. Doncaster, 655; The Progress of, Prof. W. Bateson, 214
Mensuration, Elementary, Constructive Plane Geometry, and Numerical Trigonometry, P. Goyen, 390
Mercury: as an Evening Star, 674; Liquid, The Thermo-electricity of, Demonstrated by means of the Galvanometer, C. Benedicks, 187
Mesa Verde National Park, Colorado, Field-work on the, Dr. J. W. Fewkes, 359
Mesopotamia, British Museum Excavations in, 341
Metabolism, Basal, in Man, A Biometric Study of, J. A. Harris and F. G. Benedict, 644
Metallic Tubes, the Fragility of, A New Method of Testing, C. Frémont, 347
Metallurgical: Position, The, in this Country and the Central Empires, Prof. Desch, 455; Specimens Presented to the Royal Microscopical Society, by Sir Robert Hadfield, Report on the, F. I. G. Rawlins, 406
Metallurgy, Modern, The Trend of, Prof. H. C. H. Carpenter 243
Metals: and Alloys, Institute of, Forthcoming Annual General Meeting of the, 671; The Journal of, Vol. Institute of, Forthcoming Annual General Meeting of xxi., Edited by G. Shaw Scott, 391; of the Rare Earths, The, Dr. J. F. Spencer, 310; The Microscopy of, 535, Sir Robert Hadfield and T. G. Elliot, 537
Metaphysical Research, 559
Metcalf's Comet, Miss V. Hansen and Mr. Fischer-Petersen; Prof. Leuschner, 12
Meteoric Shower, The December, 400
Meteorite, Fall of a, in America, 361
Meteorites, The Classification of, Dr. G. T. Prior, 649
Meteorological: Committee, International, Meeting of the, 135; Report of the, 446; Features of 1919, 475; *Magazine* (Formerly *Symons's Meteorological Magazine*), C. Salter and F. J. W. Whipple, Editors of the, 608; Observations, Monthly Record of, of Canada, Bermuda, and Newfoundland, for March, 79; Office Circulars, Nos. 37 and 38, 11; Staff, Changes in the, 135; The Position of the, 705; The Status of a, and its Relation

to the State and to the Public, Capt. C. J. P. Cave, 705
Meteorology and Aviation, Lt.-Col. E. Gold, 641; and Gunners, Dr. E. M. Wedderburn, 641; and the State, 685; in Three Dimensions, Lt.-Col. E. Gold, 505; Manual of, Part iv.; The Relation of the Wind to the Distribution of Barometric Pressure, Sir Napier Shaw, 525; On the Use of the Normal Curves of Errors in Classifying Observations in, Capt. E. H. Chapman, 675; Professional, 675; Progress of, W. H. Dines, 247
Meteors, Large 179
Methyl Alcohol, Action of Sulphuric Anhydride and of Oleum on, J. Guyot and J. J. Simon, 347
Mexico: A remarkable Picture-map from, A. C. Breton, 702; A Violent Earthquake in, 474; Strong Earthquakes in, 541; City, Stone and Terra-cotta, Remains Discovered in the Neighbourhood of, Prof. W. Niven, 9
Mica Miner's and Prospector's Guide, The, A. A. C. Dickson, 276
Michell Thrust Bearing, A, 80
Microbalance, A Cheap and Simple, Capt. J. H. Shaxby, 325
Microscope: Forthcoming Symposium and Discussion on the, 378; Symposium on the, 535, 539; Sir Robert Hadfield, Introductory Address at the, 545
Microscopes, Construction and Use of, J. E. Barnard, 546
Microscopical: Invention, The History of, Sir Robert Hadfield, 535; Optics, Prof. A. E. Conrady, 548
Military Bridges, Portable, Prof. Inglis, 486
Milk: Contamination, F. Bordas, 523; The Examination of, for Public Health Purposes, J. Race, 467
Mind and its Disorders, Dr. W. H. B. Stoddard, Third Edition, 624
Mineral: Oils, Some Laboratory Tests on, A. Philip, 298; Resources of Georgia, 171; Resources of Great Britain, Special Reports on the, Vols. viii., ix., x., 429
Mineralogical Society, Election of Officers and Council of the, 296
Mineralogy, Blowpipe Analysis, and Geometrical Crystallography, Handbook of, Prof. G. M. Butler, 434
Minerals and Ores, The Analysis of, of the Rarer Elements for Analytical Chemists, Metallurgists, and Advanced Students, Dr. W. R. Schoeller and A. R. Powell, 310
Mines: Chief Inspector of, Resignation of Sir Richard Redmayne as, 376; W. Walker appointed, 397; Stray, in the North Atlantic, Albert, Prince of Monaco, 187
Mining and Metallurgy, Institution of, Awards of the, 573; The War Memorial of the, 671
Minnesota, State Entomologist of, Seventeenth Report of the, 64
Minoan Palace at Malia, in Crete, Discovery of a, 356
Minor Planet G. M., 704
Mirage: at Ingatestone, Appearances of, G. F. Quilter, 458; Effects, Cicely M. Botley, 565; S. Pickering; L. N. Norris-Rogers; H. Hillman, 630; R. Ross; A. Tarn, 662
Modern: Briton, Racial Characters of the, Prof. F. G. Parsons, 487; Science, Aspects of, Prof. F. Soddy, 625
Molecular Weights, A New Method of Measuring, J. G. Stephens, 555
Molecules, Atoms and, Prof. F. Soddy, 230
Molluscs of the Family Turritidæ, New Species of, from the West Coast of America and Adjacent Regions, Dr. W. H. Dall, 98
Monaxonid Sponges, New Genera of, Related to the Genus Clathria, E. F. Hallmann, 555
Moon: Determination of the Position of the, by Photography, Dr. C. E. Adams, 518; The Birth of the, Prof. W. H. Pickering, 479; The Motion of the, Dr. J. K. Fotheringham, 612; The Secular Acceleration of the, Prof. E. W. Brown, 299
Morocco, Work of the French in, A. de Tarde, 298
Mosses, Herbarium of, Proposal to Purchase M. J. Cardot's, 572
Motion in Elliptic and Hyperbolic Orbits, the Theorems of Lambert and Adams on, L. V. Meadowcroft, 427
Motor Fuel, Future Supplies of, H. Moore, 554
Mural Paintings and Inscriptions at Knockmoy Abbey, H. S. Crawford, 475
Muscular Exercise, The Physiology of, Prof. F. A. Bainbridge, 590
Museums, Education, and the Board, 114
Museums, Local, and the Board of Education, E. E. Lowe, 703
Musical Drums with Harmonic Overtones, Prof. C. V. Raman and Sivakali Kumar, 500
Musk, The Trade in, A. J. Clements, 97
Mutational *v.* Recapitulatory Characters, Dr. Ruggles Gates, 521
Mutation Theory, The Present Position of the, Prof. H. de Vries, 213
Mycetozoa, The, A Short History of their Study in Britain; an Account of their Habitats Generally; and a List of Species recorded from Essex, G. Lister, 332
Mysore, Department of Mines of the State of, Report of the, for 1917-18, 641
Myxophyceæ, The, or Blue-green Algæ of Lahore, S. L. Ghose, 297

National: Academy to Sciences, Washington, Award of a Gold Medal to Prof. A. Fowler, 296; Physical Laboratory, Prof. J. E. Petavel Appointed Director of the, in Succession to Sir Richard Glazebrook, 8; Retirement of Sir Richard Glazebrook from the Directorship of, 77; The, 264; *N.P.L. Review,* Part i. of the, 400; Representation upon International Councils, Dr. Norman R. Campbell, 72; Research Council of the United States, The, 668; Scientific Organisation and Education, Prof. Ross, 578; Union of Scientific Workers and Research, The, Dr. H. Jeffreys, 23; Inauguration of a London Branch, 267; Dr. J. W. Evans Elected President of the, Address of Sir Ronald Ross to the, 297; First Annual Report of the, 340; Major A. G. Church Appointed Secretary of the, 444; Questions, Nomination of Representative Committees to deal with, 8
Nationalities, The Study of, C. E. Stromeyer, 490
Nationality and Race from an Anthropologist's Point of View, Prof. A. Keith, 476
Natural: History, Open-air, 132; Museum, Retirement of F. Jeffrey Bell from the, 157; Capt. P. R. Lowe Appointed Assistant in Charge of the Bird-room at the 340; Congress of the, Dr. S. F. Harmer, 353; The late Sir A. H. Church's Collection of Gems in the, 357; A Scientific Reunion at the, 377; Expeditions in Connection with the, 507; History of South Africa, 469; Resources, The Development of Our, and the Application of Science to Industry, Sir H. Trueman Wood, 339
Naturalist's Sketch-book, A, A. Thorburn, 432
Nature: A Great Artist of, 432; The Uniformities of, Prof. C. E. Fawsitt, 586
NATURE: The Jubilee of, Congratulatory Messages, 281; Further Official Messages, 380
Naval: Architects, The Institution of, The Cammell Laird Scholarship Awarded to H. J. R. Biles; the Parsons Scholarship to W. G. Simmonds, 186; Forthcoming Scholarship of the, 386; Forthcoming Annual Meetings of the, 573; Scholarships of the, 681; Officer, The Inheritance of the, 396; Officers: their Heredity and Development, Dr. C. B. Davenport and M. T. Scudder, 396
Navy, Hydrographer of the, Appointment of Rear-Admiral F. C. Learmouth in Succession to Rear-Admiral Sir John F. Parry, 77
Nearctic Diving Birds of the Order Pygopodes, The, A. C. Bent, 320
Neolithic Graveyard, Discovery of a Large, at Gestilren, Dr. B. Schnittger, 77
Neon, F. W. Aston, 334
Nervous Disorders: Two Points of View, 22
Nervousness, The Mastery of, Based upon Self-re-education, Dr. R. S. Carroll. Third revised edition, 687
Nettle, The Common, Formic Acid in the Stinging Hairs of, Dr. L. Dobbin, 64
Neuroterus, A Gall-fly, Nuclear Phenomena in the Oocytes of L. Hogben, 346

Newburyport, Mass., The Maritime History of, F. B. C. Bradlee, 639
New: Guinea, People of the Hilly Country of the Interior of, E. W. P. Chinnery, 488; Stonework and Goldfields in, E. W. P. Chinnery, 488; Unexplored, W. N. Beaver, 663; Jersey, The Department of Conservation and Development of, Report of, 672; South Wales, Additional Trilobites from, J. Mitchell, 587; Camden Haven District, Tabanidæ from, E. W. Ferguson and Marguerite Henry, 587; Peridineæ of, G. I. Playfair, 587; Report of the Director-General of Public Health, 1917, 475; Sequence and Correlation of the Permo-Carboniferous and Carboniferous Rocks of, Part i., C. A. Sussmilch and Prof. T. W. Edgeworth David, 587; Year Honours, The, 474
Newton's: Interpolation Formulas, D. C. Fraser, 42; Rings, An Unnoticed Point in the Theory of, J. Marshall, 714; Views on Gravitation and their Subsequent History, Prof. R. A. Sampson, 458; Zealand, A New Typographical Map of, 609; A Research Institute for, 442; Destructive Boring Crustacea in, Prof. Chilton, 78; Floral Northern Invasions of, Dr. J. C. Willis, 520; Institute, Aims and Aspirations of the, Dr. L. Cockayne, 516; National Hydro-electric Schemes for, H. Hill, 517; Plea for the Development of the Natural Resources of, Hon. G. W. Russell, 516; Science Congress, 1919, The, 516; The Economic Value of the Forests of, D. E. Hutchins, 159
Niagara Falls, The Electro-chemical Industries at the, 99
Nickel: -steel Tubes, Magnetic Strains in, Dr. C. G. Knott and Miss Dallas, 715; Chromium Steel Forgings, Andrew, Greenwood, and Green; R. H. Greaves, 480
Nigeria, Forest Administration of, Report on the, for 1918, 158
Nile Projects, The, Sir William Willcocks, 120
Nitric Oxide, Velocity of Oxidation of, E. Wourtzel, 683
Nitro-cellose, The Stress-strain Properties of, and the Law of its Optical Behaviour, Prof. E. G. Coker and K. C. Chakko, 617
Nitrogen: Problem, The, 533, 568; Products Committee, Munitions Inventions Department, Final Report, 533; Note on, Rashmat Rai, 187
Nitrous: Anhydride in the Gaseous State, Existence of, E. Wourtzel, 651; Pure, Some Properties of, and of its Solution in Nitrogen Peroxide, G. Baume and M. Robert, 407
Nobel Prizes, Award of, to Profs. M. Planck, H. Stark, and F. Haber, 318
North: Atlantic Halibut Fishery, The, P. Jespersen, 158; Atlantic Ocean, Monthly Meteorological Chart of the, 99; Central Asia, Relation of History and Ethnology, with Special Reference to, Miss M. A. Czaplicka, 487
Norway, New Sources of Aluminium in, L. Hawkes, 160
Nosema-disease in Bees, G. F. White, 41
Notched-bar Tests, Results of, Dr. W. C. Unwin, 79
Nova: Aquilæ, Observations on, Father Cortie, 454; Prof. Stroobant, 676; Discovery of a Faint, Miss Mackie, 119; Discovery of, Miss Woods, Dr. Shapley, C. P. Olivier, Van Maanent and Sanford, 160; Geminorum, Types of Spectra in, Stratton, 454; in Lyra, Miss Mackie, 704
Novaya Zemlya, Forthcoming Expedition to, led by Dr. O. Holtedahl, 357
Nullagine Formation, The, Gibb Maitland, 579
Number: Puzzles before the Log Fire, Prof. D. E. Smith, 42; Stories of Long Ago, Prof. D. E. Smith, 42
Numbers, History of the Theory of, Vol. i., Divisibility and Primality, Prof. L. E. Dickson, 4
Nutrition and Longevity, 527; The Newer Knowledge of, The Use of Food for the Preservation of Vitality and Health, Prof. E. V. McCollum, 527
Nuzhat-al-Qulūb, The Geographical Part of the, Hamd-Allāh Mustawfī of Qazwīn, Translated by G. Le Strange, 112

Oat-cross, Early and Late Ripening in an, A. St. Clair Caporn, 81
Obscure Disease, an, *Encephalitis lethargica*, 452
Occlusion of Gases by Metals: The, a General Discussion held by the Faraday Society, November, 1918, 690
Oceanography, The Birth of, Prof. D'Arcy W. Thompson, 686
October, 1919, Exceptional Dryness of, W. D. Christmas, 278
Oil-hardening Industry, The, 494
Oils: The Hydrogenation of, Catalysers and Catalysis and the Generation of Hydrogen and Oxygen, C. Ellis. Second edition, 494
Old Red Sandstone Plants showing Structure from the Rhynie Chert-bed, Aberdeenshire. Part iii., Dr. R. Kidston and Prof. W. H. Lang, 458
Olive Oil and Mannitol, The Food Value of the Synthetic Product Prepared from, Prof. Halliburton, J. C. Drummond, and R. K. Cannan, 419
Olympia Agricultural Co., Ltd., Establishment of a Research Department by the, 579
Olympia, The, to be Equipped for the Use of Oil-fuel, 379
Ophthalmology, Report of the Council of British Ophthalmologists on the Desirability of a Special Qualification in, 416
Optical: Polishing Tool, The Surface Layer of an, J. W. French, 682; Society, Election of Officers of the, 671; Systems and the Graphical Methods of Determining Images, Prof. von Rohr, 704; The Physical and, Societies', Forthcoming Annual Exhibition, 417
Optics: British Technical, The Outlook of, Prof. F. Cheshire, 530; Microscopical, Prof. A. E. Conrady, 548; Physical, Researches in, Part ii., Resonance Radiation and Resonance Spectra, Prof. R. W. Wood, 526
Orchestia tucuranna in New Zealand, Prof. C. Chilton, 41
Orchids of Hants and Dorset, Col. Godfrey, 520
Ore Extraction, Flotation Principles of, 401
Organo-metallic Derivatives of Chromium, Tungsten, and Iron, G. M. Bennett and E. E. Turner, 148
Orion Nebula, The, Prof. W. H. Pickering, 448
Orthogenetic Evolution in Pigeons, 566
Ostracod and Shell-marl, An, of Pleistocene Age from Boneo Swamp, Victoria, F. Chapman, 108
Ostrich: Phylogenetic Degeneration in the, Prof. J. E. Duerden, 609; Plumes, Evolution of, 155; Results of Crossing the Northern and Southern Forms of African, Prof. J. E. Duerden, 81
Ostriches, Breeding Experiments with, Prof. J. E. Duerden, 155
Otago University: Dr. R. J. T. Bell Appointed Professor of Pure and Applied Mathematics at, 146; Dr. D. W. Carmalt Jones Appointed Professor of Systematic Medicine in, 490
Out-of-school Training and Environment, The Need of, Sir Robert Baden-Powell, 522
Owl, The Little, a Danger to Poultry and Game, 10
Oxford: and Cambridge, The Universities of, The Royal Commission on, 329; University, Impending Retirement of Prof. S. H. Vines from the Sherardian Chair of Botany in, 167; A Record Number of Freshmen; The Resignation of Prof. Vines; R. S. Troup Elected Professor of Forestry; A Treasury Grant Received; The Question of the Admission of Women to Matriculation and Degrees, 186; Passing of the Preamble of a Statute Providing that Women may be Matriculated and Admitted to Degrees; Increase of Students in Rural Economy; A Vote to be Taken on Greek in Responsions, 681; Question of the Admission of Women; Col. T. E. Lawrence Elected to a Research Fellowship at All Souls College; The Statute Making Greek Optional in Responsions, 306; Appointment of Royal Commissioners to Consider Financial Assistance to, 325; Bequest to, by Mrs. M. L. Medley, 325; Prof. A. Keith's Boyle Lecture on Race and Nationality from an Anthropological Point of View, 344; Amendment by Prof. Gilbert Murray to the Responsions Statute Moved in Congregation and Lost, 364; G. H. Hardy Appointed Savilian Professor of Geometry in, 398; Dr. F. W. Keeble Appointed Sherardian Professor of Botany, 426; E. S. Goodrich Constituted Professor of Comparative Embryology, 616

Palæontology and the Evolution Theory, D. M. S. Watson, 485
Palestine: Some Features in the Topography and Geological History of, H. H. Thomas, 345; Upper Air over, Some Observations of the, Capt. A. J. Bamford, 366
Panama Canal, Source of Power for the Plant and Machinery of the, 400
Pan-American Union, Bulletin of the, 9
Panorpoid Complex, The, part iii.: The Wing-venation, Dr. R. J. Tillyard, 408
Paper: Micro-organisms Living in, their Resistance to the Action of Heat and of Time, V. Galippe, 347; Pulp in Australia, Manufacture of, 64
Papua, Unexplored, S. H. Ray, 663
Paravane or Otter, The, R. F. McKay, 487
Paris: Academy of Sciences, Prize Awards of the, 512; Bonaparte and Loutreuil Foundations, 550; Prizes Proposed for 1921, 577; the University of, Dr. Sebileau Appointed Professor of Laryngology in, 107; Courses of Instruction in the Faculty of Medicine of, 364; Prof. H. G. Greenish Nominated for the Honorary Doctorate Degree of, 397
Pavia University, Retirement of Prof. C. Golgi from the Chair of General Pathology and Histology in, 19
Peach-growing, H. P. Gould, 495
Pearson's Formulæ for Psychophysics, the Availability of, Prize Awarded to Dr. G. H. Thomson for a Paper on, 608
Peas, Culinary, The Genetics of "Rogues" among, Prof. W. Bateson and Caroline Pellew, 649
Peat Investigation Officer, Prof. P. Purcell Appointed, 540
Pellagra, Pathology of, Dr. H. E. Roaf, 520
Penrose's Annual, edited by W. Gamble, 690
Pensées sur la Science, la Guerre et sur des Sujets très Variés, Dr. M. Lecat, 689
Perchlorate, The Electrolytic Formation of, J. G. Williams, 523
Percussion Figures in Isotropic Solids, J. W. French, 312; W. J. Lewis Abbott, 600
Perseids, The Recent Shower of, 12
Petrified Plants from the Silicified Peat-bed in the Old Red Sandstone of Rhynie, Dr. R. Kidston and Prof. W. H. Lang, 641
Petrograd, Conditions of Scientific Men and Scientific Collections in, Dr. Tolmatcheff, 443
Petrographic Subjects, Articles on, Prof. W. Deecke, 673
Phagocytosis and Protozoa, E. S. Goodrich, 456
Pheasant and Gold Campine Fowl, The Spermatogenesis of Infertile Hybrids between, D. W. Cutler, 81
Phenakite and Scheelite at Wheal Cock, St. Just, Occurrence of, A. Russell, 326
Phenological Returns, Royal Meteorological Society's, H. B. Adames and J. E. Clark, 437
Pheretima posthuma, The Excretory System of, K. N. Babl, 359
Philippine Earthquakes in 1918, Rev. M. S. Masò, 98
Philosophical Club of the Royal Society, Annals of the, Written from its Minute Books, Prof. T. G. Bonney, 45
Phonetic Theory, Some Questions of, Chap. v., The Perception of Sound, W. Perrett, 591
Photographic: Arts and Crafts Exhibition, Forthcoming, 443; Plate, Action of a Weak Solution of a Soluble Iodide on a, S. E. Sheppard and G. Meyer, 642; Cause of the Shape of the Characteristic Curve of a, Dr. R. E. Slade and G. I. Higson, 510
Photography: of Coloured Objects, The, Sir William J. Pope, 346; Progress of, Chapman Jones, 251
Photometer, A New Form of, H. T. Harrison, 358
Photo:-electric Spectrophotometry, Experiments on, by the Null Method, K. S. Gibson, 478; synthesis and the Electronic Theory, Prof. H. H. Dixon and H. H. Poole, 682
Phyllophaga, The Natural Enemies of, J. J. Davis, 40
Physical: and Chemical Constants, an American Compendium of, Forthcoming Compilation of, 340; and Optical Societies' Annual Exhibition, The Forthcoming, 417, 514; Chemistry, Prof. W. C. McC. Lewis, 3; —Past and Present, Prof. J. C. Philip, 223; Laboratory Experiments for Engineering Students, Profs. S. Sheldon and E. Hausmann. Part i., Mechanics, Sound, Heat, and Light, 4; Properties, Measurement of, at High Temperatures, A. G. Tarrant, 523; Science, X-rays in, Prof. W. H. Bragg, 235; Society of London, Election of Officers and Council of the, 701
Physics: A Manual of, Dr. J. A. Crowther, 658; Applied, Dictionary of, Forthcoming Publication of a, 320; at the British Association, 454; Elements of, Dr. R. A. Houstoun, 658; for Medical Students, Dr. H. S. Allen, 658; in War, 2; the Commercial Applications of, Forthcoming Lectures on, C. R. Darling, 386
Physiology: and Biochemistry in Modern Medicine, Prof. J. J. R. Macleod, assisted by Dr. R. G. Pearce and others, 389; and Medicine, Prof. W. M. Bayliss, 389; at the British Association, 519; Developments of, Sir E. Sharpey Schafer, 207; *General, Journal of*, 15; General, An Introduction to, with Practical Exercises, Prof. W. M. Bayliss, 654; Mammalian, Prof. C. S. Sherrington, 71; Modern, 654; of Muscular Exercise, 590
Physique pendant la Guerre, Les Applications de la, H. Vigneron, 2
Phytopathological Society, Establishment of a Canadian Branch of the; Meeting of the; Prof. A. H. R. Buller Elected President, 541
Pigeons: Inheritance, Fertility, and the Dominance of Sex and Colour in Hybrids of Wild Species of, Prof. C. O. Whitman, edited by Dr. O. Riddle, 566; Orthogenetic Evolution in, Prof. C. O. Whitman, edited by Dr. O. Riddle, 566; The Behavior of, Prof. C. O. Whitman, edited by Prof. H. A. Carr, 566
Pines, Experimental Bacterial Tumours in, J. Dufrénoy, 168
Pistia and the Lemnaceæ, The Vegetative Morphology of, Agnes Arber, 345
Pitot Tube, An Integrating, for Measuring the Average Velocity of Variable Currents, Y. Délage, 683
Place-names, Formation of a Committee on, 97
Planets: and Comets, Aphelia of, C. D. Perrine, 343; in December, Heliocentric Grouping of, 361; Minor, 100; Dr. F. Cohn, 511; The Constitution of the Ring of, Prof. Stroobant, 676
Planetary Rotation Periods and Group Ratios, F. A. Black, 370
Plane Strain: The Direct Determination of Stress, S. D. Carothers, 617
Plankton, Contribution to the Quantitative Study of, Dr. E. J. Allen, 707
Platinum in Canada, J. J. O'Neill, 574
Plant: Life on Land, The Origin of, 624; -growth, Effect of Nitrogen-fixing Organisms and Nucleic Acid Derivatives on, W. B. Bottomley, 345; -lice in the Tropics, 648; Morphology, Applied, 578; Nutrition, Experiments on, J. S. Burd, D. R. Hoagland, 446; -sports Produced at Will, Col. H. E. Rawson, 346; the Living, Botany of, Prof. F. O. Bower, 274
Plants: The Response of, to Wireless Stimulation, Sir J. C. Bose, 172; and Ferns, A Dictionary of the, Dr. J. C. Willis. Fourth edition, 410; and Ferns, Flowering, 410
Pleistocene Deposits around Cambridge, The, Prof. J. E. Marr, 386
Pleochroic Haloes, Reversed, Prof. J. Joly and J. H. J. Poole, 92
Plumage: Bill, Promotion of a, H. J. Massingham, 413; Prof. J. E. Duerden, 499; Proposals for a, L. Gardiner, W. Dewar, 564; Relation of, to Ovarian Condition, Drs. L. J. Cole and W. A Lippincott, 81
Polarisation Electromotive Forces of Iron in Solutions of Complex Salts, N. R. Dhar and G. Urbain, 618
Political Science, Bishop J. E. C. Welldon, 494
Polypodium spinulosum, Burm. f., Identity of, Prof. E. D. Merrill, 20
Poplar, The *miellée* of the, G. Tanret, 367
Porcelain, The Porosity of, C. C. Farr, 517
Potash: Recovery at Cement Plants, 137; Salts, The Deposits of, in the Punjab Salt Range and Kohat, Dr. M. Stuart, 268
Potato-tubers, A Fungus Disease of, 341
Potentiometer, Rectangular Component Alternating-current,

A New Form of, Prof. A. E. Kennelly and E. Velander, 42
Poultry, The Secondary Sexual Characters of, Prof. T. H. Morgan, 159
Powders: Flameless, M. Delpech, 167; The Pure "B," J. Delpech, 68
Power: Circuits, The Interference of, with Telephone Circuits, E. Parry, 517; Known and Unknown, Sources of, Sir Oliver Lodge, 397
Practical Chemistry, 688
Prague, A Tribute from, Prof. B. Brauner, 374
Precious Stones, The Production of, in 1919, Dr. G. F. Kunz, 610
Precipitates, A New Method of Physico-chemical Analysis of, P. Jelibois, 523
Prehistoric Pottery in Eastern Macedonia and the Plain of Philippi, Discovery of, 178
Pre-history of Man in Britain, Flint Implements from the Chalky Boulder Clay of Suffolk, J. Reid Moir, 706
Pressure: and Temperature, The Effect of, on a Meter for Measuring the Rate of Flow of a Gas, Dr. N. W. McLachlan, 325; Distribution on the Head of a Shell Moving at High Velocities, L. Bairstow, R. H. Fowler, and D. R. Hartree, 618
Preventive Medicine since 1869, Dr. C. J. Martin, 210
Prices and Government Control, Sir Charles G. Wade, 485
Primary Current at Break, An Experimental Method of Determining the, in a Magneto, Dr. N. W. McLachlan, 366
Primates, Certain Cranial Sutures in the, Dr. R. W. Shufeldt, 44
Primeverose, Characters and Composition of, A. Goris and Ch. Vischniac, 367
Princeton and other American Universities, Bequests to, H. C. Frick, 386
Prismatic Binocular, Use of a, for Viewing Near Objects, Capt. D. Wilson Barker, 432
Probabilità, Calcolo delle, Prof. G. Castelnuovo, 464
Probabilities, The Neglected Study of, Prof. G. H. Bryan, 464
Process Year Book, The, vol. xxii. (*Penrose's Annual*), edited by W. Gamble, 690
Proctotrypid, Hyper-parasite of Aphidius (Lygocerus sp.), Preliminary Note on the Life-history of a, Miss M. D. Haviland, 366
Progress and Promise, 190
Psychical Research, Society for, Dr. W. McDougall Elected President of the, 608
Psychology, Industrial, Lectures on, B. Muscio. Second edition, revised, 687; Normal and Morbid, 624; The Modern Science of, 208
Psychoanalysis? What is, Dr. I. H. Coriat, 22
Psychonévroses de Guerre, Traitement des, G. Roussy, J. Boisseau, M. d'Œlsnitz, 22
Public Libraries, etc., Proposal for Certain Powers and Duties in Relation to, to be Transferred to the Board of Education, 522
Pultenæa, A Revision of the Genus, H. B. Williamson, 555
Pyriform Figure, the Stability of the, The Calculations of G. H. Darwin on, P. Humbert, 650
Pyrometry, Practical, The Theory, Calibration, and Use of Instruments for the Measurement of High Temperatures, E. S. Ferry, G. A. Shook, and J. R. Collins, 47
Pyrophorus Beetle, a Living, Photographs showing the Actinic Quality of the Light from, F. Martin Duncan, 345

Quadrant Electrometers, Improvements in Measurements with, Part ii., V. H. Jackson and A. T. Mukerjee, 459
Quadrilatère Complet, Premiers Eléments d'une Théorie du, A. Oppermann, 169
Qualitative Analysis, A Treatise on, Prof. F. Clowes and J. B. Coleman. Ninth edition, 688
"Quantico" Typhoon, The, Rev. J. Coronas, 79
Quarterly Journal of Microscopical Society, Jubilee of the Editorship of Sir E. Ray Lankester of the, 295
Quaternionic System, The, as the Algebra of the Relations of Physics and Relativity, Prof. W. Peddie, 715
Queensland: Lecythidaceæ, A Revised Account of the, C. T. White, 587; Mesozoic Insects of, No. 6: Blattoidea, Dr. R. J. Tillyard, 147; No. 7, Dr. R. J. Tillyard, 587
Queen's University, Kingston, Ontario, Dr. G. S. Melvin appointed Professor of Physiology in, 19

Race: and Nationality, Prof. A. Keith, 311; An Inquiry into the Origin and Growth of Patriotism, 311; Consciousness, Rev. Dr. W. Flint, 118
Racehorses, The Colours of, Sir William Ridgeway, 334
Radiation: Pressure, E. G. Barter, 188; Megh Nad Saha, 448; Temperature: Dew, S. Skinner, 277; Temperatures, S. Pickering, 153
Radiators, Improvement of the Efficiency of, in the Heating of Rooms, Prof. G. H. Bryan, 487
Radioactivité, Mesures Pratiques en Dr. W. Makower and Dr. H. Geiger. Traduit de l'Anglais by E. Philippi, 626
Radio-activity: and Gravitation, Sir Ernest Rutherford and Dr. A. H. Compton, 412; of the Water from the Large Spring at Bagnoles-de-l'Orne and its Variations, P. Loisel, 347; Relativity and, Prof. J. Joly, 468
Radio: -communication and the Thermionic Valve, 462; Principles of, 330; The Principles Underlying, 330; Direction and Position Finding, Capt. H. J. Round, 576; -finding Apparatus, The Theory and Use of, Capt. A. S. Blatterman, 137
Radiographic Prints, Exhibition of, 507
Radiology, Industrial and Medical, Dr. G. W. C. Kaye, 696
Radio: Research Board, A, Established by the Department of Scientific and Industrial Research, 638; *Review*, No. 1, 178; -Telegraphy and Telephony, The Thermionic Value and its Developments in, Prof. J. A. Fleming, 462; during the Solar Eclipse of May 29, 323; -transmission and Reception, J. H. Dellinger, 543
Radium: and the Electron, Sir Ernest Rutherford, 226; Bromide, Methods Used in France for the Production of, M. Demenitroux, 419
Rain: Electricity of, Effect Produced by the, on an Insulated Wire, A. Baldit, 387; Map of Australia for 1918, 476
Rainfall: British, 1918, Dr. H. R. Mill and M. de Carle S. Salter, 411; in England in 1919, 609; of the United States, The, 483
Ramsay: Memorial Fund, Contributions to, from Holland, 474; the late Sir William, Unveiling of a Medallion Portrait of, in the University of Glasgow, 397
"Randers Fjords Naturhistorie," 378
Rarer Elements, The, J. H. Gardiner, 310
Rat Destruction, Methods of, E. G. Boulenger, 97
Ray: Plotter, A, F. G. Smith, 682; Society, Dr. W. T. Calman Appointed Secretary of the, 158
Reaction, Heat of, and Gravitational Field, Prof. F. G. Donnan, 392
Reading, University College, Research Institute in Dairying, Appeal for Funds, 357
Reconstruction, 174
Red: Colouring Matter of Plant Galls, The, 707; "-pea Gall," The Colouring Matter of the, Dr. M. Nierenstein, 707
Rede Lecture, 1919, The, Science and War, Rt. Hon. Lord Moulton, 352
Refractive Index, Variations of, F. Twyman, 315; Indices, Variation of, Sir Henry A. Miers, 334
Refractory: Materials, Expansions of, H. J. Hodsman and Prof. Cobb, 379; Properties of Aluminous Materials, H. Le Chatelier and B. Bogitch, 128
Relatività, La Teoria di, nel suo sviluppo storico, Dr. A. Palatini, 552
Relativity: Prof. Einstein, 360; Prof. A. S. Eddington, and others, 454; An Exposition on, Sir Oliver Lodge, 339; and Radio-activity, Prof. J. Joly, 468; and the Displacement of Fraunhofer Lines, Prof. W. G. Duffield, 659; Discussion on, Prof. Eddington, and others, 400; Italian Papers on, Dr. L. Silberstein, 552; Generalised, in Connection with W. J. Johnston's Symbolic Calculus, Sir Joseph Larmor, 365; Theory, Results of the Total

Solar Eclipse of May 29, and the, Dr. A. C. D. Crommelin, 280; of Gravitation, Einstein's, E. Cunningham, 354; The Theory of, Prof. Eddington, 385; Dr. A. C. D. Crommelin, J. H. Jeans, and others, 631
Re-mapping of the World, The, 658
Reproduction of Illustrations, 1869–1919, Emery Walker, 252
Research: and its Application, Dr. W. H. Nichols, 262; Associations and Consulting Work and the Collection and Indexing of Information, Major H. J. W. Bliss, 399; Conference of, 399; Defence Society, January Report of the, 703; Laboratories, The Equipment of, Dr. W. Lawrence Balls, 399; The Organisation of, 6; The Promotion of, Sir Richard A. Gregory, 259
Resolution of a Curve into a Number of Exponential Components, J. W. T. Walsh, 325
Respiratory Exchange of Man during and after Muscular Exercise, The, J. M. H. Campbell, C. G. Douglas, and F. G. Hobson, 427
Retrospect and Prospect, Sir Archibald Geikie, 195
Reticularia lineata, Morphogenesis of, W. E. Alkins, 427

REVIEWS AND OUR BOOKSHELF.

Agriculture and Horticulture:
Bedford (Duke of), and S. Pickering, Science and Fruit-growing: Being an Account of the Results obtained at the Woburn Experimental Fruit Farm since its Foundation in 1894, 558
Butterfield (K. L.), The Farmer and the New Day, 592
Ekblaw (K. J. T.), Farm Concrete, 495
Fletcher (Prof. S. W.), Strawberry-growing, 592
Gehrs (Prof. J. H.), Productive Agriculture, 495
Gould (H. P.), Peach-growing, 495
Harris (Prof. T. S.), The Sugar-beet in America, 592
Mercier (Dr. C.), A Manual of the Electro-chemical Treatment of Seeds, 562
Thom (C.), and Prof. W. W. Fisk, The Book of Cheese, 528
Walker-Tisdale (C. W.), and T. R. Robinson, Practical Butter-making. Fourth revision, 528
Weigall (Lt.-Col. A. G.), and C. Wrey, A Large State Farm: A Business and Educational Undertaking, 592

Anthropology and Archæology:
Czaplicka (M. A.), The Turks of Central Asia in History and at the Present Day, 273
Johnston (Sir H. H.), A Comparative Study of the Bantu and Semi-Bantu Languages, 129
Oakesmith (Dr. J.), Race and Nationality: An Inquiry into the Origin and Growth of Patriotism, 311
Smith (Prof. G. Elliot), The Evolution of the Dragon, 350
Theal (Dr. G. McCall), Ethnography and Condition of South Africa before A.D. 1505. Second edition, 315
Warren (S. H.), Pre-history in Essex, as Recorded in the Journal of the Essex Field Club, 112

Biology:
Babcock (Dr. H. L.), The Turtles of New England, 23
Bower (Prof. F. O.), Botany of the Living Plant, 274
Bower (Prof. F. O.), Joseph Dalton Hooker, 561
Bower (Prof. F. O.), Prof. J. Graham Kerr, and Dr. W. E. Agar, Lectures on Sex and Heredity delivered in Glasgow, 1917-18, 351
Chamberlain (Prof. C. J.), The Living Cycads, 410
Church (A. H.), Thalassiophyta and the Subaerial Transmigration, 624
Church (A. H.), The Building of an Autotrophic Flagellate, 594
Crabtree (J. H.), British Ferns and How to Identify Them, 410
Davenport (Dr. C. B.), and M. T. Scudder, Naval Officers: Their Heredity and Development, 396
Dendy (Prof. A.), and others, Animal Life and Human Progress, 21
Dobell (Prof. C.), The Amœbæ Living in Man, 369
Downing (E. R.), A Source Book of Biological Nature-study, 465
Duncan (F. Martin), Insect Pests and Plant Diseases in the Vegetable and Fruit Garden, 467
Farrer (R.), The English Rock-garden. 2 vols., 664
Fitzsimons (F. W.), The Natural History of South Africa. 4 vols., 469
Frohawk (F. W.), Birds Beneficial to Agriculture, 72
Kerr (Prof. J. Graham), Text-book of Embryology. Vol. xi., Vertebrata with the Exception of Mammalia, 309
Life and its Maintenance: A Symposium on Biological Problems of the Day, 90
Lister (G.), The Mycetozoa: A Short History of their Study in Britain; An Account of their Habitats Generally; and A List of Species recorded from Essex, 332
Lovell (J. H.), The Flower and the Bee: Plant Life and Pollination, 132
Lydekker (R.), Wild Life of the World: A Descriptive Survey of the Geographical Distribution of Animals. In 3 vols., 69
Macfarlane (Prof. J. M.), The Causes and Course of Organic Evolution: A Study in Bioenergics, 149
Morgan (Prof. C. Lloyd), Eugenics and Environment, 351
Punnett (Prof. R. C.), Mendelism. Fifth edition, 655
Richet (Prof. C.), La Sélection Humaine, 351
Robbins (Prof. W. W.), The Botany of Crop Plants, 46
Robson (F.), The Seashore: Its Inhabitants and How to Know Them, 132
Step (E.), Insect Artizans and their Work, 132
Stokes (Dr. A. C.), Aquatic Microscopy for Beginners, or, Common Objects from the Ponds and Ditches. Fourth edition, 498
Swann (H. Kirke), A Synoptical List of the Accipitres (Diurnal Birds of Prey). Parts i. and ii., 529
Thomson (Prof. J. Arthur), Heredity. Third edition, 92
Thorburn (A.), A Naturalist's Sketch-book, 432
Ward (Prof. H. B.), and Prof. G. C. Whipple, Fresh-water Biology, 498
Willis (Dr. J. C.), A Dictionary of the Flowering Plants and Ferns. Fourth edition, 410

Chemistry:
Annual Reports on the Progress of Chemistry for 1918, issued by the Chemical Society. Vol. xv., 91
Armstrong (Dr. E. F.), The Simple Carbohydrates and the Glucosides. Third edition, 526
Atack (F. W.), assisted by L. Whinyates, The Chemists' Year-book, 1918-19. 2 vols., 112
Bausor (H. W.), Senior Practical Chemistry, 497
Calvert (A. F.), Salt and the Salt Industry, 497
Chemical Dictionary, The Condensed, 622
Clowes (Prof. F.), and J. B. Coleman, A Treatise on Qualitative Analysis. Ninth edition, 688
Clowes (Prof. F.), and J. B. Coleman, Elementary Practical Chemistry. Part i., General Chemistry. Seventh edition, 688
Ellis (C.), The Hydrogenation of Oils: Catalysers and Catalysis and the Generation of Hydrogen and Oxygen. Second edition, 494
Experimental Researches carried out in the Department of Glass Technology, University of Sheffield. Vol. i., 1917-18, 2
Getman (Dr. F. H.), Outlines of Theoretical Chemistry. Second edition, 3
Greenwood (Dr. H. C.), Industrial Gases, 622
Hale (A. J.), The Manufacture of Chemicals by Electrolysis, 529
Hampshire (C. H.), Volumetric Analysis for Students of Pharmaceutical and General Chemistry. Second edition, 497
Lincoln (Prof. A. T.), Text-book of Physical Chemistry, 3
Peters (Prof. C. A.), The Preparation of Substances Important in Agriculture: A Laboratory Manual of Synthetic Agricultural Chemistry. Third edition, 497
Pilcher (R. B.), The Profession of Chemistry, 409
Race (J.), The Examination of Milk for Public Health Purposes, 467
Ranken (Dr. C.), Industrial Chemistry, 497
Rideal (Dr. E. K.), and Prof. H. S. Taylor, Catalysis in Theory and Practice, 463
Schoeller (Dr. W. R.), and A. R. Powell, The Analysis of Minerals and Ores of the Rarer Elements for Analytical Chemists, Metallurgists, and Advanced Students, 310

Simmonds (C.), Alcohol: Its Production, Properties, Chemistry, and Industrial Applications. With Chapters on Methyl Alcohol, Fusel Oil, and Spirituous Beverages, 431
Spencer (Dr. J. F.), The Metals of the Rare Earths, 310
Walker (Prof. J.), Organic Chemistry for Students of Medicine. Second edition, 499

Engineering:
Davis (Dr. A. P.), and H. M. Wilson, Irrigation Engineering. Seventh edition, 70
Johnson (Prof. D. W.), Shore Processes and Shoreline Development, 70
Matthews (Prof. E. R.), Studies in the Construction of Dams: Earthen and Masonry, 434
Morgan (J. D.), Principles of Electric Spark Ignition in Internal-combustion Engines, 372
Peel (T.), Examples in Heat and Heat Engines, 690
Thompson (H.), Modern Engineering Workshop Practice, 352

Geography and Travel:
Beaver (W. N.), Unexplored New Guinea, 663
Brown (Dr. R. N. Rudmose), Spitsbergen: An Account of Exploration, Hunting, the Mineral Riches and Future Potentialities of an Arctic Archipelago, 635
Daily Telegraph, The, Victory Atlas of the World. Part i., 276
Fisher (Prof. E. F.), Resources and Industries of the United States, 131
Keltie (Sir J. Scott), and Dr. M. Epstein, The Statesman's Year-book, 1919, 152
Mustawfī (Hamd-Allāh), of Qazwin, The Geographical Part of the Nuzhat-Al-Qulūb. Translated by G. Le Strange, 112
Shackleton (Sir Ernest), South: The Story of Shackleton's Last Expedition, 1914-17, 602
Times, The, Survey Atlas of the World, Part i., 658
Wade (Sir C. G.), Australia: Problems and Prospects, 130
Watts (Prof. W. W.), Shropshire: The Geography of the County, 331
Weston (Capt. W. J.), The North Riding of Yorkshire, 4

Geology and Mineralogy:
Butler (Prof. G. M.), Handbook of Mineralogy, Blowpipe Analysis, and Geometrical Crystallography, 434
Cantrill (T. C.), Dr. R. L. Sherlock, and H. Dewey, Iron Ores: Sundry Unbedded Ores of Durham, East Cumberland, North Wales, Derbyshire, the Isle of Man, Bristol District and Somerset, Devon and Cornwall, 429
Cole (Prof. G. A. J.), Ireland: The Outpost, 411
Dickson (A. A. C.), The Mica Miner's and Prospector's Guide, 276
Ghambashidze (D.), Mineral Resources of Georgia and Caucasia: Manganese Industry of Georgia, 171
Howchin (W.), The Geology of South Australia. In two divisions, 91
Mineral Resources of Great Britain, Special Reports on the. Vols. viii., ix., x., 429
Sibly (Prof. T. F.), Iron Ores: The Hæmatites of the Forest of Dean and South Wales, 429
Smith (B.), Iron Ores: Hæmatites of West Cumberland, Lancashire, and the Lake District, 429
Wadia (D. N.), Geology of India for Students, 502

Mathematical and Physical Science:
Adolfo Stahl Lectures in Astronomy, The, delivered in San Francisco, Cal., in 1916-17 and 1917-18, 370
Black (F. A.), Planetary Rotation Periods and Group Ratios, 370
Cashmore (M.), Fermat's Last Theorem: Three Proofs by Elementary Algebra. Revised edition, 171
Castelnuovo (Prof. G.), Calcolo delle Probabilità, 464
Chapman (Prof. R. W.), The Elements of Astronomy for Surveyors, 499
Crestani (Prof. G.), Meteorologia Aeronautica, 656
Crowther (Dr. J. A.), A Manual of Physics, 658
Dander (Lieut. M. M.), Dizionario Internazionale di Aeronavigazione e Costruzioni Aeronautiche: Italiano, Francese, Inglese, Tedesco, 656
Dickson (Prof. F. E.), History of the Theory of Numbers. Vol. i., Divisibility and Primality, 4
Elgie (J. H.), The Stars Night by Night: Being the Journal of a Star Gazer, 467
Fawdry (R. C.), Dynamics. Part ii., 109
Ferry (E. S.), G. A. Shook, and J. R. Collins, Practical Pyrometry: The Theory, Calibration, and Use of Instruments for the Measurement of High Temperatures, 47
Fleming (Prof. J. A.), The Thermionic Valve and its Developments in Radio-telegraphy and Telephony, 462
Garuffa (Dr. E.), L'Aviazione. Aeroplani, Idrovolanti, Eliche. Seconda edizione, 656
Gheury (Sgt. M. E. J.), A Simple and Rapid Method of Tide-Prediction (including Diurnal Time and Height Inequalities), 171
Goyen (P.), Elementary Mensuration, Constructive Plane Geometry, and Numerical Trigonometry, 390
Heath (Prof. R. S.), Solid Geometry, including the Mensuration of Surfaces and Solids. Fourth edition, 109
Hedrick (Dr. H. B.), Interpolation Tables or Multiplication Tables of Decimal Fractions, 152
Hosmer (Prof. G. L.), Text-book on Practical Astronomy. Second edition, 3
Houstoun (Dr. R. A.), Elements of Physics, 658
Macfarlane (A.), Lectures on Ten British Physicists of the Nineteenth Century, 561
Macpherson (Rev. H.), Herschel, 561
Makower (Dr. W.), and Dr. H. Geiger, traduit de l'Anglais by E. Philippi, Mesures Pratiques en Radioactivité, 626
Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, and Papers in Elementary Engineering for Naval Cadetships for the Years 1909-18. Edited by R. M. Milne, 626
Miller (H. W.), Descriptive Geometry. Fourth edition, 169
Milne (Dr. W. P.), and G. J. B. Westcott, A First Course in the Calculus. Part i., Powers of X, 109
Oppermann (A.), Premiers Eléments d'une Théorie du Quadrilatère Complet, 169
Owen (W. D.), Guide to the Study of the Ionic Valve: Showing its Development and Application to Wireless Telegraphy and Telephony, 332
Phillips (Dr. H. B.), Differential and Integral Calculus, 109
Radio-communication, The Principles Underlying, 330
Roberts (Prof. M. M.), and Prof. J. T. Colpitts, Analytic Geometry, 390
Running (Prof. T. R.), Empirical Formulas, 109
Shaw (J. B.), Lectures on the Philosophy of Mathematics, 390
Sheldon (Prof. S.), and Prof. E. Hausmann, Physical Laboratory Experiments for Engineering Students. Part i., Mechanics, Sound, Heat, and Light, 4
Stanley (Prof. R.), Text-book on Wireless Telegraphy. New edition in two volumes, 462
Torricelli (Evangelista), Opere di, Edite da Gino Loria e Giuseppe Vassura. 3 vols., 557
Vigneron (H.), Les Applications de la Physique pendant la Guerre, 2
Webber (Dr. W. P.), and Prof. L. C. Plant, Introductory Mathematical Analysis, 169
Wood (Prof. R. W.), Researches in Physical Optics. Part ii., Resonance Radiation and Resonance Spectra, 526

Medical Science:
Allen (Dr. R. W.), Practical Vaccine Treatment for the General Practitioner, 466
Bainbridge (Prof. F. A.), The Physiology of Muscular Exercise, 590
Barrett (Sir J. W.), A Vision of the Possible: What the R.A.M.C. Might Become: An Account of Some of the Medical Work in Egypt, together with a Constructive Criticism of the R.A.M.C., 21
Barrett (Lt.-Col. J. W.), and Lieut. P. E. Deane, The Australian Army Medical Corps in Egypt, 560

Bayliss (Prof. W. M.), An Introduction to General Physiology: With Practical Exercises, 654
Bolduan (Dr. C. F.), and J. Koopman, Immune Sera. Fifth edition, 434
Fox (Dr. R. H.), Dr. John Fothergill and his Friends: Chapters in Eighteenth-century Life, 1
Keith (Prof. A.), Menders of the Maimed: The Anatomical and Physiological Principles underlying the Treatment of Injuries to Muscles, Nerves, Bones, and Joints, 493
Macleod (Prof. J. J. R.), assisted by Dr. R. G. Pearce and others, Physiology and Biochemistry in Modern Medicine, 389
McCollum (Prof. E. V.), The Newer Knowledge of Nutrition: The Use of Food for the Preservation of Vitality and Health, 527
Newsholme (Sir Arthur), and others, Influenza, 275
Sherrington (Prof. C. S.), Mammalian Physiology, 71
Stoddart (Dr. W. H. B.), Mind and its Disorders. Third edition, 624
Weber (Sir H.), edited by Dr. F. Parkes Weber, On Longevity and Means for the Prolongation of Life. Fifth edition, 527

Metallurgy:
Hatch (Dr. F. H.), The Iron and Steel Industry of the United Kingdom under War Conditions, 111
Metals, Institute of, The Journal of the, vol. xxi., edited by G. Shaw Scott, 391
Occlusion of Gases by Metals, The, A General Discussion held by the Faraday Society, November, 1918, 690

Meteorology:
Chapman (E. H.), The Study of the Weather, 312
Mill (Dr. H. R.), and M. de Carle S. Salter, British Rainfall, 1918, 411
Shaw (Sir Napier), Manual of Meteorology. Part iv., The Relation of the Wind to the Distribution of Barometric Pressure, 525

Miscellaneous:
Barbellion (W. N. P.), Enjoying Life, and other Literary Remains, 529
Barrett (Sir J. W.), The War Work of the Y.M.C.A. in Egypt, 560
Bond (F. B.), The Hill of Vision: A Forecast of the Great War and of Social Revolution with the Coming of the New Race, 690
Bonney (Prof. T. G.), Annals of the Philosophical Club of the Royal Society, Written from its Minute Books, 45
Branford (B.), A New Chapter in the Science of Government, 494
Buchanan (J. Y.), Accounts Rendered of Work Done and Things Seen, 686
Darrow (F. L.), The Boys' Own Book of Great Inventions, 152
Domville-Fife (C.), Submarines and Sea-power, 433
Elliot (H.), Modern Science and Materialism, 625
Fedden (R.), Golden Days from the Fishing-log of a Painter in Brittany, 391
Harmsworth's Universal Encyclopedia, Edited by J. A. Hammerton. No. 1, 659
Hodgson (E. S.), Trilingual Artillery Dictionary. 3 vols. Vol. i., English-French-Italian, 332
Ingram (Dr. T. A.), The New Hazell Annual and Almanack, 562
Lapsley (Dr. G.), and others, The America of To-day. Being Lectures delivered at the Local Lectures Summer Meeting of the University of Cambridge, 1918, 151
Lecat (Dr. M.), Pensées sur la Science, la Guerre et sur des Sujets très Variés, 689
Leupp (F. E.), George Westinghouse: His Life and Achievements, 592
Marvin (F. S.), The Century of Hope. A Sketch of Western Progress from 1815 to the Great War, 130
Matthews (R. B.), The Aviation Pocket-book for 1919-20. Seventh edition, 562
Miller (Dr. I. E.), Education for the Needs of Life: A Text-book in the Principles of Education, 169
Mills (J.), The Realities of Modern Science, 625
Moulton (Lord), Science and War: The Rede Lecture, 1919, 352
Myers (F. W. H.), Human Personality and its Survival of Bodily Death, Edited and abridged by S. B. and L. H. M., 595
National Education, Problems of, by Twelve Scottish Educationists, 89
Penrose's Annual, Edited by W. Gamble, 690
Perrett (W.), Some Questions of Phonetic Theory. Chap. v., The Perception of Sound, 591
Rawlley (R. C.), The Silk Industry and Trade, 591
Voyage of a Vice-Chancellor, The, 151
Wells (H. G.), The Outline of History: Being a Plain History of Life and Mankind. Part i., 371
Wood (Dr. H. B.), Sanitation Practically Applied, 311

Philosophy and Psychology:
Aristotelian Society, Proceedings of the, New Series, vol. xix.; Supplementary Volume 11, 559
Carroll (Dr. R. S.), The Mastery of Nervousness based upon Self-re-education. Third revised edition, 687
Coriat (Dr. I. H.), What is Psychoanalysis?, 22
Joad (C. E. M.), Essays in Common-sense Philosophy, 352
Lossky (Prof. N. O.), translated by N. A. Duddington, The Intuitive Basis of Knowledge, 110
Muscio (B.), Industrial Psychology, Lectures on. Second edition, revised, 687
Parmelee (Dr. M.), Criminology, 687
Roussy (G.), J. Boisseau, and M. d'Œlsnitz, Traitement des Psychonévroses de Guerre, 22
Science and Philosophy, Problems of, Aristotelian Society; Supplementary Volume 11, 559
Znaniecki (Dr. F.), Cultural Reality, 110

Technology:
Benson (W. A. S.), Rudiments of Handicraft, 72

Revista d'Ottica e Meccanica di Precisione, 542
Rewards for Medical Discovery, 488
Rhodes Scholarships Trust, Statement for 1919, 585
Rochdale Literary and Scientific Society, Transactions of the, vol. xiii., 447
Rochester University, New York, Foundation of a School of Music in, G. Eastman, 19
Rockefeller: Foundation, Review of Work in 1918 of the, 97; Institute, Further Gift to, by J. D. Rockefeller, 267
Rocky Mountain Belt in Alberta, The, J. S. Stewart, 672
Rodrigues, The Natural History of, H. J. Snell and W. H. Tams, 366
Romanes Lecture, Dean Inge Appointed, for 1920, 266
Röntgen Society, Election of Officers and Council of the, 96
Root-pressure, The Phenomenon of, Prof. Priestley, 521
Rose Research Fellowship at St. Bartholomew's Hospital Medical School, Forthcoming Election to the, 319
Rothamsted: Establishment of an Entomological Laboratory at, 157; The New Laboratories at, 180
Royal: Academy of Belgium, The, and Enemy Countries, 541; Astronomical Society, Centenary of the, Prof. A. Fowler, 674; Election of Officers and Council of the, 671; Botanic Society, Suggestions of the Committee Appointed by the Board of Agriculture upon the, 116; College of Physicians, Dr. F. W. Andrewes Appointed Harveian Orator, Dr. R. C. Wall, Bradford Lecturer, and Dr. M. Flack, Milroy Lecturer; The Sharpey Prize Awarded to Prof. E. Roux, 608; College of Surgeons of England, Prof. A. Depage, Dr. P. Duval, Dr. A. Gosset, Prof. J. M. T. Finney, and Dr. C. H. Mayo Elected Honorary Fellows of the, 670; Commission on the Universities of Oxford and Cambridge, The, 329; Horticultural Society, Resignation of the Rev. W. Wilks of the Secretaryship of the; W. R. Dykes Nominated Secretary of the, 377; Institute of Public Health, Prof. M. Nicoll Appointed Harben Lecturer of the, 376; Forthcoming Congress of the, in Brussels, 377; Institution, Gifts to the, 296; Prof. W. H. Bragg to Deliver the Christmas Course of Juvenile Lectures at the, 318; Forthcoming Lectures at the, 358; Dr.

P. Sabatier, Dr. P. P. E. Roux, Dr. J. Loeb, Dr. R. A. Millikan, Dr. A. G. Webster, and Dr. W. W. Campbell Elected Honorary Members of the, 358; Meteorological Society, Election of Officers and Council of the, R. H. Hooker Elected President; The Symons Gold Medal Presented to Prof. H. H. Hildebrandsson, 573; Phenological Returns, H. B. Adames and J. E. Clark, 437; Photographic Society, Annual Exhibition of the, 157; The Scientific and Technical Group of the, 297; Society, Awards of the; Sir J. J. Thomson recommended for Re-election as President of the, 295; Anniversary Meeting of the; Resignation of R. J. Harrison of the Assistant Secretaryship; Presidential Address by Sir J. J. Thomson, 361; Medallists of the, 362; The Prince of Wales Admitted a Fellow of the, 571; Dr. E. Deller appointed Assistant Secretary to the, 572; of Edinburgh, and the Universities of Edinburgh and Glasgow, Bequests to, by Dr. J. Aitken, 376; Election of Officers and Council of the, 177
Russia, The Population of, Dr. A. Hrdlička, 341

Saccharose, The Diastatic Inversion of, H. Colin and Mlle. A. Chaudin, 367
Sahara, Discoveries in the, Col. J. Tilho, 610
Salpidæ, The, M. M. Metcalf, 40
Salt and the Salt Industry, A. F. Calvert, 497
Salters' Institute of Industrial Chemistry, Works of the, W. B. M. Bird, 398
Saltpetre, the Deposits of, near Prieska and Hay, Cape Province, Frood and Hall, 477
Sanitation Practically Applied, Dr. H. B. Wood, 311
Saphæosaurus, The Genus, G. A. Boulenger, 271
Saturn's Rings, The Albedo of, L. Bell, 138
Savilian Chairs of Geometry and Astronomy, The Foundation of the, 398
Scab in Horses, Treatment of, by the Vapours of Chloropicrin, G. Bertrand and M. Dassonville, 88
Schaumasse Comet, The Return of, G. Fayet and A. Schaumasse, 19, 347
Science: and Fruit-growing: Being an Account of the Results Obtained at the Woburn Experimental Fruit Farm since its Foundation in 1894, The Duke of Bedford and S. Pickering, 558; and Philosophy, Problems of, Aristotelian Society. Supplementary Volume ii., 559; and Sociality, Sir Archibald Geikie, 45; and the Church, the Ven. Canon J. M. Wilson, 201; and War: The Rede Lecture, 1919, Rt. Hon. Lord Moulton, 352; at Universities, Aspects of, Dr. A. Hill, 255; Books, a List of, Suitable for Use in Schools, 457; Importance of, as Part of a Liberal Education, W. W. Vaughan, 514; in Preparatory Schools, Major V. S. Bryant, 514; Masters' Association, Forthcoming Annual General Meeting of the, 306; Modern, and Materialism, H. Elliot, 625; The Realities of, J. Mills, 625; Popular, Victorian, 630; Teaching, Method and Substance of, Prof. H. E. Armstrong, and others, 521; Progress in, Sir William A. Tilden, 253
Scientific: and Industrial Research, Department of, Appreciation of the work of the, Sir Robert Hadfield, 670; Report of the Committee of the Privy Council for, for the year 1918-19, 470; The Control of, Dr. M. W. Travers, 597; and Technical Books, a Catalogue of, 66; Biography, 561; Research for Naval Requirements, 357; Need of the Encouragement of, Sir Oliver Lodge, 75; The British Association and, 337; The National Need for, A. J. Balfour, 399; Signalling and Safety at Sea, Prof. J. Joly, 41; Workers and a National Federation, Major A. G. Church, 693; Work in India, The Organisation of, 653; Organisation of, Prof. F. Soddy; Dr. A. B. Rendle, 691; Worthies, xli., Sir Norman Lockyer, Dr. H. Deslandres, 191
Sclerometer, The Magnetic, 269
Scottish: Journal of Agriculture, October, 379; Meteorological Society, Forthcoming Lectures in Connection with the; Dr. C. G. Knott elected President of the, 444; Ornithology, Report on, for 1918, Misses Rintoul and Baxter, 10
Sea-fishery Investigations and the Balance of Life, Prof. W. Garstang, 48; Prof. W. C. McIntosh, 49
Seals, Protection of, by the New Zealand Government, 475
Seashore, The, Its Inhabitants and how to know them, F. Robson, 132
Secondary: School Curriculum, The, 669; School Examination Council, Reports of the Investigators Appointed to Inquire into the Methods and Standards of Award in the Seven Approved First Examinations held in July, 1918, 669
Seedlings, Comparative Culture of, at High Altitudes and in the Plain, G. Bonnier, 523
Seed-plants, The Relation of the, to the Higher Cryptograms, Dr. Scott, 521
Seessel, Theresa, Research Fellowships, Forthcoming Award of, 457
Seistan, Aquatic Fauna of, Dr. N. Annandale, and others, 453
Sélection Humaine, La, Prof. C. Richet, 351
Selenia bilunaria, Effect of Alcohol on, Dr. J. W. H. Harrison, 609
Selenium, the Elastic Properties of, Prof. O. U. Vonwiller, 347
Sera and Vaccines, The Preparation and Conservation of, by Drying in an Absolute Vacuum, F. Bordas, 307
Sericulture in India, 471
Sewage: Effluents, The Bacterial Flora of, Purified by *boues activées*, P. Courmont and A Rochaix, 650; Waste Involved in the Discharge of, into the Sea and Rivers, Dr. V. E. Shelford, 78
Sex: and Soma, Prof. R. C. McLean, 407; and Heredity; Lectures on, Delivered in Glasgow, 1917-18, Profs. F. O. Bower, J. Graham Kerr, and Dr. W. E. Agar, 351; of Frogs Developed from Parthenogenetic Eggs, Prof. J. Loeb, 81; Phenomena in the Common Limpet (*Patella vulgata*), Dr. J. H. Orton, 373
Shackleton's Antartic Expedition of 1914-17, R. W. James, 554, 602
Shakespearean Garden, A, 441
Shan Alphabet, The Origin of the, 378
Sharply Pointed Bars, Lateral Vibrations of, The, Prof. J. W. Nicholson, 713
Sheffield: Museums and Mappin Art Gallery, Report of the, for the Past Five Years, 702; University, Gift to the Applied Science Department of, by J. D. Brunton, 67; Resignation of Prof. J. O. Arnold, 107; The Work of Prof. J. O. Arnold in, 127; Speech by D. Lloyd George at, on the Place of the University in Education, 167; A. Connell appointed Professor of Surgery in, 385; Prof. C. H. Desch appointed to the Chair of Metallurgy in, 405
Shells of the Family Doliidæ, E. W. Vredenburg, 78
Shide Seismological Observatory, Future of the, 8
Shore Processes and Shoreline Development, Prof. D. W. Johnson, 70
Shropshire: The Geography of the County, Prof. W. W. Watts, 331
Shrubs Belonging to the Genus Carissa, H. H. Haines, 159
Siberia, Forthcoming Expedition to, to be Conducted by Dr. O. Olsen, 158
Silica Glass, The Doubly Refracting Structure of, Lord Rayleigh, 153; R. W. Lawson, 335
Silk: Industry in, Report on an Inquiry into the, Prof. H. Maxwell Lefroy and E. C. Ansorge, 3 vols., 471; Industry, The, and Trade, R. C. Rawlley, 591
Silks, Kashmir and Indian, 591
Silkworm: Linkage in the, A Correction, Prof. W. Bateson, 315
Silurian Geology and Faunas of Ontario Peninsula, The, 574
Silver-leaf Disease, Symptons and Distribution of, J. Bintner, 359
Single-layer Flat Coils, The Self-inductance of, S. Butterworth, 366
Snails, Mortality among, and the Appearance of Bluebottle Flies, Dr. N. Annandale, 412
Snowfalls, Remarks on, Stapfer and Moleski, 618
Société Royale Zoologique et Malacologique de Belgique, Admission of Ten Honorary Members, 573
Sociological Society, The, T. J. C. Fraser Davies, 662

Sodium: Nitrite, Some Properties of, C. Matignon and Mlle. G. Marchal, 683; The Reversible Oxidation of, C. Matignon and E. Monnet, 683; Stearate and Sodium Oleate, The Distillation of, Pictet and Potok, 360
Soil at Night, Cooling of the, Capt. T. B. Franklin, 450, 458
Solar: Eclipse of November 22, 1919, Observation of the, I. Tarazona, 491; Eclipse of May 29, Radiotelegraphy during the, 323; Observations of the, made at Principe, Prof. A. S. Eddington, 454; The, C. R. Davidson, 544; Prominence, The Great, of last May, 420; Protuberances, 1880-1918, Heliographic Latitudes of the, A. Riccò, 187; Radiation, C. G. Abbot, 160; at the Altitude of the Mont Blanc Observatory, The Oxogenic Power of the, R. Bayeux, 407
Solution, Volume Changes in the Process of, G. J. Burrows, 147
Sound: Perception, Theories of, 591; -ranging, Prof. W. L. Bragg, 187; 278
South: The Story of Shackleton's Last Expedition, 1914-17. Sir Ernest Shackleton, 602; Africa, Fishery Investigations in, Report on, Prof. J. D. F. Gilchrist, 615; The Natural History of, Mammals, In four volumes. F. W. Fitzsimons, 469; The Pre-history of, Sir H. H. Johnston, 315; African Botanical Survey, Dr. J. B. Pole-Evans to act as Director of the, 607; Mygalomorph Spiders, J. Hewitt, 64; Termites, The Wing Venation and Respiratory System of Certain, C. Fuller, 78, 639
Southampton University College, Prof. T. Loveday appointed Principal of, 585
South-Eastern Agricultural College, Wye, Rev. S. G. Brade-Birks appointed Lecturer in Zoology at the, 167
Sparrowhawk, Nesting Habits of the, J. H. Owen, 178
Spectral Lines, Displacement of, R. W. Lawson, 565
Spectrophotometry, A New Method of, in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide, R. E. Slade and F. C. Toy, 713
Spectroscopic Astronomy, Prof. A. Fowler, 234
Spermatozoa, The Relation of, to certain Electrolytes, (ii.), J. Gray, 427
Spiders, "Gynandry" among, Rev. J. E. Hull, 81
Spiral Nebulæ, The, C. L. Charlier, 68
Spitsbergen: An Account of Exploration, Hunting, the Mineral Riches and Future Potentialities of an Arctic Archipelago, Dr. R. N. Rudmose Brown, 635; The Coal Export Trade from, Dr. Rudmose Brown, 514; The Development of, 635
Squid, The, as Food, 446
St. Andrews Institute for Clinical Research, Prof. P. T. Herring, 615
Stahl, Adolfo, Lectures in Astronomy, The, 370
Standardisation, International, 12
Stannic Chloride, Action of, on Dimethyl Sulphate, Ch. Boulin and L. J. Simon, 271
Stanton Drew Stones, The, E. Sibree, 445
Stark Effect, the Electrical Resolution of the, 65
Star, Formation of a, Time and Temperature of, A. Véronnet, 367
Stars: Binary, Relative Masses of, G. van Biesbroeck, 643; Night by Night: The, Being the Journal of a Star Gazer, J. H. Elgie, 467; of High Velocity, W. S. Adams and A. H. Joy, 612; of Type F, Distances of the, C. F. Lundahl, 479; Possessing a Total Annual Proper Motion of more than 0.5″, E. Cosserat, 68; Two, with large Parallaxes, Prof. F. Schlesinger, 342
State Geological Survey, The Organisation and Functions of a, P. G. Morgan, 517
Statesman's Year-Book, The, 1919, Edited by Sir John Scott Keltie and Dr. M. Epstein, 152
Statistics: Imperial, The Organisation of, G. H. Knibbs, 551; Public, the Collection and Presentation of, a Petition Urging the Appointment of a Royal Commission or Select Committee on the Methods of, 416
Steam: -boiler Plants, the Running of, D. Brownlee, 611; Boilers and Economisers, C. E. Stromeyer, 675
Steel: A New Alloy Tool-, Prof. J. O. Arnold, 416; High-class, Reported Discovery in the Manufacture of, 702; Rails, A Cause of Rupture of, and a Means of Suppressing it, G. Charpy and J. Durand, 271; The Solution Theory of, and the Influence of Changes in Carbide Concentration on the Electrical Resistivity, Prof. E. D. Campbell, 523
Steels at High Temperatures, The Viscosity of, P. Chevenard, 326
Stellar: Clusters, Dr. and Mrs. Shapley, 119; Open, Dr. H. Shapley; Sir F. W. Dyson, and Mr. Melotte, 576; Energy, The Sources of, Prof. Russell; Prof. Eddington, 269; Parallax, Spectroscopic Determination of, W. S. Adams and G. Strömberg, 511
Stereolepis gigas, The Growth of the Young of, 703
Stomatopoda at Buitenzorg, Dr. A. L. J. Sunier, 446
Stone-axe Factory, A, at Graig-lwyd, Penmaenmawr, S. H. Warren, 346
Straight Path, The, Dr. A. A. Robb, 599
Straits Settlement Gold Medal: The, Awarded to Prof. R. T. Leiper, 540; the Award of the, to Dr. R. T. Leiper, 572
Strains, Internal Longitudinal, The Influence of various Factors on the Creation of, during the Rapid Cooling of Steel Cylinders, M. Portevin, 407
Streatfeild Memorial Lecture: The, to be Delivered by Prof. T. H. Morgan, 78; Prof. G. T. Morgan, 147
Strasbourg: The University of, Mathematics at, H. B. Heywood, 74; Inauguration of the, 345; Re-inauguration of the, 365
Stratosphere, Winds and Temperature-Gradients in the, G. M. B. Dobson, 458
Strawberry-growing, Prof. S. W. Fletcher, 592
Students, Suggested Exchange of, between Denmark and Great Britain, Dr. V. Naser, 522
Submarine Mining, Comdr. Gwynne, 487
Submarines and Sea Power, C. Domville-Fife, 433
Sucrose, A Cryoscopic Method for the Estimation of, Prof. H. H. Dixon and T. G. Mason, 554
Sudan Irrigation Works, The, Dr. B. Cunningham, 120
Suess's "Sal" and "Sima" Magmas, Dr. Holtedahl, 574
Sugar: Beet in America, The, Prof. T. S. Harris, 592; Seed, Prof. T. D. A. Cockerell, 661; Canes, some Indian, and their Origin, Dr. C. A. Barber, 14; from Formaldehyde and its Polymers, The Synthesis of, its Quantitative Relations, and its Exothermic Character, A. J. Ewart, 555; Group, Scientific Study of the, 526; Industry, Appointment by the Government of India of a Committee on the, 444; Manufacture, the Nitrogen Balance in, E. Saillard, 651
Sulphide of Silver and of Bismuth, Change in the Electrical Resistance of the, W. W. Coblentz and H. Kahler, 478
Sulphur, The Viscosity of, C. C. Farr and D. B. Macleod, 712
Sulphuric Acid, Making, by the "Grillo" Plant, R. Curtis, 341
Summer Time, 63; Impending for the Present Year, 701
Sun: Dance of the Teton Sioux, The, F. Densmore, 437; Observations of the, made at the Lyons Observatory, J. Guillaume, 491; Power from the, A. A. Campbell Swinton, 392; A. S. E. Ackermann, 500; A. A. Campbell Swinton, 532; Spot Curve, The, S. B. Nicholson, 160; Temperature in the, A. Mallock, 113
Surface-tension, C. T. Whitmell, 278
Surgery of Deformities, 493
Surgical Tradition, The, Sir John Tweedy, 418
Swanley Horticultural College, Miss F. M. G. Micklethwait appointed Principal of the, 490
Swansea University College, Dr. T. F. Sibly appointed Principal of, 616
Swiney Lectures, Forthcoming, by Dr. J. D. Falconer, 178
Sydney University: Bequest to, by Sir Samuel McCaughey, 107; Government Grant to, 616
Symons: Memorial Gold Medal of the Royal Meteorological Society, The, awarded to Prof. H. H. Hildebrandsson, 340; *Meteorological Magazine*, Sept., 99
Synapsis, Studies of a, I.; Oogenesis in the Hymenoptera, L. T. Hogben, 649; L. T. Hogben, a correction, 674
Syria, The Geographical Unity of, E. de Marbonne, 97
Syringa Vulgaris, Electrolytes in the Leaf-sap of, T. G. Mason, 427
Syringothyris Winchell, etc., F. J. North, 586

"Tactite," A New Geological Term, F. L. Hess, 574
Tanks, British, Used in the War, Sir E. H. Tennyson d'Eyncourt, 486
Taxation of Profits, The, Dr. J. C. Stamp, 486
Technical: Book Review Index of the Carnegie Library, Pittsburgh, 478; Education, Fifty Years of, J. H. Reynolds, 257; *Review,* The, 77
Teeth, Forward Protrusion of the Upper Incisor, etc., D. M. Shaw, 136
Telegony, Prof. J. Cossar Ewart, 216
Telephoning by Light, Prof. A. O. Rankine, 604
Temperatures: High, and Pressures, Researches at, Hon. Sir Charles A. Parsons, 677, 709
Tertiary Fossils: from Ooldea, F. Chapman, 619; from the Ooldea Soak, South Australia, F. Chapman, 347
Testudo Loveridgii, G. A. Boulenger, 715
Teton Sioux, The Sun Dance of the, F. Densmore, 437
Thalassiophyta and the Subaerial Transmigration, A. H. Church, 624
Theme, The Missing, 69
Thermionic: Tubes, Three-electrode, The Variations of Wave-length of the Oscillations Generated by, due to Changes in Filament Current, etc., W. H. Eccles and J. H. Vincent, 617; Valve, Radio-communication and the, 462; and its Developments in Radio-telegraphy and Telephony, Prof. J. A. Fleming, 462; Three-electrode, J. M. Miller, L. M. Hull, 510; Application of the, Prof. Fortescue, 487; Prof. Eccles, Prof. Fortescue, Dr. Whiddington, 454; on Aircraft, Prof. R. Whiddington, 630
Thompson, Elizabeth, Science Fund, The, 608
Thule Expedition to Northern Greenland, The Second, 453
Thunder, The Audibility of, Capt. C. J. P. Cave, 132; Dr. H. O. Forbes, 315
Tibesti, Volcanic Lavas of, Mineralogical and Chemical Constitution of the, A. Lacroix, 68
Tibet and Neighbouring Regions, Exploration in, Col. L. Conyngham, 570
Tidal Observations and the Prediction of Tides, The Harmonic Analysis of, Dr. C. E. Adams, 517
Tide Prediction, A Simple and Rapid Method of (including Diurnal Time and Height Inequalities), Sgt. M. E. J. Gheury, 171
Timber: Diseases in Prepared, Dr. C. J. Gahan to Assist the Science Committee of the Royal Institute of British Architects in the Matter of, 573; Mechanical Strains in, Microscopical Features of, W. Robinson, 345
Time Relations in a Dream, J. Barcroft, 154
Times: African Flight, The, Discovery of a New Volcanic Field, Prof. J. W. Gregory, 667; Survey Atlas of the World, Prepared under the Direction of Dr. J. G. Bartholomew, part i., 658
Tin-plate Manufacture, Influence of Hours of Work and of Ventilation on Output in, Dr. H. M. Vernon, 136
Toas, Description of, or Australian Aboriginal Direction Signs, the late Sir E. Stirling and E. R. Waite, 643
Tobacco Beetle, The, G. H. Runner, 301
Tool-steel, A New Alloy, Prof. J. O. Arnold, 416
Torbernite, A. F. Hallimond, 650
Toronto University, Conferment of Degree upon the Prince of Wales, 19
Torporley, Nathaniel, The Remains of, 297
Torricelli: Opere di Evangelista, Edite da Gino Loria e Giuseppe Vassura, 3 vols., 557
Total Solar Eclipse of May 29, Results of the, and the Relativity Theory, Dr. A. C. D. Crommelin, 280
Toxins and their Anti-toxins, Mutual Precipitation of, M. Nicolle, E. Debains, E. Césari, 619
Tractor: Trials, The Lincoln, 359; Work of the, on the Farm, Garrad, 98
Traiettorie dinamiche dei sistemi olonomi con tre gradi di libertà, Dr. A. Palatini, 552
Train Resistance, Experiments on, 581
Transit Circle, The Future of the, J. E. de Vos Van Steenwijk, 80
"Traube" Waves, Prof. Halliburton, 418
Tricuspidaria lanceolata, Floral Development in, Mrs. L. Porter, 346
Tri-lingual Artillery Dictionary, E. S. Hodgson. 3 vols., vol. i., English-French-Italian, 332
Trilobites, Two New, from Bowning, N.S.W., J. Mitchell, 271
Triode Valves as Electric Amplifiers, Prof. W. H. Eccles, 501
Tropical: Australia, The Future of, G. Taylor, 648; Diseases Bureau, The, 265
Tropics, Comfort and Health in the, Dr. C. Crossland, 573
Trout, The "Trypanosome" of the, Mlle. M. Gauthier, 650
Truth?, What is, Viscount Haldane, 405
Tungsten Arc ("Pointolite") Lamps, P. Freedman, 358
Turbines: Geared, for the Propulsion of Ships, R. J. Walker, 486; The Geared, supplied to the *Wrangel* and *Wachtmeister,* 160
Turkestan, Western, S. Casson, 335
Turks of Central Asia, The, Sir Henry H. Howorth, 273; in History and at the Present Day, M. A. Czaplicka, 273
Turtles of New England, The, Dr. H. L. Babcock, 23
Twenty-four-hour Day, The, 100
Tyndall Mining Research Fund Studentships, Forthcoming Award of, 457

Ultra-violet: the Extreme, A Helium Series in, Prof. W. M. Hicks, 393; Prof. T. Lyman, 565; A Spectroscopic Arrangement for the Study of, L. and E. Bloch, 683
Union of South Africa, Fifth and Sixth Reports of the Director of Veterinary Research of the, 477
United States: Cement Production in the, in 1917, 641; Concrete Shipbuilding in the, 641; General Education Board, Gift to, by J. D. Rockefeller, 158; Index of Economic Material in Documents of the States of the, The State of Pennsylvania, Adelaide R. Hasse, 704; Mathematics in the, 601; National Academy of Sciences, C. W. Beebe Awarded the Elliot Medal of the, 376; National Academy of Sciences and the National Research Council, Gift to, by the Carnegie Corporation of New York, 638; National Museum, Collection of Ecclesiastical Art in the, I. M. Casanowicz, 40; National Research Council, Work of the, 116; Rainfall of the, Some Characteristics of the, Prof. R. De C. Ward, 483; Resources and Industries of the, Prof. E. F. Fisher, 131; The National Research Council of the, 668
Universities: Science at, Aspects of, Dr. A. Hill, 255; and the Training of Teachers, F. J. R. Hendy, 681; The League of, 637
University Bureau in Connection with the Commerce Degree, Scheme for the Establishment, in London, of a, 617; College, London, Appeal on Behalf of the School of Engineering of, 586; 621; College, Southampton, Dr. A. Hill resigning the Principalship of, 306; Education, The Government and, Austen Chamberlain, 75; Women, International Federation of Forthcoming Meeting of the, 712
Upper-air Temperatures at Martlesham Heath, February, 1917, to January, 1918, Lt. W. F. Stacey, 675
Uranium, The Radio-activity of, C. Straehling, 459

Vaccine: -therapy, 466; Treatment, Practical, for the General Practitioner, Dr. R. W. Allen, 466
Vagueness and Discrimination, 110
Vagus Nerves, The Fatal Result of Section of Both, Sir E. Sharpey Schafer, 418
Valedictory Memories, Sir Norman Lockyer, 189
Valour and Service, Statistics of, Major A. G. McKendrick, 660
Vapour-pressure: Determinations, Apparatus for, R. Wright, 581; of Binary Mixtures, The, Prof. A. W. Porter, 523
Variables, Long-period, Prof. H. H. Turner, 643
Venus Cloud-covered? Is, J. Evershed, 675
Vertebrate: Embryology, 309; Remains in the Caverns of Grimaldi, 581
Vertical-pipe Irrigation for Orchards and Market-gardens in Arid Climates, Prof. I. Giglioli, 276
Veterinary: Science and Practice, 418; Staffs in the Colonies and Protectorates, Appointment of a Committee on the, 608

Vicary, The Thomas, Lecture, Sir John Tweedy, 418
Villamaninite, a New Mineral, Dr. W. R. Schoeller and A. R. Powell, 326
Vision: of the Possible: A, What the R.A.M.C. might Become: An Account of Some of the Medical Work in Egypt, together with a Constructive Criticism of the R.A.M.C., Sir J. W. Barrett, 21; The Hill of, A Forecast of the Great War and of Social Revolution with the Coming of the New Race, F. B. Bond, 690; The Theory of, Sir Oliver Lodge, 454
Visual Tests for Motor-drivers, 646
Vitalism, Prof. Dakin, 578
Volcanic Rocks in Northern Kordofan, Sudan, W. Campbell Smith, 693
Volumetric Analysis for Students of Pharmaceutical and General Chemistry, C. H. Hampshire. Second edition, 497
Voyage of a Vice-Chancellor, The, 151
Vulcanicity, Natural and Artificial, E. Belot, 575

Wales: A Primitive Type of Man in, Prof. H. J. Fleure, 487; National Museum of, Annual Report of the, 639
War Gleanings, 21
Water: in Action—Controlled and Free, Dr. B. Cunningham, 70; for Electrical Purposes, The General Principles of the Development and Storage of, J. W. Meares, 161; from the Atmosphere, Use of Trees in Extracting, P. Descombes, 491; -lily, Immersion of the Leaves of the, Causes of the, L. Daniel, 407; -power and Dartmoor, 461
Watt, James: Proposal for a Memorial to, Sir D. Brooks, 74; Centenary Celebrations in Birmingham, 63, 74; Address on, Rev. Dr. E. W. Barnes, 75; and Invention, Prof. Hele-Shaw, 75
Wave Action in Harbours, The Reduction of, Dr. Brysson Cunningham, 614
Wax Scale from New Guinea, A New Species of, W. W. Froggatt, 271
Weather: Pioneers in the Science of the, Sir Napier Shaw, 613; Summer, 41; The Study of the, E. H. Chapman, 312
"Wedge" Pyrometer, The, 11
Wellcome Chemical Research Laboratories, Publications of the, 65
Western: Australia, Sub-arid, Rock Expansion by Temperature Variation in, J. T. Jutson, 108; Sub-arid, The "Clawing" Action of Rain in, J. T. Jutson, 108; The Plateau of, Montgomery, 570; The Royal Society of, 578; Persia, A Rift-valley in, Prof. S. J. Shand, 490
Westinghouse: George, His Life and Achievements, G. E. Leupp, 592
Wheat: Production, the future of, 399; Yield, Australian Rainfall and, 606
"White Water," The, Capt. A. R. Palmer, Prof. J. Stanley Gardiner, 563
Wild: Birds, The Protection of, 7; Life of the World: A Descriptive Survey of the Geographical Distribution of Animals, R. Lydekker, 3 vols., 69
Wimbledon, The Village Club at, 295
Wind: and Barometric Gradient, W. H. Dines, 525; Direction and Cloud Amount at Richmond, on the Interrelation of, Lt. D. Brunt, 675; High velocity of the, 507; Velocity in the Stratosphere, Ch. Maurain, 618; The Variation of, with Height, Capt. E. H. Chapman, 675
Winnipeg, Greater, The Supply of Water to, 298
Wireless: Communications, Imperial, appointment of a Committee to prepare a scheme of, 340; Method of Measuring *e/m*, A, Dr. Whiddington, 454; Navigation for Aircraft, Capt. J. Robinson, 24; Operations, Mysterious Interruptions in, Mr. Marconi, 571; Society of London, L. McMichael Elected Honorary Secretary of the, 8; and the Post Office, 40; Telephony, Speaking across the Atlantic by, Prof. J. A. Fleming, 179; Telegraphy, Directive, as applied to Aircraft, Capt. J. Robinson, 487; Text-book on, Prof. R. Stanley, New edition in two volumes, 462; Time Signals, 380
Wiring Rules of the Institution of Electrical Engineers, Amended edition, 178
Women: at Cambridge, 265; in Industry, The Economic Future of, Sir L. Macassey, 9
Wood for the spars of Aeroplane Wings, Tests on, J. R. Watkins, 42
Wooden Object, a Remarkable Carved, from Santa Domingo, Dr. J. W. Fewkes, 378
Wool, Fine, A Search for, Prof. J. C. Ewart, 153
Works: Management, F. C. Van Dyke, 543; Schools, A. P. M. Fleming, and others, 522
Worms: Luminous, Rev. S. Graham Brade-Birks, 23; Rev. H. Friend, 334
Wrekin, Round the, 331

X-ray: and Electro-medical Apparatus, Watson and Son's Catalogue of, 320; and γ-rays, Scattering of, by Rings of Electrons, G. A. Schott, 365
X-rays in Medical Science, Dr. A. C. Jordan, 237; in Physical Science, Prof. W. H. Bragg, 235; The Fundamental Constants of the Spectrometry of the, Ledoux-Lebard and Dauvillier, 347

Yale: Observatory, Dr. F. Schlesinger Elected Director of the, 417; University, Bequest to, by J. W. Sterling, 67; The Lord Strathcona Legacy to, 146
Yorkshire, The North Riding of, Capt. W. J. Weston, 4
Young-Helmholtz Theory of Colour-vision and Colour-blindness, The Adequacy of the, Prof. W. Peddie, 715
Y.M.C.A. in Egypt, The War Work of the, Sir J. W. Barrett, 560
Youth, The Waste of, Prof. F. Soddy, 89

Zoological: Sculpture in Art and Architecture, S. B. P. Trowbridge, and others, 117; Society of London, Prosperity of the, 444
Zoologists, The Salaries and Remuneration of, 554
Zoology: and Human Welfare, Dr. J. F. Gemmill, 21; at the British Association, Prof. J. H. Ashworth, 456; The Teaching of, in Schools, 554

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NATURE

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, SEPTEMBER 4, 1919.

AN EIGHTEENTH-CENTURY PHYSICIAN.

Dr. John Fothergill and his Friends: Chapters in Eighteenth-century Life. By Dr. R. Hingston Fox. Pp. xxiv+434. (London: Macmillan and Co., Ltd., 1919.) Price 21*s.* net.

MORE than any other period, the eighteenth century is rich in memoirs and biographical history, and from these sources have been obtained most of our facts regarding the mode of life, the characters, and the mental activities of those who were representative of that age. But estimates of the lives and work of physicians have not appeared so frequently, although many medical men in the eighteenth century influenced the social life of their period profoundly enough to merit a biographical memoir.

The life of Dr. John Fothergill is a case in point, and the book under review is a valuable contribution to the biographical history of medicine. Fothergill is fully worthy of the care Dr. Fox has bestowed upon his history, for, in a sense, he was representative of his age and profession. He occupied a respectable, if not a commanding, position in medicine; he was ever ready to promote with his purse and influence the claims of science, and in an age when few paid attention to public health and education he was an energetic and enlightened reformer. Others, notably Lettsom, have essayed the portrait of Fothergill, but we do not remember any memoir in which the character of the great Quaker physician is depicted with more accuracy and skill.

The life of Fothergill may be considered from the point of view of the physician, the man of science, and the philanthropist. In all he played a considerable part, but his precise position as a physician is difficult to describe. He was, it is true, very successful in private practice, and enjoyed an unusually large share of public patronage. From accounts that have been handed down, he appears to have been a shrewd and accurate observer of the clinical phenomena of disease. But to judge from the scanty and hastily composed medical writings left by Fothergill, he does not appear to have been a sagacious scientific thinker, nor has he contributed much to the advance of medicine. He was content to cling to the traditions of the old clinician, and was uninfluenced by the advances that were being made in the study of morbid anatomy as an aid to the diagnosis and treatment of disease. As a physician he belongs to the class of which Richard Warren, Henry Revell Reynolds, and Sir Henry Halford were leaders, but he cannot be assigned a place among the great men who advanced medicine, such as Matthew Baillie, William Prout, and Richard Bright.

Fothergill's position in science was not unlike that of Sir Joseph Banks, whose influence, more than actual scientific work performed, produced a salutary effect on British science in the eighteenth century. Botany interested him keenly, and nearly all the time he could snatch from his medical commitments was devoted to the cultivation of his famous garden of thirty acres at Upton Park, where fifteen gardeners were continually employed. Fothergill's estate at Upton Park was no mere pleasure garden devised for the purpose of social entertainment, but a nursery for the rearing of shrubs and plants brought from all parts of the world by collectors in Fothergill's pay. In this way he was responsible for the introduction of many varieties which can be seen in any garden at the present day.

Besides medicine and botany, Dr. Fox gives a full account of Fothergill's work in education and politics, and his position as a leader of the Society of Friends is dealt with in a temperate and able manner. The book is trustworthy, and should commend itself to those who are interested in the intellectual progress of the eighteenth century.

PHYSICS IN WAR.

Les Applications de la Physique pendant la Guerre. By H. Vigneron. Pp. viii + 322. (Paris: Masson et Cie, 1919.) Price 7 francs net.

A BOOK with this title, appearing so soon after the termination of hostilities, could scarcely fail to excite considerable interest. The public in general and people with a scientific turn of mind in particular have been vaguely aware that, during the war, much work has been done in applying scientific principles to military purposes. In this country, as well as in Allied countries, there have been spread, in spite of the censorship, most exaggerated and distorted accounts of the practical results of these experiments. Here, then, in this book, it might have been supposed, would be afforded an opportunity of testing the truth of the rumours which have been current. To a reader in this frame of mind a perusal of the book will be somewhat disappointing. There are no great revelations, and it is a little difficult to see why the French censorship would not allow the author to publish the major portion of the contents during the war as he desired. The important subject of submarine detection and destruction, for example, is dealt with in a couple of pages. There is internal evidence that this does not arise from lack of knowledge on the part of the author, but rather from the operation of the censorship, which can have been removed in a very limited sense only. The author has, no doubt, been seriously handicapped in this way, for the French authorities appear to have been much more strict than our own.

M. Vigneron, in his preface, very properly lays stress on the important part played in the war by those men of science who, before the war, conducted speculative research without thought of the possibility of its practical application, and were forced by circumstances to join hands with the "techniciens," as he calls them. This alliance has produced far-reaching results, and there will be general agreement with the author that it should be fostered and perpetuated. The work of purely scientific workers is very liable to be lost sight of when it becomes absorbed in industry. One feels that M. Vigneron would have been able to do more justice to them had he delayed publication until it was permissible to refer more explicitly to their work. The author is evidently a believer in the practical fruits of pure science, and his advocacy of the methods of the General Electric Co. of Schenectady in this respect is sound.

The first of the seven sections of the present volume deals principally with the applications of optics for military purposes. Of particular interest are the chapters concerning rangefinders, and the many and varied uses of photography in warfare. One misses, however, any adequate reference to modern methods of signalling, such as those with infra-red and ultra-violet light, invented by Prof. R. W. Wood. Sections 2 and 3 are devoted, respectively, to the aerial and submarine aspects of war, and contain many interesting facts and diagrams. There is a long section on artillery and projectiles, containing much information, most of which was probably available before the war. The sixth section, on wireless telegraphy, is shorter than might have been expected, but gives an interesting outline of present methods, including the use of thermionic valves as oscillators and amplifiers. There is merely a mention of wireless telephony, which actually came into considerable practical use during the war. Localisation of foreign materials in the human body, mainly by means of X-rays, forms the subject of the last chapter.

The book is interesting and well written. It is illustrated with many good diagrams and photographic reproductions, which are explained clearly in the text. What is lacking with regard to "secret" developments the author will, we hope, take up in a subsequent volume.

EXPERIMENTAL RESEARCHES ON GLASS.

Experimental Researches Carried Out in the Department of Glass Technology, University of Sheffield. Vol. i., 1917–18. (Reprinted from the Journal of the Society of Glass Technology.) Pp. iii + 178. (Sheffield: The University, n.d.)

DR. W. E. S. TURNER is to be congratulated upon the success which has attended the formation of the Department of Glass Technology, Sheffield University, of which he is the head, and of the Society of Glass Technology, of which he is secretary, and in the foundation of which he played a leading part. The results of the experimental researches carried out in the department are now reprinted from the journal of the society, together with certain reports to the council of the university.

Glass is a peculiarly elusive subject for scientific investigation, but neither man of science, technologist, nor practical worker will deny that it is a fascinating one. We know practically nothing about the nature of glass, and in this respect we are much in the position of the metallurgists prior to the introduction of thermal and micrographic methods of investigation. We have as yet no key to the constitution of glass, and this must be sought in the purely scientific study of simple mixtures rather than in the investigation of complex glasses, which experience has proved to be practically useful.

At the beginning of the war very little information was available with regard even to the essential facts relating to scientific glassware, miners' lamps, and electric bulbs, which our glass manufacturers were called upon to supply with the least possible delay. Which was the best of the various brands of beakers and flasks at the moment in everyday use in chemical laboratories? was a question to which only the vaguest answer could be given. As to how these glasses should anneal so as to withstand the strain of laboratory use nothing was known at all.

The researches which are now republished relate mainly to the practical class of problems. The seven papers on the testing of laboratory glassware contain information which has been of the greatest value to glass manufacturers. They should also be very carefully studied by everyone engaged in analytical work. The attention of chemists and physicists is also directed to some interesting papers relating to the calibration of volumetric apparatus and to blowpipe work.

Experimental work in connection with refractory materials, furnace problems, etc., is also being undertaken, but only preliminary notes on the results are as yet available.

The publication contains an account of the educational activities of the department, which includes a school of instruction in blowpipe work.

M. W. T.

PHYSICAL CHEMISTRY.

(1) *Text-book of Physical Chemistry*. By Prof. A. T. Lincoln. Pp. viii + 547. (London: G. G. Harrap and Co., Ltd., 1918.) Price 12*s*. 6*d*. net.

(2) *Outlines of Theoretical Chemistry*. By Dr. F. H. Getman. Second edition, thoroughly revised and enlarged. Pp. xvi + 539. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 16*s*. 6*d*. net.

IN the matter of text-books, physical chemistry seems to be coming into its own. It is a healthy sign. Not, indeed, that mere numbers of text-books are any trustworthy measure of the growth and vigour of a science, nor is the unrestricted compilation of them to be encouraged, but physical chemistry is a relatively youthful science, and there is still ample room for individual exposition of the subject.

We have before us two general text-books of physical chemistry of moderate size and scope, and it may be said at once that both can be recommended to students who are commencing the subject. In books of this kind the great difficulty for the writer is to know what to exclude, for, of course, much has to be excluded, and no very detailed discussion of any problem is possible. The two books, although of much the same "standard," naturally exhibit their individuality in this respect. There is one point which should not be overlooked: both books are by American authors. It is evident that physical chemistry is taken much more seriously in America than it is in our own country. The fact is that the Americans, like the Germans before them, have realised the fundamental importance of physico-chemical thinking, not only for advance on the theoretical side, but equally so for technical and industrial progress.

(1) Prof. Lincoln's book is well written, and the fundamental principles are clearly developed and explained. Considerable attention is paid to the laboratory side of the subject. There are a few historical references, which give added interest to the text. Without going into detail, it may be said that optical properties are particularly well treated, as is also the general problem of heterogeneous equilibrium—*e.g.* the phase rule and its manifold applications, the principles of fractional distillation, and the solubility relations of three components. (In the last connection a particularly good account is given of the use of the triangular diagram.) There is likewise a fairly comprehensive discussion of colloids, of non-aqueous solutions, and of the ionising power of a solvent. Except in a few sections, only the most elementary mathematics is employed. This makes the book very suitable for those beginning the subject, but, of course, limits its scope. There are a few misprints—*e.g.* Frick for Fick on p. 434—and a rather remarkable statement on p. 378 in connection with hydration, which is not quite what the author intends. The absence of a name index is perhaps a drawback, and the use of the term *heat-tone* as a translation of *Wärmetönung* is to be deprecated.

(2) Dr. Getman's book, which now reaches its second edition, is an excellent exposition of physical chemistry for those commencing the subject. Again only elementary mathematics is used, and, although numerous thermodynamical results are quoted and applied, the author has not attempted any systematic treatment of the principles of thermodynamics which would have taken him beyond the general aim and scope of the book. It may be mentioned that the subject of conduction of electricity through gases is given much more prominence than is usual in a book of this kind. The same thing is true of the subjects radio-activity, atomic structure, polarisation, and photochemistry. The results of modern research have been incorporated in a skilful manner, and the student is frequently referred to original sources for further information. The presentation of the whole subject is consequently very much up to date. Each chapter is furnished with a set of problems which will be of good service in enabling the student to grasp thoroughly the meaning of what he reads.

W. C. McC. LEWIS.

OUR BOOKSHELF.

Text-book on Practical Astronomy. By Prof. George L. Hosmer. Second edition, revised. Pp. ix + 205. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 9*s*. 6*d*. net.

THE professed object of the author was to satisfy the requirements of civil engineering students, who are unlikely to take up a more advanced study of astronomy, and to produce a text-book intermediate between those formally devoted to astronomy and geodesy, and the short chapter on astronomy generally to be met with in works on surveying. By the lucidity of the explanations and the simplicity of the general treatment of the subject, the book seems well adapted to the needs of such students, and suggests comparison with the work on astronomy by the late Hugh Godfray, which has held the field in our universities for so many years. A good deal of space is wisely devoted to the chapter on time, for the experience of teachers generally will confirm the remark made in the preface that "this subject seems to cause the student more difficulty than any other branch of practical astronomy."

The young student of spherical trigonometry, entering upon the practical solution of triangles, is sometimes a little bewildered by the number and variety of the formulæ put before him for the determination of an angle from three given sides, by means of the halved sine, cosine, tangent, etc. A somewhat novel feature of Prof. Hosmer's work is a short discussion of the conditions under which one of these is to be preferred to the others.

To each chapter is appended a small collection of examples, some numerical, some calculated to test the grasp obtained upon the subject-matter of the chapter. These should be of great assistance to the student. H. B. G.

History of the Theory of Numbers. Vol. i. *Divisibility and Primality.* Publication No. 256. By Prof. L. E. Dickson. Pp. xii+486. (Washington: Carnegie Institution of Washington, 1919.)

THIS work appears to be a chronological encyclopædia rather than a history as that word is usually understood. Prof. Dickson has aimed at giving references to all papers bearing on the subject, and in most cases he has given a summary of the contents.

These papers are so numerous that the need for brevity has forced the author into a style which is often abrupt and occasionally irritating, but the subject-matter will be found invaluable by all who aim at original work in the theory of numbers.

The volume begins with an account of the theory of perfect numbers[1]; these are now of historical interest only, but the quest for all perfect numbers has proved one of the greatest driving forces in the general theory of numbers.

The next topic includes the theorems of Fermat and of Wilson; it is remarkable that the first proof known of the one and the first enunciation of the other are both due to Leibniz.

The section on indices, binomial congruences, and circulating decimals includes a large number of writings of an unusually miscellaneous character, and the reader will find that this source contains much information which has not been easily accessible hitherto.

The most elaborate chapter bears the title "Sum and Number of Divisors"; and this chapter contains many references to the analytical theory of numbers, which has grown so rapidly of late years. On the other hand, recent work on prime number theory is but lightly sketched, and rightly so, inasmuch as the treatise by Landau and subsequent reports have provided all the necessary material.

[1] The Greeks called a number *perfect* if the number happens to be equal to the sum of its divisors. For example, we have

$$6=1+2+3.$$
$$28=1+2+4+7+14.$$

Physical Laboratory Experiments for Engineering Students. By Prof. Samuel Sheldon and Prof. Erich Hausmann. Part i. *Mechanics, Sound, Heat, and Light.* Pp. v+134. (London: Constable and Co., Ltd., 1919.) Price 6*s.* net.

THIS book, prepared for use in the Polytechnic Institute of Brooklyn, is suitable for candidates for engineering degrees who have already pursued laboratory courses in physics. "Each experiment has been chosen because of its close connection with engineering work, and in many cases the theoretical result may be calculated from the constants of the apparatus with which that result obtained by experiment may readily be compared. As these two results approach to an equality the student gains confidence in the apparatus, confidence in the theory, and confidence in himself." This is well said. There can be no doubt that many students lose not only confidence but also interest in physics when they find that owing to inefficient apparatus results of reasonable accuracy cannot be obtained. The experiments here described are well selected, and as apparatus of engineering design has been chosen, the equipment with ordinary care in use should continue to give sufficient accuracy. Special mention may be made of the apparatus for the study of the harmonic motion of a rotating system, which appears to be unknown to British instrument makers. The book is printed on good paper, and is well illustrated.

H. S. A.

The North Riding of Yorkshire. By Capt. W. J. Weston. Pp. viii+161. (Cambridge: At the University Press, 1919.) Price 2*s.* 6*d.* net.

IN view of the time which has elapsed since the greater proportion of these well-known county geographies were issued, one had almost feared that the greatest county had been overlooked. It is now apparent that three volumes will be issued for Yorkshire, one for each Riding, and the first of these, dealing with the North Riding, has just appeared. As we are fairly familiar with all that have previously been published, it is a pleasure to be able to state that this is one of the best; the author seems to have had a better grasp of the object of the work he has had in hand, resulting in a volume which is much more a geography than a guide-book. The illustrations are numerous and well chosen; misprints, as usual, are few—which makes that in the word "Montreal" on p. 58 all the more glaring. The only statement we cannot agree with is in reference to the "raised beach" at Saltburn, which is now known to be a "kitchen midden." The colouring of the geological map at the end, for which the author is not responsible, does not seem quite so successful as with the maps in the earlier volumes.

T. S.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Explosion at Bailleul.

THE reports referred to in NATURE of August 28 (p. 511) of the effects observed at Denmark Hill, Norwich, and elsewhere by the explosion of a munition dump at Bailleul at 1.10 p.m. G.M.T. on August 8 suggest that these effects were due mainly to earth tremors caused by the explosion, since the rattling of windows, extending in one case throughout two and a half minutes, is alone mentioned. Here, however, at Harpenden, and also at Luton and Stevenage, an actual sound of a very marked character was heard. The first impression produced in my own case was that a ceiling or heavy picture had fallen in one of the upper rooms, and I at once went round the house to ascertain if that was the case. Everyone in the immediate neighbourhood seems to have heard the noise equally clearly, and it was very generally attributed at first to an explosion of a factory or munition dump four to six miles distant. The noise, which may have lasted two seconds, was preceded by a lesser sound, or perhaps only a tremor, which made one anticipate that something was coming. This, of course, is usual in the case of explosions. SPENCER PICKERING.

Harpenden, Herts.

British Well-worms.

FROM facts which have recently come to light, I am led to believe that there is a good deal yet to be learned about the Oligochæts which occur in our wells and water-supplies. It is now many years since I directed attention to the occurrence of *Pachydrilus* (*Lumbricillus*) *subterraneus*, Vejd., in tap-water and elsewhere. The first well-worm to be discovered in the country was named by me *Diachaeta curvisetosa*. It was afterwards discovered that it belonged to the Haplotaxidæ, and is now known as *Haplotaxis curvisetosa*, Friend. In spite of Michaelsen's conclusion to the contrary, this is quite a distinct worm from *Haplotaxis gordioides*, which I have found in this country. Another well-worm, the description of which may be expected to appear shortly in the Quarterly Journal of the Microscopical Society, is *Anagaster fontinalis*, Friend, which has been found in East Anglia. I have notes of other species of worms found in water, including Rhynchelmis, taken in Hampshire, and some which have not been named for want of perfect material. As I am now engaged on the preparation of a monograph of British Oligochæts, it seems very desirable that our knowledge of this branch of the subject should be perfected, and it would be esteemed a great favour if persons who find worms in their wells, pumps, taps, and water-supply would send me the same for identification and record. HILDERIC FRIEND.

"Cathay," Solihull, August 29.

THE PROTECTION OF OUR "KEY" INDUSTRIES.

IT has long been foreseen that one of the immediate consequences of peace would be to subject this country to a flood of manufactured articles from Germany. It has been known for some time past that German manufacturers were preparing, by every means in their power, to recover and retain their former hold on our home markets. They were steadily accumulating stocks to be "dumped" in Great Britain on the first possible opportunity. It was a policy of despair, but it was the only policy open to them. The salvation of certain of their industries depended on their being able to thwart, by fair means or foul, the expansion of such of these industries as the exigencies of war had called into existence in this country. Our national welfare, indeed, was bound up in these industries. The country was quick to recognise their importance, and the Government responded to public pressure by the steps it took to foster their initiation and development. Some of these steps were of paramount necessity as war measures, but they had a still wider significance. With the outbreak of war the Empire realised, as never before, that it had in large measure failed to perceive the full importance of the bearing of science upon industry. Owing to a variety of causes on which it is no longer necessary to dwell, we had allowed our chief enemy to take over and gradually to obtain almost exclusive possession of certain "key" industries depending upon the applications of physical science, such as the manufacture of synthetic dyestuffs and drugs, analytical reagents and other chemical products, optical glass and instruments, electrical apparatus and magnetos, etc. We had become wholly dependent upon Germany for a large number of articles comprised under these categories which are absolutely essential to the prosecution of war under modern conditions. It speaks volumes for the innate genius of our race that our men of science and our manufacturers, when thus confronted with a national emergency, should have responded as they did to the country's call. We have not only triumphed over difficulties which at one time seemed well-nigh insuperable, but, as is well known, we have also in many cases bettered the example of our enemies, and certain of our manufactured articles have reached a pitch of excellence which Germany never attained.

This pre-eminence—the fruit of so much anxiety and toil—ought surely to remain with us. Our legislators would be false to their trust if they allowed political expediency and party faction to rob the country of the position it has now gained through the circumstances and fortune of a war which was thrust upon it. The common sense of the nation demands that those industries which we have been compelled by the necessities of this war to establish by a great expenditure of effort and capital, and which are everywhere recognised as no less important in times of peace, should be preserved and fostered. "Never again" has become a watchword. But, even apart from any question of security, the country would be blind to its opportunity if it allowed these "key" industries to fall back into their pre-war condition. The few years of their existence are, however, too short to have brought them into a position of stability. There is an enormous amount of leeway to make up. One cannot expect in four years to reach the position which it has taken forty years of organisation, skill, and enterprise on the part of Germany to secure.

The country, therefore, will welcome the steps which the Board of Trade has taken, in conformity with the Prime Minister's recent statement in Parliament, to protect goods manufactured in Great Britain and Ireland against "dumping," and to check any flood of imports (for instance, from Germany) that might arise from a collapse of exchange so disproportionate to costs of production in the country of origin as to enable sales to take place in this country at prices altogether below costs of production here. It is, of course, too much to expect that this action will pass unchallenged. There is a school of politicians in this country who, like the Bourbons, learn nothing and forget nothing. They are a decreasing faction, it is true, and recent events have tended to submerge the survivors. In a few years they will be as extinct as the dodo. It is a significant fact that the fiscal tenets of the Manchester School are never cherished by a real democracy.

Pending the legislation which is to be introduced into Parliament when it reassembles in the autumn, the Board of Trade under the powers conferred upon it will, as from September 1, 1919, prohibit the importation into the United Kingdom of synthetic dyestuffs, drugs, and "intermediates" needed in their manufacture; also synthetic flavourings and perfumes, synthetic photographic chemicals, and a considerable number of inorganic products and medicaments of which the manufacture had to be started in this country in consequence of the war, and which German manufacturers had intended to "dump" into this country as soon as trade relations were re-established.

In addition to the chemical products enumerated in the schedule of the proclamation, the Board of Trade is taking steps to protect the new industries dealing with optical glass, scientific glassware, laboratory porcelain, and a number of products of which the Germans by various means, some of them of a very dubious character, had secured a monopoly. This action will, no doubt, occasion great perturbation in the Teutonic mind. It may even amount to dismay. The enemy had probably calculated, and as usual miscalculated, on prejudices which occasionally seem to obscure the recognition of our true interests as a trading community. "'Tis sport to have the engineer hoist with his own petar."

THE ORGANISATION OF RESEARCH.

PART of the scheme devised by the Department of Scientific and Industrial Research for the administration of the funds placed at its disposal by Parliament was the formation of associations among groups of manufacturers, and a conference was held on July 29 of representatives of the associations already formed for the purpose of discussing some of the many problems which have presented themselves in connection with their work.

In the absence of Mr. H. A. L. Fisher, President of the Board of Education, the chair was taken by Sir William McCormick, chairman of the Advisory Council. Sir Frank Heath, secretary of the Department of Scientific and Industrial Research, was also present, besides some sixty to seventy representatives. A great diversity of subjects was thus represented, though some, especially the great chemical industries, were conspicuously unrepresented.

The meeting was informed that nine research associations were in operation, eight more have been approved and are only waiting the licence of the Board of Trade, while twelve others are under discussion. So much having been accomplished in the three years which have elapsed since the idea originated, it may be assumed that a general approval has been given to the scheme by the industrial world, but the initial difficulties are far from being overcome as yet.

Among the subjects discussed at the conference the first was the formation of a records bureau, and the second the difficult and important one of the conditions of employment of research workers engaged by the associations. Other questions related to co-operation among the associations, and the amount and method of assessment of the subscriptions to be paid by the associated firms in addition to the subsidy from departmental funds.

The formation of a bureau of information and for the recording of results secured by research is a matter of the utmost importance. In the first place it is proposed that its task should consist in storing up the results of work done by the associations, but even this will be found very expensive and not free from difficulties, owing to the views prevalent in some quarters as to secrecy. The associations require access to information of every kind, and apparently the representatives assembled have something to learn with regard to the existing sources of much of the information they require, for throughout the discussion no reference was made to the magnificent journals, containing both original papers and abstracts, issued by some of the British and American engineering and chemical societies. It seems to be recognised that a large number of reference libraries will have to be established, especially in the neighbourhood of great centres of industry; but it ought also to be understood that every association will require a library stored with works of reference, and especially journals cognisant of the subjects it represents; indeed, every works which has a laboratory for research must be similarly provided. All this represents a large outlay of money, the amount of which can scarcely be calculated as yet.

The other serious point under discussion concerned the interests of the separate associations, and perhaps more particularly those of the individual research workers. And here it would be well to consider the difference between discovery and invention. The former is usually the result of protracted inquiry by highly skilled and highly educated workers, while invention may, and does often, result from the recognition of a need or opportunity for improvement in a machine or process by a mere workman, ignorant of science in a general sense, but whom long experience in some one industry has led to realise the technical difficulties peculiar to the work in which he has been engaged. The question before the conference was how to estimate the value of the services rendered by a successful employee and the right way to reward them. This is a very difficult problem. Any system of bonuses would be for various reasons undesirable and perhaps unfair. There was agreement that the scale of remuneration must be liberal, in order, for one thing, that the man so employed may be free from anxieties as to his own future. But it is becoming clear to everyone that if industry is to enjoy the advantage of engaging the best brains of the nation this kind of calling must be made attractive to the rising young men and women. At present, as pointed out by the chairman, the new research associations are finding that there are not sufficient scientific workers to go round.

THE BOURNEMOUTH MEETING OF THE BRITISH ASSOCIATION.

The success of the meeting of the British Association, which opens in Bournemouth on September 9, should be a foregone conclusion if one may judge by its appeal to the imagination. It may be said that a scientific history of the war will be presented. Commencing with the inaugural address of the president (the Hon. Sir Charles A. Parsons, K.C.B.), which will deal with "Engineering and the War," throughout the week the invaluable war-work of men of science, which played so magnificent a part in our victory, will be the subject of a great variety of lectures and debates. Secrets which have hitherto been jealously preserved will be made public, and it should be possible after the meeting to estimate as never before the enormous importance of science in modern military operations.

Apart from questions of war, a large proportion of the papers and discussions will be closely in touch with the problems and activities of the Empire to-day. Education, citizenship, and economic and industrial difficulties will all be prominent features of the programme.

There is every reason, therefore, to believe that the meeting will be of unique interest and importance. Whether it will be an equal success in point of numbers in attendance is less certain. The amount of interest shown locally in the proceedings cannot at the time of writing be said to have come up to expectations. This comparative lack of enthusiasm is not, however, surprising in a town of so many and diverse distractions. The number of applications for associateship and membership is at present much smaller than anticipated, but in the opinion of those competent to judge the eleventh hour will bring a marked improvement in this direction.

One of the greatest problems which the local executive committee has had to face has been that of finding accommodation for visitors. A popular seaside resort in September inevitably presents extraordinary difficulties in this respect. Great efforts have been made to deal with the situation, and considerable public spirit has been displayed by hotel-keepers and others in helping the committee in its task.

The local preparations for the meeting are well in hand. The work of adapting the Municipal College to the needs of the Association is practically complete, and better accommodation has probably never been provided.

THE PROTECTION OF WILD BIRDS.

The Report of the Departmental Committee on the Protection of Wild Birds, which has just been issued, after a considerable delay due to war conditions, marks an important step towards the proper and efficient control of British bird-life, which has been subject to the varying and complicated regulations of a long series of legislative enactments. The report foreshadows unified and simplified lines of regulation which, if adopted in law, ought to make the protection of wild birds not only more practicable, but also more effective. Of the fresh suggestions made by the expert Departmental Committee, to which the thanks of all naturalists are due, the most far-reaching is that regarding the formation of a permanent Ornithological Advisory Committee, which would sit in London and not only advise the Central Authority on all ornithological questions, but also collect information and control investigations bearing upon the activities and status of wild birds. It is astounding to learn, though it is undoubtedly on a par with the official attitude towards science, that the Wild Birds Protection Acts have been administered without any expert ornithological assistance, except in the case of Scotland. Even there the matter of advice seems to have been, so to speak, behind the scenes, for there is no evidence of public acknowledgment of this highly technical information and advice.

Of many suggested improvements upon the old laws, mention can only be made of a few. All birds are recommended for protection during the breeding season, from May 1 to September 1, subject to the right of the owner or occupier, but even this exception is abolished in the case of scheduled birds, which, in Schedule A, including more than fifty species, are absolutely protected during the breeding season, and in Schedule B, including about twenty-seven species, are absolutely protected throughout the year. The unifying of the schedules for the protection of both birds and eggs is a vast improvement upon the present independence of the two groups, which has led only to confusion; while the protection of all birds and eggs on Sundays and the licensing of bird-catchers and bird-dealers are new and valuable suggestions. It must be the hope of the British naturalist that as soon as possible these recommendations will be adopted and become the law of the land.

NOTES.

WE are informed that the council of the Royal Society has nominated representative committees to deal with national questions connected with the international unions which it is intended to form under the International Research Council. The committee for astronomy will consist of the Astronomers Royal for England, Scotland, and Ireland, the Superintendent of the Nautical Almanac, six members nominated by the Royal Society, six members nominated by the Royal Astronomical Society, two members nominated by the Royal Society of Edinburgh, two members appointed by the Royal Irish Academy, and two members appointed by the British Astronomical Association. The committee for geodesy and geophysics will consist of the Astronomers Royal, the Director of the Meteorological Office, the Director-General of the Ordnance Survey, the Hydrographer of the Navy, two representatives of the Royal Society of Edinburgh, two representatives of the Royal Irish Academy, two members nominated by the British Association, and two members nominated by the Royal Society. Since their formation these committees have advised the council of the Royal Society on the formation of the international unions in their respective subjects, and nominated the delegates to the recent meeting at Brussels. The Federated Council for Pure and Applied Chemistry was also recognised as the national committee on that subject. As regards other subjects, similar committees will no doubt be established, but, no definite proposals having been submitted by any country, no action has hitherto been taken, and the powers of the delegates attending the meeting at the invitation of the council of the Royal Society were limited to the obtaining of information with regard to the views of other countries concerning the establishment of international unions. The recommendations made only express the personal views of delegates attending the conference, and will, no doubt, be submitted to the proper authorities before any action is taken.

AT the death of Prof. Milne in 1913 the British Association Seismological Committee decided to maintain the work at Shide, both the actual observations with seismographs and the collation of results from the Milne stations scattered over the globe. The seismographs were mounted in a disused stable; the clerical and computational work was carried on in an annexe built to the dwelling-house by the liberality of the late Mr. M. H. Gray. Mr. J. H. Burgess and Mr. S. W. Pring, two residents in the neighbourhood who had worked with Prof. Milne, were able to devote part of their time to the work under the general superintendence of the committee. The war steadily rendered this arrangement more and more difficult; Mr Burgess and Mr. Pring both ultimately left Shide, and early in the present year Mrs. Milne, from whom the observatory had been rented by the committee, announced her desire to sell the house, including the observatory, and to return to her home in Japan. In anticipation of the difficulties becoming acute, preparations had been made for transferring the work to Oxford. A seismograph was mounted last October in the basement of the Clarendon Laboratory, where Prof. C. V. Boys made his well-known gravity determination. Permission to make trial of this site was kindly granted by Mr. James Walker, then in charge, and has since been confirmed by Prof. F. A. Lindemann. The results have been eminently satisfactory, and there is ample room for the other component. The arrangements for housing the Milne seismological library (definitely left in his will to the British Association Committee) and the computational work are not yet finally settled, but no serious difficulty is anticipated in finding a solution. The arrangements are necessarily of a provisional type at this moment, and liable to be modified by future events, such as the possible establishment of a geophysical institute at Cambridge, and the action ultimately taken by the Seismological Section of the International Union of Geodesy and Geophysics recently established at Brussels. The Union itself was fully constituted, but the Seismological Section was suspended until some legal formalities connected with the extinction of the former International Seismological Association have been completed.

WE regret to announce the death on September 2, at seventy-five years of age, of Prof. Alexander Macalister, F.R.S., professor of anatomy in the University of Cambridge.

DR. C. A. MERCIER, physician for mental diseases to Charing Cross Hospital, and a distinguished authority upon mental diseases and related subjects, died on September 2 at sixty-seven years of age.

THE Lord President of the Council has appointed Prof. J. E. Petavel, F.R.S., to be director of the National Physical Laboratory in succession to Sir Richard Glazebrook, C.B., F.R.S., who retires on reaching the age-limit on September 18 next. Prof. Petavel is professor of engineering and director of the Whitworth Laboratory in the University of Manchester. He is a member of the Advisory Committee for Aeronautics of the Air Ministry.

THE committee of the Wireless Society of London met on July 24, under the presidency of Mr. Alan A. Campbell-Swinton, with a view to an early resumption of activities. The hon. secretary, Mr. R. H. Klein, having resigned, and been elected an acting vice-president, Mr. Leslie McMichael, of 30 West End Lane, West Hampstead, N.W.6, has been elected hon. secretary, and to him all communications should be addressed. The society is open to all those interested in the study and furtherance of wireless telegraphy, amateur or professional.

THE Edward Longstreth medal of the Franklin Institute, Philadelphia, has been awarded to Mr. J. J. Skinner, of the Bureau of Plant Industry of the U.S. Department of Agriculture, for his papers on "Soil Aldehydes," concerning which the committee reported: "These papers present the results of scientific study of a new class of deleterious soil constituents, clearly described and effectively illustrated, the whole forming a valuable contribution to the science of agricultural chemistry, and one of marked practical importance."

FROM the Proceedings of the Institute of Chemistry we note that the preparation of an account of the services of British chemists during the war is under consideration. A synopsis of the possible contents of a book on the subject has been drawn up, and preliminary arrangements have been entered into with publishers. Such a work may be made both interesting and valuable, and it is to be hoped that the project will be worthily carried out. All chemists who are in a position to assist in the matter are invited to communicate with the registrar of the institute.

Two important geological collections of more than local interest have recently been acquired by the Hull Municipal Museum, viz. the Drake and Bower collections. The first was formed by the late H. C. Drake, F.G.S., who spent many years in the Scarborough district, and also collected largely among the saurian and other vertebrate remains of the Oxford Clay in the Peterborough area. The other collection was formed by the Rev. C. R. Bower. Many of the specimens are described and some figured in his paper on "The Zones of the Lower Chalk of Lincolnshire" in the Proceedings of the Geological Association for 1918. This collection consists of more than a thousand excellently cleaned Chalk fossils, carefully labelled and localised, including many of those which have been figured in his paper, as well as one of the two known examples of *Actinocamax boweri*, the other specimen being in the British Museum. The collections are largely from the Lower Chalk of Lincolnshire and the Chalk of Yorkshire, and there is an interesting series from the Upper Cretaceous of Dover, Folkestone, Kent, and Norfolk.

THERE is no denying the value of intelligent propaganda for increasing business and cultural relations between various nations. As an example of the right kind of propaganda we would mention the Bulletin of the Pan-American Union, published in English, Spanish, Portuguese, and French. This magazine contains authoritative articles on North and South American activities, most of them being splendidly illustrated.

THE *Bulletin officiel de la Foire de Lyon*, of which two recent issues are to hand, is the outcome of the first Lyons Fair, and its object is to keep manufacturers and others in touch with the development of these fairs in France and other countries. In this connection it is interesting to note that the next Lyons Fair will be held on October 1–15 next. The previous fair was a great success, but it is hoped that British manufacturers will be more adequately represented at the forthcoming fair. American competition in France, especially in matters engineering, is very keen, and it is up to British enterprise to see that no trouble is spared in order that French traders, engineers, consumers of scientific products, etc., may know exactly what Britain is able to offer them.

IN the current issue of the *Quarterly Review* Sir Lynden Macassey discusses very ably "The Economic Future of Women in Industry." The author is specially well qualified for his task, as he was a member of the War Cabinet Committee which made extensive inquiries into the subject, and during the war he acted as arbitrator in innumerable labour disputes. He rightly states that the public in general but little appreciates the enormous latent and unutilised capacities for production possessed by the women of the nation. He points out that between 1914 and 1918 more than 700,000 women directly replaced men in industry, and did work customarily done by men. On repetition work, which was such a pronounced feature of war-time employment, women often proved superior to men, as they do not suffer from the monotony to which men are so susceptible. On the other hand, they are not man's equal in skilled work, and because of their greatly inferior physical strength they cannot replace him in the heavier types of industry. As regards the future, there ought to be no trade union rules which debar women from any employment which is commensurate with their industrial qualifications, but women must not be allowed to undercut and displace men. They must come in as additional workers to accelerate the increased productivity which is such a crying need of the present day. Sir Lynden Macassey approves the conclusion of the Committee that women on piece-rates must, as compared with men, receive "equal pay for equal work," but both he and they have missed the fallacy involved in such a contention. If the average woman has as large an output as the average man she is entitled to equal pay, but not otherwise. In most industries the cost of establishment and machinery is far higher than the cost of wages, and if, for instance, the woman produces only four-fifths as much as the man, it would not be reasonable for her employer to pay her four-fifths his wages. Probably he could not afford to give her even three-fifths as much.

AMONG the pamphlets on reconstruction problems recently published by H.M. Stationery Office is one relating to Industrial Research (No. 36, price 2*d*.), which ought to be read by the public, whether directly concerned with industry or not. It contains in fewer than thirty pages a very instructive sketch of the position in the past, and of what has already been accomplished in the way of instituting and organising new fields of research and indicating what may be hoped for in the future. At the present time there can be few people who are not convinced of the necessity for research in its relation to industry, but it was not always so. Looking back only forty years or thereabouts, it may be asserted that at that time practically no provision was made by manufacturers for improvements in their several industries. Among the earliest of the manufacturers of iron and steel to carry on research were Sir Isaac Lowthian Bell and Sir Bernard Samuelson, but in other directions there was practically nothing to be seen in the way of research except—to their credit be it said—among the great brewers, who set a fine example to the rest of the world in the way they proceeded to apply the results of Pasteur's discoveries. In connection with agriculture the work of Sir John Lawes at Rothamsted, aided through many years by Sir Henry Gilbert, represented an advance of incalculable importance. Besides showing what can be done, their work seems to illustrate the fact that research, and hence discovery, have in the past depended chiefly on the enthusiasm of the individual man of science. It remains to be seen how far this will continue to be the case. This certainly seems probable in connection with pure science, but we have yet to learn the extent to which organisation will facilitate the discovery of new facts and principles, though there can be no doubt as to the more abundant results which must accrue from the application of such facts and principles to practical purposes. It is now clear that as there must be more scientific work done, there must be a larger number of properly trained scientific workers; and one of the first duties of the State will be to see that the universities and places of higher instruction are provided with the means of giving the instruction needed, and that conditions are so improved as to give the encouragement wanted to induce the most capable among the rising generation to pursue science as a career. It is rightly pointed out in the pamphlet that working-class opinion especially should be made aware of the vital importance of research.

THE *Mexican Review* of July describes, with photographs, a remarkable series of stone and terracotta remains discovered in the neighbourhood of the city of Mexico by Prof. W. Niven. The writer supposes that these remains, rude in design and workmanship in comparison with those from the upper strata, represent Chinese, Egyptian, and negro faces, buried under deposits of lava from volcanoes in prehistoric times. Besides these were found beads of jade, "presumably from China," and seals, "in imitation, or perhaps precedence, of like objects found in the Babylonian and other ruins of the Far East." It is to be hoped that these articles will soon be examined by experts. If these statements can be verified, they will furnish valuable evidence in support of the conclusions of Prof. Elliot Smith and other advocates of the theory of culture transmission.

We have received No. 14 of the Journal of the East Africa and Uganda Natural History Society, written by residents in the African tropics, but printed in this country and published by Messrs. Longmans and Co. The issue contains descriptive articles on such subjects as the transmission of human and animal diseases by blood-sucking insects, and a number of short original notes on the habits of various African animals, such as baboons, crocodiles, and the aardvark.

The report on Scottish ornithology for 1918 by the Misses Rintoul and Baxter, which appears in the July–August issue of the *Scottish Naturalist*, is an excellent and comprehensive compilation, and affords much information on a variety of subjects associated with bird-life. Though the necessary field-work during the year was carried out under greater disadvantages than ever before, yet the contributions of the numerous recorders relate to observations on no fewer than 184 species. No new birds were added to the avifauna, and the list of uncommon alien visitors is a short one, but a number of species are mentioned as appearing in counties in which they were previously unknown. The influence of weather on bird-life during the year, the results of "ringing," and notes on plumage, food, habits, etc., are also given. The final section of the report deals with the migratory movements of both native species and birds of passage. The observations, which are concisely treated, have been made throughout the mainland and at coastal and insular stations from the Muckle Flugga—the northernmost outpost of the British Isles—to the Tweed and the Solway. The data relate to the comings and goings of no fewer than 160 species.

The *Times* of August 18 contained an interesting article on the little owl as a danger to poultry and game. This bird was not originally a native of the British Isles, but was introduced into several parts of England in some numbers about a quarter of a century ago by several well-known ornithologists, who cannot have been aware of its harmful proclivities. Apart, however, from its vices, it is an attractive little bird. Since its introduction it has increased very rapidly, and is now widely distributed over England, and some have found their way into Wales, Scotland, and Ireland. Wherever it has established itself it has become a pest to poultry-keepers and game-preservers owing to the havoc it makes among the chicks. It also destroys great numbers of small birds up to the size of a blackbird. Although the little owl's record is, in the main, a black one, and far outweighs anything that can be placed to its credit, yet it must be admitted that it destroys large numbers of small rodents, such as field-voles, as well as beetles and other insects, and thus renders some service to the agriculturist. The article is evidently based upon a wide knowledge of the bird, and affords much information on other aspects of its life-history.

In the Bulletin of the Imperial Institute (vol. xvii., 1919, pp. 40–95) there is an excellent detailed account of the production and consumption of cocoa, chiefly in the different countries of the Empire, and showing very clearly the disparities between them in various parts of the world. The United States, using 66,500 tons in 1913, is the greatest consumer, whilst its production is negligible. The United Kingdom in 1913 consumed about 28,000 tons, a great deal of which was imported from foreign countries, while the Empire produced about 88,000 tons, the bulk of which had to go abroad for consumption. In 1917, owing chiefly to the enormous increase of cultivation on the Gold Coast and elsewhere in West Africa, the production increased to 142,800 tons. No attempt is made to describe the methods of preparation in use in the different Colonies, and one is left to infer, when noting the comparative values of cocoa given in various places, that in general they leave a good deal to be desired. The cocoa situation at present evidently turns upon the crop of West Africa, and if that country continues to turn out such enormous quantities of an inferior article, trouble is certain to ensue. The great desideratum at the moment is to increase the consumption of this most valuable food and palatable drink, and it is difficult to do so if the quality be but poor. Cocoa, it is well known, can be produced with less trouble than many other tropical crops, especially if some of the poorer Forastero varieties be employed, but to prepare it of really good quality—as, for instance, it is prepared by the English planters of Ceylon—involves much trouble and the use of better varieties. Nothing less than this, however, will save the market from being glutted with inferior brands of cocoa.

Under the title "Gossypium in Pre-Linnæan Literature" (Botanical Memoirs No. 2, Oxford University Press), H. J. Denham traces the literature of cotton-yielding plants from the earliest writers to the time of Linnæus. The earliest reference to the use of cotton for textiles is by Herodotus, who mentions trees in India "the fruit whereof is a wool" of which the natives make clothes. The first reference in botanical literature is by Theophrastus (370–285 B.C.), who speaks of a wool-bearing tree on the Island of Tylos (in the Persian Gulf). Pliny (A.D. 23–79) repeats the information, but quotes the name "Gossypinum" for the trees. Between the classical writers and the herbalists who followed the Renaissance no botanical mention of cotton occurs. By this time the plant was well known around the Mediterranean. The first figure of Gossypium in European literature would seem to be in the "Herbal" of Dorstenius (1540) under the name of Bombax—apparently a conventional drawing of the Asiatic species, *Gossypium herbaceum*. A better figure of this plant was given by Fuchs ("Historia Stirpium," 1542), with a detailed account; but that of Matthioli ("Kreutterbuch," 1563) is more satisfactory. Cæsalpino (1583) was the first botanist to indicate the relationship of the plant to the mallows. In 1592 Prosper Alpinus, in his account of the flora of Egypt, describes and figures another species, *G. arboreum*, a small perennial shrub, a native of northern Africa. Columbus and the early explorers had found cotton in cultivation in the New World, and in 1651 Hernandez figured a Mexican species, *G. mexicanum*, the possible parent of the upland cottons. The botanical history of cotton in the later pre-Linnæan writers is mainly a record of the attempt to simplify the confusion created by the description of different species under the same headings, as, for instance, by Plukenet ("Phytographia," 1691), though fortunately in this case the specimens from which the plates were drawn are preserved in the Sloane Herbarium in the British Museum. Linnæus (1753) defined four species, the two Old World forms and two American, one of the latter being *G. barbadense*, presumably the parent of the "Sea Island" cotton.

METEOROLOGICAL Office Circulars Nos. 37 and 38, issued July 1 and August 1 respectively, deal with current official notices. Reference is made in the July circular to Professional Notes No. 7—"The Climate of North-West Russia," which was prepared for the use of the British forces acting on the Murman coast. The general climate is discussed for the district extending from the Arctic Ocean on the north to Petrograd and the Gulf of Finland on the south, and from the Swedish frontier on the west to 45° east on the east. It deals with the dates of the thawing and freezing of the rivers. The temperature of the upper air is discussed, and other meteorological information is given. Upper-air temperatures in the north-east of France are given for the end ot April last as being of interest in connection with the heavy snowfall over England on April 27. The upper air was abnormally cold. The August circular has an obituary notice of Lord Rayleigh.

THE very effective hardening solution for gelatine negatives that Messrs. Ilford, Ltd., recently introduced is applied as a preliminary bath, before development, and enables development, etc., to be carried on at as high a temperature as 110° F. without any cooling being necessary. In the specification of the patent granted to Messrs. Agnew and Renwick, both of Messrs. Ilford, Ltd. (see *British Journal of Photography*, August 8), it is stated that the formaldehyde, which is the real hardening agent, is mixed with a salt of the class which tends to restrict the swelling of dry gelatine in water and raise its melting-point, so that even though the bath may be at as high a temperature as 110° F., the gelatine has no opportunity of melting before it is hardened by the formaline. This class of salts includes acetates, tartrates, citrates, oxalates, sulphates, phosphates, chromates, bicarbonates, and horates. Example formulæ are given, using sodium sulphate and ordinary sodium phosphate.

A PAMPHLET issued by the Optical Pyrometer Syndicate, of Audrey House, Ely Place, E.C.1, contains some notes on optical pyrometers in general, and a special account of the "wedge" pyrometer and its uses. The early form of this instrument was described in NATURE for July 22, 1915, the principle relied upon being the complete extinction of the source of light by means of a wedge of dark glass interposed between the eye and the source, the temperature being deduced from the thickness of dark glass needed to secure extinction. It is claimed that not only can concordant results be obtained by a single observer trained to the use of the instrument, but also that separate observers may obtain readings agreeing to within 20° C. at 1500° C. One of the disadvantages of all optical pyrometers is that the personal judgment of the operator must be relied upon, either in matching tints or in producing total extinction, and for these purposes all eyes are not equally sensitive. In view of the great increase in the use of optical pyrometers, an impartial investigation of the various types from this point of view would be an advantage, due regard being paid to the type of observer employed in workshops. If the agreement in readings claimed for the "wedge" pyrometer should prove to be general for all types of observer, this instrument ought to be very useful, and its simple construction a recommendation for industrial purposes.

ACCORDING to an editorial note in the *Scientific American* for July 19, the romance of invention is to be illustrated in a series of articles on Americans who have produced inventions of the first rank which have proved financially successful. The whole record shows that the ability to invent and the ability to make a commercial success of an invention are seldom combined in one man, and the editor almost regards them as mutually exclusive. The first article of the series deals with the telephone. Dr. Graham Bell, who is now seventy-two, invented the telephone in 1876. He himself says he is not a business man and that his interest in the commercial side of an invention is small. He was, however, in the early days of the telephone so fortunate as to be associated with able business men who not only made it a commercial success, but also safeguarded the inventor's interests in such a way that its success was of benefit to him. It is not desirable that so large a proportion of those who invent or discover something of the greatest value to humanity should see the reward pass to others while they themselves get little or no recognition from their country or the world at large.

THE Journal of the British Science Guild for July contains a summary of the proceedings of various committees, including those dealing with education and with the metric system, and an account of the thirteenth annual meeting held on June 17. The education committee emphasises the unfavourable position of this country, as regards both the financial position of institutions for higher education and the number of students of university grade, in comparison with other countries. A detailed report on "Industrial Research and the Supply of Trained Scientific Workers" has been sent to the Prime Minister, to the President of the Board of Education, and to universities and similar educational bodies. Special attention has also been devoted by the guild to the organisation of research in relation to fisheries, and importance is attached to the establishment of an institute and museum of oceanography, similar to those in existence in Berlin and in contemplation in Denmark. The attention of the Government has also been directed to the importance of establishing a strong optical industry in this country. A measure recommended is the introduction of certificates of origin of optical goods as a safeguard against fraudulent competition. The report of the thirteenth annual meeting includes the addresses delivered on that occasion by Major-Gen. Seely, Lord Sydenham, and Sir J. J. Thomson. The journal also contains an appreciation of the late Sir Boverton Redwood by Prof. F. Clowes.

Mr. Edward Arnold announces a new series entitled The Modern Educator's Library. The general editor is Prof. A. A. Cock, and the aim is to present the considered views of teachers of wide experience and ability upon the changes in method involved in the development in educational theory and practice, and upon the problems as yet unsolved. The first volume of the series (by Prof. T. Percy Nunn) will form an introduction to it, and will deal with the fundamental questions which lie at the root of educational inquiry. It will be entitled "Education: Its Data and First Principles." Succeeding volumes will be "Moral and Religious Education," Dr. Sophie Bryant; "The Teaching of Modern Foreign Languages in School and University," Prof. H. G. Atkins and H. L. Hutton; and "The Child under Eight," E. R. Murray and H. Brown Smith. Other books announced by the same publisher are:—"A Physician in France," Sir Wilmot Herringham; "The Struggle in the Air, 1914–18," Major C. C. Turner; "Memories of the Months," Sir Herbert Maxwell, Bart., sixth series; "Gardens: Their Form and Design," Viscountess Wolseley; and "Modern Roads," H. P. Boulnois. *Messrs. Thomas Murby and Co.* announce:—"An Introduction to Palæontology," Dr. A. Morley Davies; "Petrographic Methods and Calculations," Dr. A. Holmes; and "A Nomenclature of Petrology," Dr. A. Holmes. *Messrs. Scott, Greenwood, and Son* have ready for publication the second English edition of "Chemical Reagents: Their Uses, Methods of Testing for Purity, and Commercial Varieties," Dr. C. Krauch; a new edition, by A. B. Searle, of the translation of E. Bourry's "A Treatise on Ceramic Industries"; and a new edition of "Modern Brickmaking," A. B. Searle.

ALL communications for the Imperial Mineral Resources Bureau should in future be sent to 2 Queen Anne's Gate Buildings, Westminster, S.W.1, to which address the Bureau has recently removed.

OUR ASTRONOMICAL COLUMN.

METCALF'S COMET.—The following orbit of the comet discovered by Mr. Metcalf on August 21 is by Miss Vinter Hansen and Mr. Fischer-Petersen from observations on August 21, 22, 25:—

$$T = 1919 \text{ Oct. } 16{\cdot}1984 \text{ G.M.T.}$$

$$\left.\begin{array}{l}\omega = 128^\circ\ 33{\cdot}32' \\ \Omega = 311^\circ\ 22{\cdot}93' \\ i = 19^\circ\ 58{\cdot}03'\end{array}\right\} 1919{\cdot}0$$

$$\log q = 9{\cdot}68280$$

Error of middle place (observed *minus* computed), $+0{\cdot}39' + 0{\cdot}09'$.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Sept. 5 ...	19 13 33	74 56·2	0·0147	9·3095
7 ...	16 25 41	76 26·4	9·9997	9·3174
9 ...	14 19 50	71 48·1	9·9842	9·3375
11 ...	13 19 10	65 9·2	9·9681	9·3666
13 ...	12 47 47	58 37·0	9·9515	9·4016

The magnitude remains nearly constant at 6½, so that it is on the verge of naked-eye visibility.

Prof. Leuschner telegraphs that he identifies the comet with comet 1847 V (Brorsen), which was expected about this time. If this is confirmed, it will be the fourth member of the Neptune group to be observed at a second return, the others being Olbers's, Pons-Brooks's, and Westphal's. Halley's comet is not reckoned.

THE RECENT SHOWER OF PERSEIDS.—The return of these meteors was fairly well observed this year, though the full moon occurring on August 11 greatly moderated the visible aspect of the display. The weather was very favourable, and a considerable number of meteors were recorded by Mrs. F. Wilson at Totteridge, Mr. S. B. Maltey at Ilfracombe, Mr. A. King at Scunthorpe, in Lincolnshire, and Mr. Denning at Bristol. The radiant point appeared rather more diffuse or scattered than usual, but it exhibited the usual E.N.E. movement amongst the stars when observed on successive nights. A companion shower between α and β Persei was strikingly evident this year, and it furnished some fine meteors radiating from the point $48^\circ+44^\circ$. Other contemporary showers were remarked from $336^\circ-10^\circ$, $310^\circ+80^\circ$, $313^\circ+48^\circ$, $303^\circ-9^\circ$, and $303^\circ+24^\circ$; and between August 22–29 many small, slowish meteors were traced from positions at $332^\circ+57^\circ$ and $348^\circ+61^\circ$. The most brilliant Perseid seen flashed out on August 12 at 10h. 32m. G.M.T., and it was recorded at Totteridge, Bristol, and several other places. Its height was from 76 to 51 miles, and it passed from a point above 10 miles W.N.W. from Worcester to 10 miles E. of Tredegar in South Wales.

INTERNATIONAL STANDARDISATION.[1]

M. GUILLAUME, the distinguished director of the Bureau International, is to be congratulated on the issue of this important volume.

And yet it is a sad record; the greater part is occupied with the *procès-verbaux* of the fifth International Conference of Weights and Measures held at Paris in 1913, and attended by representatives of all the principal countries of the world, many of whom will never meet again. Much of the rest is the last work of Pierre Chappuis, whose death is recorded in a note to one of the papers by M. Guillaume, and to whose labours are due the determinations of so many important constants.

The *procès-verbaux* of the conference demand our first attention, for the meeting was, in many respects, important, and new ground was broken in various directions. The decisions reached by the delegates remain unfulfilled, and it will no doubt be the business of the sixth conference—which it is generally understood is to meet shortly—to consider the steps that should now be taken to give effect to them or to modify them as may seem best; for on some of the matters discussed considerable difference of opinion may well arise.

The fundamental business of the conference concerns weights and measures, the determination of standards of mass and length, the kilogram and the metre. The accurate calibration of these at once involves the measurement of temperature, and accordingly much of the work of the Bureau has dealt with scales of temperature; the scale of the constant-volume hydrogen thermometer was chosen as standard, and all temperatures referred to it. For the range 0° to 100°, or, indeed, for one rather outside these limits, this sufficed, but accurate determinations of temperature are now required down to the temperature of liquid air and up to perhaps 2500° C. The hydrogen thermometer is useless for such a range, and some steps were necessary to secure international agreement throughout the scale. There was no doubt that the absolute thermodynamic scale was the standard to aim at; on the other hand, there was no certainty as to the methods to be taken to realise that scale over the greater portion of the range. And so the conference, after emphasising the importance of researches which had for their object the perfecting of our knowledge of thermometric scales, expressed itself as (1) ready to substitute for the international service of weights and measures the Absolute scale in place of the "normal"—*i.e.* hydrogen—scale so soon as the relationship between these scales had, thanks to the researches contemplated, been determined with sufficient certainty, and (2) approving the determination of a certain number of standard temperatures as fixed points of the scale, to be suitably chosen and agreed upon as soon as possible.

With the view of giving effect to this last resolution, the conference invited the International Committee on Weights and Measures to arrange with the directors of the national laboratories which had been dealing with the measurement of temperature to meet at the Bureau to select the standard temperatures and to take steps to secure their general adoption. In

1 "Travaux et Mémoires du Bureau International des Poids et Mesures." Tome xvi. (Paris: Gauthier-Villars et Cie, 1917.)

view of this invitation there was to have been a preliminary meeting of the directors of some of the laboratories concerned in Berlin in September, 1914; much correspondence had passed and all arrangements were complete. Representatives of the Reichsanstalt visited the National Physical Laboratory in June, 1914, to compare standards. *Sed dis aliter visum.* So far as England and America are concerned, uniformity has been secured over the range from −182° C. to about 1100° C. by agreement between the directors of the Bureau of Standards and the National Physical Laboratory, and a common scale is in use at those institutions.

Another important question dealt with by the conference related to the standardisation of end measures of length. M. Pérard presented an interesting report on the results of his investigation as to the methods of comparing end measures and line measures, and particularly as to the accuracy with which a length gauge built up of a number of Johannsen slips, the use of which has become so familiar during the war, represented the sum of the lengths of the individual gauges. He states as the result of his measurements that it is necessary to add an amount of about eight-hundredths of a micron for each contact in the complex gauge, a quantity which is negligible for all practical purposes when using the standards. But the report led to an interesting discussion on another point. The metre is standard at 0° C.; end gauges are used chiefly in engineering work, and the temperature in engineering shops is probably between 15° C. and 20° C. If, then, a gauge is standard at zero, it is necessary when using it at 20° to know its temperature coefficient with some accuracy; two gauges, one of steel, the other of gun-metal (say), both correct at the standard temperature, differ appreciably at the temperature of use. Accordingly it has been proposed to standardise gauges for industrial purposes at a temperature more nearly that of an average shop; the correction which would then be required would in most cases be so small as to be negligible. English practice, of course, secures this; our measures are standard at 62° F. ($16^2/_3$° C.). In America a temperature of 20° C. has been suggested.

The International Committee of Weights and Measures had in 1909 preferred to accept 0° C. as the standard temperature, and the French Technical Section of Artillery had adopted that in the standards employed by it. After discussion the matter was referred to a special committee consisting of Dr. Foerster and MM. Blumbach,[2] Egoroff, Guillaume, and Pérard, and on their recommendation the conference decided to invite the International Committee to pursue its investigations with the view of reaching as complete knowledge as possible of the metrological properties of steels, as well as of the construction, standardisation, and method of use of end standards of length. Sir David Gill pointed out that, while recognising that the adoption of 0° C. as the standard temperature was theoretically desirable, he accepted the resolution as one which reserved a final decision on the question until the completion of the experiments. The question is a vital one if international standardisation is to become a reality. Its importance was illustrated during the war. A number of screw gauges about 2 in. in diameter were ordered on the Continent; the first batch received failed to pass inspection. They had been made correct at the freezing-point, and the expansion between that temperature and the English standard, 62° F., brought them outside the limits for acceptance. A visit to the Continental works was necessary to explain the point and put matters straight, causing delay and loss when time was of great importance.

A third decision of the conference is of special interest to meteorological circles. In correcting a barometer to a standard, sea-level at latitude 45° has been accepted, and a formula due to Clairaut, but modified by Broch, based on the accepted value of g in latitude 45° and its variations with latitude, has been employed. The accepted value for g at sea-level at latitude 45° has been 980·665 cm./sec.^{2}; recent observations, however, lead to 980·615 cm./sec.^{2} as the more correct value,[3] and it became a question whether to modify the normal standard or not. The conference decided against any modification in view of the fact that the figure 980·665 cm./sec.^{2} had received legislative sanction in many countries. They agreed, however, that observations into which the local value of g entered should be reduced, not by the usual formula, but by means of a numerical factor "determined, if possible, directly for the locality in question."

Now the unit of barometric pressure is the millibar —a pressure of 1000 dynes per sq. cm.—and the length of the column of mercury the weight of which gives rise to a pressure of one millibar is known as a baromil. A barometer the scale of which is graduated in baromils reads pressure in millibars. The length of the baromil is dependent on the value of g, and so varies with the locality, but it has been agreed by the International Conference of Meteorologists to take as standard the value of g at sea-level in latitude 45°, and the relation of the baromil to the mm. or the inch has been evaluated on the hypothesis that the standard value of g is 980·617 cm./sec.^{2}, the value assigned to it by Helmert. The decision, then, of the International Conference of Weights and Measures to retain as the standard value of g the old figure 980·665 involves, if it be used, a reduction of about 5 parts in 100,000 in the height of the column of mercury producing under standard conditions a pressure of one millibar. The certificates usually issued with barometers state the temperature at which the scales read pressure in millibars under standard conditions. If reduction is to be made to a nominal standard of gravity of 980·665 cm., these temperatures will all need to be reduced correspondingly. The difficulty, of course, is avoided if we take the true value of g at latitude 45° instead of the standard value as the figure to be used in calculating the length of the baromil, *i.e.* if we assume that this is one of the cases in which a numerical factor directly determined is to be employed, and some such course as this no doubt will be adopted.

A fourth matter of some interest which was discussed was the proposal to adopt in future legislation for metric countries the M.K.S. system of units, in which the unit of length is the metre, that of mass the kilogram, and of time the second. On this system the unit of force is the "Newton," the force required to produce per second in a mass of 1 kilogram a velocity of 1 metre per second. Thus,

$$1 \text{ Newton} = 1000 \times 100 \text{ C.G.S. units} = 10^5 \text{ dynes.}$$

The unit of work will be the work done by a Newton in moving its point of application 1 metre or $10^5 \times 10^2$ ergs, and this is the joule of the C.G.S. system. Accordingly, the unit of power is the watt.

As a result of the discussion the International Committee was invited to continue the study of all questions connected with legislation based on metrical units.

At the last session of the conference M. Battistella, the Italian delegate, raised a far-reaching question. The work of the conference and of the committee

[2] M. Blumbach's many friends will be glad to know that he is well: a message has been received from him asking for help to reconstitute the Weights and Measures Department in Russia.

[3] The value given by Helmert is 980·617 cm./sec.^{2}.

had hitherto, he pointed out, been limited to the fundamental standards of mass and length and questions intimately connected with these. M. Battistella urged that this was insufficient to secure uniformity in all the details of importance to international science. In the name of his Government he directed attention to (1) the necessity for a legal definition, not only of the fundamental units of mass and length, but also of a whole series of connected units—units dealt with in the study of light, heat, engineering, and electrical problems, and others, as well as for the specification of the instruments best suited for the measurement of these quantities; and (2) the importance of the standardisation of the types of instruments to be employed so as to secure uniformity among countries using the metric system. As a result the International Committee was entrusted with the mandate of examining the proposal of the Italian delegate with the view of securing agreement on the questions raised.

Enough has, perhaps, been written to show that the matters under discussion were of no small importance. None of them were settled; it remains for a future conference to examine them afresh and to decide each in the manner which promises best to be of service to the world and to turn to advantage the lessons of the past five years of trial.

And now there is no space to describe the other half of the volume: M. Pérard's elaborate note on the reduction of certain classes of observation or M. Chappuis's two papers on the determination of the boiling-point of sulphur and the coefficient of dilatation of mercury. It must suffice to mention the results. For the boiling-point of sulphur on the thermodynamic scale under normal pressure he finds the value, 444·60°. Holborn and Henning give 444·51°, and Day and Sosman 444·55°. The value at present in use at the National Physical Laboratory is 444·5°.

For the coefficient of dilatation of mercury his value is $0{\cdot}18162884 \times 10^{-3} + 8{\cdot}5962282 \times 10^{-9}\,T$. This value does not differ greatly from that deduced from his own earlier experiments of 1890; the differences between these results and those of Callendar and Moss (Phil. Trans., 1911) are considerably greater. For the range from 60° to 100°, where Chappuis's two results agree very closely, the difference between them and the figures of Callendar and Moss would correspond with a temperature error of 0·25°, an error ten times greater than that which M. Chappuis considers possible.

M. Chappuis died as the proofs of his paper were passing through the press. Those who know his work will wish to join in M. Guillaume's tribute to his memory. He writes:—"These two determinations of the coefficient of dilatation of mercury, separated by a quarter of a century, carried out by methods entirely different and with instruments which had no part in common, and yet in close agreement, will remain for metrologists of the future among the finest examples of the work of an experimenter gifted with consummate skill, with a devotion to his task which stood every test and with an intense desire to reach the truth." R. T. G.

SOME INDIAN SUGAR-CANES AND THEIR ORIGIN.

DR. C. A. BARBER, Government Sugar-Cane Expert, Madras, continuing his studies on Indian sugar-canes, has given an account of the classification of two new groups which he describes as Saretha and Sunnabile (Memoirs of the Department of Agriculture in India, Botanical Series ix., No. 4). In the course of study of the Indian canes a sharp distinction was observed between two classes. There was, on one hand, a large series of thick, juicy canes commonly grown on a crop-scale in the more tropical parts, or in the northern parts usually in small plots under high cultivation near large towns, in which they were used for eating as fruit. A second series of thin, hardy canes, grown under field conditions all over India, especially in the north, were unfitted for chewing, but were crushed and made into "jaggery" or "gur." It is this second series which includes the subject of the memoir. In contrast with the first series these thin canes are considered to be indigenous to India, and were found to include several well-defined classes. A number of apparently isolated forms from all parts of the country were at first difficult of arrangement, but were afterwards found to fall into two groups, characterised by bending or erect leaf-tips and presence or absence of circlets of hairs at the nodes; the canes known as Saretha and Sunnabile have been selected to give names to the new groups. In classifying varieties under these two groups the characters usually employed in systematic work, such as differences in the floral organs and size of organs and plants, have not been found helpful, but dependence has been placed on a series of minute local differences. Thus in all the Saretha group there is a minute incrustation on the rind, as if it had been attacked by a small mite, whereas this is absent in the Sunnabile group. The density of bloom is greater in the Saretha group, but the blackening of this bloom by fungus is sharper and more circumscribed in the Sunnabile group. Thickness of stem and size and vigour of plant seem to be of no value; and the existence of insignificant characters in canes differing considerably in external appearance, and extending through wide stretches of country under varying climatic and cultural conditions, adds to their importance. Some sixty to seventy such characters are dealt with in detail.

Dr. Barber further points out that his classification is not merely an empirical statement of unconnected differences, a sort of analytical key for the separation of varieties, but also presents data for a statement on the lines of evolution among a section of cultivated canes. He claims to have advanced towards solving the origin of cultivated canes from their wild ancestor, and to have established a series of connecting links between cultivated canes and the wild species of Saccharum now growing in India. A wide collection of specimens shows that there are some very distinct varieties of *Saccharum spontaneum* more or less confined to definite geographical regions. A development in the size of the vegetative organs is observed in passing from the dry to the humid tracts in India similar to that met with in the Saretha and Sunnabile series of sugar-canes, and in the detailed list of characters showing differences between the two groups we find a number mentioned in which the Saretha group approaches *S. spontaneum*. Such are the black incrustation on the stem, the circlet of hairs on the nodes, and certain leaf-characters, and these resemblances suggest that the Saretha group is the more primitive. But as a study of the seedlings of *S. spontaneum* raised at Coimbatore shows differences among themselves similar to those obtaining between the two groups, it is considered that the Sunnabile varieties are also traceable to the same wild species.

Dr. Barber describes a method for building up an ideal cane for each variety and group. The results have been reduced to curves, which show the differences sufficiently well, but involve considerable labour, as in some cases they are based on as many as

10,000 individual measurements. He has recently dissected some fifty stools, representing twenty-four varieties, and finds overwhelming evidence that the late canes are the thickest, thus reversing earlier conclusions drawn from the behaviour of the Punjab canes late in the season.

GENERAL PHYSIOLOGY.

INCREASED specialisation brings with it further subdivision of the sciences, and most of the new journals which are founded are restricted to narrower fields than those of existing publications. Now and then, however, an attempt is made to counteract the evils of specialisation by insistence on broad principles and by the provision of a meeting-place for workers in various branches of the same or of kindred subjects. Some such considerations must have led to the recent foundation of the *Journal of General Physiology*, which is edited by Prof. Jacques Loeb, a physiologist, and Prof. W. J. V. Osterhout, a botanist, and published by the Rockefeller Institute of Medical Research. This journal, which was referred to in our issue of October 31 last, is "devoted to the explanation of life-phenomena on the basis of the physical and chemical constitution of living matter," and first appeared in September last. Its scope may, to some extent, be illustrated by a number of reprints which we have received; they are of papers by Prof. Loeb, some physico-chemical, some botanical in nature.

In three papers on amphoteric colloids, which have appeared in the first three numbers of the new journal, Prof. Loeb has continued work previously published by him in the *Journal of Biological Chemistry*. Contrary to what is generally stated in the literature of colloid chemistry, he concludes that the physical properties of gelatin near the point of neutrality are affected only by the cations of a neutral salt, and not by its anions. "The error into which the colloid chemists have fallen is due to the fact that they always investigated the effect of a neutral salt on a protein in the presence of the salt, while the writer took the precaution to wash the excess of salt away after it had time to act on the gelatin." Accordingly, a quantity of finely powdered gelatin is left for one hour in contact with a neutral salt solution of known concentration. The powder is then filtered off, and the excess of salt removed by repeated washing with water. The gelatin is liquefied by heating to 50° C., and diluted with water to make a 1 per cent. solution. Then, for instance, the osmotic pressure of the solution is determined in a collodion bag. Treatment with salts of a bivalent metal ($MgCl_2$, $CaCl_2$) does not lead to an increase of osmotic pressure, but treatment with sufficiently concentrated solutions of salts of monovalent metals (NaCl, NaCNS, $LiNO_3$, Na_2SO_4) results in an increased osmotic pressure. When the powdered gelatin is similarly treated with hydrochloric acid of varying concentrations, it is found that about N/256 HCl (which brings the gelatin to its isoelectric point, $p_H = 4{\cdot}7$) makes the total swelling, the osmotic pressure, the conductivity, and the "alcohol number" minima. On the less acid side gelatin is regarded as existing as a negative ion (*e.g.* $\overset{-}{\text{gelatin}}\text{-}\overset{+}{\text{H}}$ or $\overset{-}{\text{gelatin}}\text{-}\overset{+}{\text{Na}}$); on the more acid side as a cation ($\overset{+}{\text{gelatin}}\text{-}\overset{-}{\text{Cl}}$ or $\overset{+}{\text{gelatin}}\text{-}\overset{-}{\text{OH}}$).

In a later paper the author has determined the amount of bromine in combination with gelatin after treatment with hydrobromic acid of varying concentrations. He regards the curves of osmotic pressure as an "unequivocal function" of the number of gelatin bromide molecules formed. Prof. Loeb has evidently not seen the recent very careful and elaborate investigation, by Sörensen and his collaborators, of egg-albumin; in the *Comptes rendus* of the Carlsberg laboratory. A considerable section of this monograph deals theoretically and practically with the osmotic pressure of an amphoteric colloid of great purity in the presence of electrolytes, and takes into account factors which are not dealt with by Prof. Loeb's simple procedure. It will be interesting to see whether, after a perusal of Sörensen's monograph, Prof. Loeb still maintains his somewhat sweeping criticism of colloid chemists.

The botanical reprints are concerned with the mechanism of regeneration in *Bryophyllum calycinum*. The leaves of this plant possess peculiar dormant buds in each of the notches, which buds may give rise to roots and shoots so soon as the leaf is separated from the plant. The chemical mechanism of the process is dealt with in a paper in the *Annales de l'Institut Pasteur*, and is a rare example of work published in English in a French journal. In other papers in the new journal the influence of the mass of a leaf on the quantity of shoots regenerated in an isolated piece of stem is measured, and the physiological basis of polarity is discussed. It is suggested that an inhibitory influence of the leaf upon shoot-formation (as compared with root-formation) is due to inhibitory substances secreted in the leaf, and carried by the sap from the leaf towards the base of the stem.

ÆTHER AND MATTER: BEING REMARKS ON INERTIA, AND ON RADIATION, AND ON THE POSSIBLE STRUCTURE OF ATOMS.[1]

PART I.—INERTIA.

WE are each of us flying through space at nineteen miles a second, probably much more. Nothing is propelling us; we continue to move by our own inertia, simply because there is nothing to stop us. Motion is a fundamental property of matter. No piece of matter is at rest in the æther, the chances are infinite against any piece having the particular velocity zero; every bit is moving steadily at some given speed, unless acted on by unbalanced force. Then it is accelerated—changed either in speed or direction, or both.

As a matter of fact, we, like other bodies on the earth, are acted on by two slight, unbalanced forces—one which makes us revolve round the earth once a day, like a satellite; the other which makes us revolve round the sun once a year, like a planet or asteroid. Our annual revolution is not because we are attached to the earth; we are not attached, but revolve as independent bodies, and would revolve in just the same time and way if the earth were suddenly obliterated; only then we should find the diurnal revolution transmuted into a twenty-four-hour rotation round our own centres of gravity, and the eccentricity of our annual orbit very slightly changed. In any case, there is no propelling force, only a residual radial force producing curvature of path.

A railway train, or a ship moving steadily, is likewise subject to no resultant force. Propulsion and resistance balance. The whole power of an engine, after the start, is spent in overcoming friction. The motion continues solely by inertia. Any steadily moving body is an example of the first law of motion. You need not try to think of a body under no force

[1] Amplified from a discourse delivered at the Royal Institution on Friday, February 28, 1919, by Sir Oliver J. Lodge, F.R.S.

at all; you cannot think of such a body on the earth, but you can think of one under no resultant force, *i.e.* under balanced forces. Such a body moves by reason of its inertia alone. It is in equilibrium; it is not at rest.

But we have no sense of straightforward locomotion, and not the slightest clue to either the magnitude or direction of our motion through space. We can ascertain approximately how the sun is moving with reference to our system or cosmos of stars, but we do not know at what rate that system is itself moving. For all we know, it may be moving very fast, hundreds of miles per second.

We have a sense of acceleration, however; we experience it in a lift as it begins to descend; and if the sensation is repeated often enough, as on a rough sea, the result is unpleasant. We have also a sense of rotation; we can tell when our vehicle—say a Tube train—turns a corner in the dark. Most animals appear to have a sense of rotation, apparently located in the ear. But we have no sense of direct translation; and we have so far failed to devise any instrumental means for detecting our motion through the æther of space.

The failure is not for lack of trying. Many experiments have been tried, but there is always some compensating effect; so we get no answer to the question: At what rate and in what direction are we moving? The best known experiment is that of Michelson and Morley, the result of which seems to assert that the æther clings to the earth, or that the earth is not moving through any kind of substance. But Fizeau's classical experiment showed that a transparent body carried with it none of the internal æther of space; and experiments made by myself[2] at Liverpool in the nineties of last century showed that a rapidly moving opaque body carries no external æther with it, that there is no perceptible viscous drag or cling between matter and æther, and accordingly demonstrates that stagnation or absence of relative æther drift past the earth is not a reasonable explanation of Michelson's negative result.

The two experiments together, in fact, ought to be taken as establishing the reality of the most interesting of all the compensating effects yet discovered, viz. the FitzGerald-Lorentz contraction of all matter in motion, which the electrical theory of cohesion renders so extremely probable. It only amounts to a 3-in. shrinkage in the whole diameter of the earth in the direction of motion; but it is enough. This slight contraction or change of shape in moving bodies I regard as the definite and interesting compensating effect in this case. Incidentally, moreover, it establishes the electrical, *i.e.* the chemical, nature of cohesion. For, given that cohesion is a residual chemical affinity—due to the outstanding attraction of molecules composed of neutral groups of equal and opposite electric charges, brought so near together that the attraction between molecules is no longer averaged to zero[3]—then, on orthodox Maxwellian electric theory, a diminution of this force due to lateral motion is inevitable. And the resulting lateral expansion or longitudinal contraction, or both, is of the right order of magnitude. So this acts as a previously quite unsuspected compensating effect, which exactly neutralises the drift effect otherwise to be anticipated. Thus, by superposition of two positive consequences of drift, the Michelson experiment, like every other yet made, declines to indicate that there is any drift at all.

Hence, after many such negative results, it seems to become hopeless to inquire experimentally as to our motion through æther, unless, indeed, gravitation were exempt from the otherwise universal compensation. In that case the electrical theory of matter applied to the motion of planets might yield a residual result. But my recent inquiry into this problem has suggested that gravitation, too, is in the conspiracy,[4] and in that case there is some ground for the contention of the extreme Relativists, not only that we do not know our motion—with which everyone agrees—but also that we never shall know it; and, in fact, that motion of matter through æther is a phrase without meaning.

I hope we shall not too readily shut the door on further attempts in this direction; and as a conservative physicist I may be allowed to lament the extraordinary complexity introduced into physics and into natural philosophy by the principle of relativity, as so remarkably and powerfully developed by the mathematical genius of Einstein, with complication even of our fundamental ideas of space and time. The complications do not commend themselves to all of us, and I for one should be glad to return to the pristine simplicity of Newtonian dynamics, modified, of course, by the electrical theory of matter; admitting the FitzGerald-Lorentz contraction, and admitting also the variation of effective inertia with speed. These things do not destroy, but supplement, Newtonian dynamics. They generalise it in a legitimate and intelligible manner. Such complications as these are clearly in accordance with truth, and are to be welcomed; but the complicated theory of gravitation created this century by Einstein, and developed by his successors, and the consequent overhauling of space and time relations, do not at present commend themselves to me, or, I think, to others of what I suppose must be called the older school.

Meanwhile, the full-blown theory has the courage of its conviction and has predicted a definite result, viz. the deflection of a ray of light by the sun's limb, equal to 1·75 seconds of arc. The prediction is going to be tested during the solar eclipse of May 29 this year, between Brazil and the Gulf of Guinea. Let the issue be clearly understood. If a star-ray grazing the sun is deflected ¾ second it will mean only that light has weight, that the wave-front not only simulates the properties of matter by carrying momentum—as we know it does from the investigations of Nichols and Hull, Poynting and Barlow, and others—but that it is even subject to gravity. For this would be the angle between the asymptotes of a cometary orbit when the comet is moving with the speed of light and passing close to the sun.[5] But the principle of relativity—through the refractive or converging influence of a strong divergent gravitational field—demands a greater deflection than this, more than twice as great. So there are three alternate deflections before us, to be settled by observation:—1·75 sec.; 0·75 sec.; and zero. Let us hope that the result of this or of some other eclipse-opportunity may be definite enough to discriminate clearly and quantitatively between these three alternative values, any one of which should be equally welcome to any lover of truth.

If the first answer is given decisively, it will be a conspicuous triumph for the theory of relativity, and will for a time be hailed as a death-blow to the æther. I claim beforehand that such a contention is illegitimate, that the reality of the æther of space depends on other things, and that the establishment of the principle of relativity leaves it as real as before; though truly it becomes even less accessible, less

[2] See Phil. Trans., vol. clxxxiv. (1893), pp. 727–804, and vol. clxxxix. (1897), pp. 149–66.
[3] See, for instance, my book on electrons, chap. xvi.

[4] See the *Phil. Mag.* for August, 1917, and February, 1918, pp. 145, 155 and 156.
[5] See, for instance, my paper in the *Phil. Mag.* for August, 1917, p. 93.

amenable to experiment, than we might have hoped. Nevertheless, the æther is needed for any clear conception of potential energy, for any explanation of elasticity, for any physical idea of the forces which unite and hold together the discrete particles of matter whether by gravitation or cohesion or electric or magnetic attraction, as well as for any reasonable understanding of what is meant by the velocity of light. Let us try to realise the position beforehand; for we shall be handicapped in the progress of our knowledge of the relation between matter and æther until these fundamental things are settled, and until everyone agrees that the æther has a real existence. I want people generally to admit that the æther is itself stationary as regards locomotion, and that it is the seat of all potential energy; and further, at least as a surmise, that it is the medium out of which matter is probably made, and in which matter is perpetually moving by reason of its fundamental property called inertia—a property the full explanation of which must, I expect, ultimately be relegated to and considered as a property derived from the æther itself.

I call this lecture "Æther and Matter," but I might equally well have called it "Inertia," for that is the main theme with which I have to deal—at least, in this first part.

Is there anything else besides matter which possesses or seems to possess inertia? Faraday discovered that an electric current had a property which bore some analogy to inertia, a property clearly depending on its magnetic field. Every current, even a convection current, is necessarily surrounded by lines of magnetic force, and when the magnetic field is intense the current behaves as if it had considerable inertia. Faraday at first called the effect "the extra current." Maxwell called it "self-induction." The latter is the better name.

To show it, I start a current in a circuit containing a stout ring of laterally subdivided iron round which the current-conveying wire is wound, and I put in circuit an instrument which only responds when the current has risen to nearly its full strength. A current usually rises what is called instantaneously, but here there is a very noticeable delay between pressing down the key and the response of the instrument. The lag shown is only a second or two, but with care I can adjust it until it is a quarter of a minute. Such delay or lag in establishing a current would be fatal to electric telegraphy. In practice the delay is reduced to a minimum by using its early values, and the actual response is exceedingly quick. Still, the law of rise of current is quite definite; there is no exception, it is only a question of degree; and the law is the same as that appropriate to the pulling of a barge on a canal. A barge gets up speed slowly, at a rate depending on its mass or inertia, and it ultimately attains a steady speed when the resistance balances the pull.

That is exactly the case of a steady current obeying Ohm's law; the E.M.F. is balanced by the resistance, the propelling force is zero, and the current flows by what we may call its own inertia—its own momentum.

To stop the current you must either increase the resistance or suspend the propelling force. If you interpose an obstacle suddenly, the motion stops with violence—a collision in the case of a train or barge, a flash in the case of electric current. This is what Faraday called "the extra current at break"; and if you are holding the wires in your hand when a current is suddenly broken in a circuit of large self-induction, you may get a nasty shock.

If you could abolish electric resistance, a current would go on for ever without propelling force.

An amazing experiment has been made by Kamerlingh Onnes at Leyden, who first cooled a metal ring down to within 4° of Absolute zero by means of liquid helium, and then started a current through it by a momentary magnetic impulse. Instead of stopping in a minute fraction of a second, as usual, the current went on and on, not for seconds, but for days. In four days it had fallen to half-strength, and there were traces of it a week later. A most suggestive experiment as to the nature of metallic conduction, as well as a demonstration of the fly-wheel-like momentum of an electric current!

This electromagnetic analogue to mechanical momentum or inertia is explicable (or supposed to be explicable) in terms of the magnetic field surrounding the current, *i.e.* really (as I think) in terms of a property of the æther of space. It exactly simulates inertia; but is it an imitation or is it the same thing? Can it be said that an electric charge possesses inertia in its own right, and retains it always, as matter does, whether it be moving or whether it be stationary?

The question was brilliantly answered by your professor of natural philosophy, Sir J. J. Thomson, so long ago as 1881. He calculated the inertia or quasi "mass" of an electric charge e on a sphere of radius a, and showed that it was $m=\frac{2\mu e^2}{3a}$.

The μ need not be attended to now, though it is really the most important of all—being a great æthereal constant of utterly unknown value [6]—but for our present purpose the μ merely signifies that the e must be measured in electromagnetic, not electrostatic, measure when the formula is interpreted numerically with $\mu=1$.

At the date 1881 this expression for true electric inertia, though an interesting result, seemed too absurdly small to have any practical significance. Take a sphere like a football, 20 cm. or 8 in. in diameter; charge it until it is ready to give more than an inch spark, say up to 60,000 volts; then calculate the inertia or equivalent mass corresponding with the charge. If I have done the arithmetic right, it comes out one-third of a millionth of a millionth of a milligram (3×10^{-16}). Absurdly small! Yes, but not zero. And whenever a quantity is not nothing, there is no telling what importance may not have to be attached to it sooner or later. Nothing real can be so small as to be really negligible in the long run as knowledge progresses. Something at present unforeseen may bring it into prominence. So it has turned out in this case. The infinitesimal result of nearly forty years ago to-day dominates the horizon. It was in some sort the dawn of a new era in physics.

Consider it further. Clearly the inertia depends not on the charge only, but on its concentration. The radius of the sphere occurs in the denominator of the expression. The same charge on a sphere 2 cm. in diameter would have ten times the inertia; on a sphere as small as an atom the inertia would be a hundred million times bigger still. But then even that is small; moreover, an atom could scarcely be expected to hold such a charge. Nevertheless, allowing only a reasonable potential, it might seem that atomic inertia could be sensibly increased by an electric charge. But, no; even on a sphere as small as an atom the concentration turns out insufficient; the effect is still excessively minute. Yet as electric inertia at given potential depends on linear dimen-

[6] I have guessed that it is a density of 10^{12} grams per c.c.$\div4\pi$. See "The Æther of Space," Appendix 2; also the *Phil. Mag.* for April, 1907.

sions, while material inertia depends on those dimensions cubed, there must be a size when the two are equal, *i.e.* when one might account for the other.

Write the charge in terms of electrostatic potential V,

$$e = KaV$$

then
$$m = \frac{2KaV^2}{3c^2}$$

where c is $1/\sqrt{(\mu K)}$, the velocity of light.

Put this expression for m equal to $\pi a^3 \rho$, the ordinary mass.

Then the potential at which the two will be equal is

$$V_1 = ac\sqrt{\left(\frac{2\pi\rho}{K}\right)}$$

which, for density of water and for a sphere 10^{-13} cm. radius, is two volts—quite a reasonable electrolytic value, such as is to be expected among atoms.[7]

The moral of this elementary, but not very satisfactory, argument is that not for bodies of atomic size, but for something 100,000 times smaller in linear dimensions, is it possible to explain inertia electromagnetically. But forty, or even twenty, years ago one would have said: There are no bodies of this size; nothing can be smaller than an atom! The strange thing is that, as nearly everyone knows now, bodies of this size have been discovered. They were isolated by Sir J. J. Thomson in 1899, having been gradually led up to by Crookes's and many other experiments on cathode rays; and they are shown to be an apparently invisible unit or atom of electricity the inertia of which is wholly electric.

The proof of this last statement I can only briefly indicate. It is established by the effect of speed on electric inertia. If an electric charge is moving with something approaching the velocity of light, its inertia increases without limit; and the formula given about 1889 by Heaviside, Thomson, and others for electric inertia as a function of speed is, in its very simplest form,

$$m = \frac{2\mu e^2}{3a}\left(1 + \frac{v^2}{2c^2} + \text{higher powers}\right).$$

The velocity of light squared occurs in the denominator, so, before we can observe the increase, enormous speeds are necessary. A cannon-ball, or even the earth in its orbit, is hopelessly slow; and we know no artificial means of getting up such a speed as this last, viz. about nineteen miles a second. But, fortunately, radium does spontaneously what we cannot do; it expels electrons with something less, but not very much less, than the speed of light; and Kauffmann's measure of the mass of these projectiles, thus flying at prodigious velocities, confirms the theory, and removes any doubt as to the reality of purely and wholly electric inertia for electrons.

Furthermore, it was found that the very same electrons can be split off or detached from any or every kind of atom, that there is only one kind of negative electron; and though at first there appeared to be many kinds of positively charged particles, the evidence is tending to the discovery of a single kind of positive electron likewise; so it is natural to suppose that electrons are an essential ingredient in matter. And since they possess inertia, even those which are clearly disembodied electric charges, it becomes possible to surmise that in some sense, or in a certain grouping, they constitute the atom; that they confer upon it the inertia with which we are familiar; and that, in fact, electric inertia is the only inertia that exists.

Electric inertia began as the simulacrum of material inertia; it has shown itself the very same thing, and it seems likely to end by displacing every other kind of inertia altogether.

This is the electrical theory of matter.

Assuming this theory for the present as a working hypothesis, we may say that material inertia is explained electromagnetically, *i.e.* is explained in terms of the magnetic field which necessarily surrounds and accompanies every charge in motion, since a charge in motion constitutes a current. For on this view a material body is but an aggregate of such charges grouped according to some definite pattern, positive and negative charges interlaced or somehow intertwined, and so far apart in proportion to their size that they do not interfere with each other or cancel each other, nor apparently overlap or encroach on each other's field, to any measurable extent. Is this possible? It is. For, comparing the size of an electron with the size of an atom, we perceive that they are relatively of the same order as the size of a planet and the size of a solar system. So it becomes possible to think of an atom as a sort of solar system, with a positive nucleus or sun surrounded by negative electrons revolving in regular orbits round it.

On this view, or, indeed, in any form of the electrical theory of matter, the atom of matter consists mainly of empty space; in other words, it is excessively porous, just as the solar system is mainly empty space, and may be spoken of as excessively porous, the actual material lumps being almost infinitesimal in proportion to the total bulk. A rapid projectile or a ray of light passing through the solar system would be unlikely to hit anything; the chances would be strongly against a collision. So also, if a point be thrown through an atom, the chance of its hitting anything is about 1 in 10,000. It might pass through 10,000 atoms before striking. This experiment has been tried by C. T. R. Wilson and others, and that is, roughly speaking, the result. Sooner or later a radium projectile meets with an obstacle and is stopped, but it traverses a good number of atoms on the average; it traverses quite a perceptible distance even in a dense solid before it strikes a nucleus.

Matter accordingly seems to me—to us, I may say, for in this most physicists are, I think, agreed—a gossamer or milky-way structure, an impalpable acci-

[7] The argument is plausible, and, taken as an illustration on ordinary lines, will serve; but considered seriously it may be quite fallacious, although the main consequences which in the text are going to be drawn are correct. Few things are more surprising than the extraordinarily large charge held by or constituting an electron in proportion to its size. The charge is so large that ordinary arguments about electricity as it exists on material spheres cannot be expected to apply. If they did, or in so far as they do, the potential of an electron would not be two volts, but well over a million volts; and the density of the æthereal substance of which it is presumably composed (if its electric inertia is to be derived in any simple, ordinary way from its bulk) would have to be nothing like that of water, but of the order 10^{12}, or a billion times the density of water. A thousand tons, in fact, to the cubic millimetre.

We are here out of our depth among quantities on which a great deal of work has to be done to reduce them to order. Yet it must not be supposed that these figures are nonsensical. They require serious consideration; and that is all that can be said for them. I do not think there is any sense in talking about the potential of an indivisible unit of charge, but we can talk about the potential existing at the confines of an atom; and that is a reasonable magnitude, about 14 volts in the case of hydrogen, and not very different for other elements.

But on the other side of the subject everything points to the density of æther being exceedingly high, though perhaps not so high as the above estimate. It must at least be greatly denser than platinum or lead, and probably immensely denser.

A difficulty is often felt as to how ordinary matter like a planet can move through such a medium without friction. Density, however, does not involve viscosity; the two are disconnected; and resistance to motion would be caused only by viscosity, of which the æther appears to have none. There are many ways, more or less satisfactory, of picturing the perfectly free motion of matter through an exceedingly substantial æther of space; there would be innumerable difficulties in supposing friction and consequent generation of heat. It is quite certain that whatever the æther does it does not dissipate energy. That imperfection belongs to the province of molecularly constituted matter.

dent in the substantial æther. Here a speck and there a speck, but, for the great bulk of it, empty space!

"Impalpable" is not the right word, for matter is essentially palpable. It is because it appeals so directly to our senses that we attend to it so vividly. It forces itself on our attention, while the æther eludes us. And why? Clearly because our bodies are composed—our sense organs are composed—of this very matter. On the material side we are part of, and thoroughly at home in, the material universe. Whereas the æther is elusive—we know nothing of it directly—and though our eyes are instruments for receiving æthereal tremors excited by agitated electrons, we only know that fact, or half know it, by rather recondite inference. Light really tells us nothing about its own nature, but only about the superficial aspect of that gross and palpable matter which has interfered with and scattered it before it enters our eye.

Nevertheless, the atoms of this solid-seeming flesh and matter as we know it, when analysed into constituents, are turning out to be composed each of a definite grouping of ultra-minute particles, the positive and negative electrons, which themselves scarcely occupy any space (save as soldiers occupy a country), and which appear to be of two kinds only: the ultimate indivisible units of positive and negative electricity.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MANCHESTER.—The following appointments are announced:—Mr. A. G. Ogilvie, reader in geography; Mr. J. Macmurray, lecturer in philosophy; Messrs. A. Gardner and R. L. Newell, demonstrators in anatomy. Mr. E. N. Ramsbottom has been elected to a research fellowship in public health.

DR. J. GRAHAM has been appointed professor of anatomy in the Anderson College of Medicine, Glasgow, in succession to the late Dr. A. M. Buchanan.

THE sum of 700,000*l.* has been given by Mr. G. Eastman, head of the Eastman Kodak Co., for the establishment of a school of music in connection with the University of Rochester, New York.

DR. G. SPENCER MELVIN, lecturer on experimental physiology in the University of Aberdeen, has been appointed professor of physiology in Queen's University, Kingston, Ontario.

THE PRINCE OF WALES, in acknowledging the degree of LL.D. conferred upon him on August 26 by the University of Toronto, said that the anti-toxin establishment with which the University is equipped had rendered invaluable service during the war for the forces of the British Empire and the Allies.

PROF. C. GOLGI has retired from the chair of general pathology and histology in the University of Pavia, but he remains in charge of the institute connected with it. A gold medal and souvenir album were recently presented to him, and a scholarship founded in his honour is to be given to the orphan of some physician killed during the late war.

DR. F. J. WILSON has been appointed professor of inorganic and analytical chemistry, and Dr. I. M. Heilbron professor of organic chemistry, at the Glasgow Technical College. Mr. W. Kerr has been appointed research assistant in the department of mechanical engineering at the same institution. The new development fund of the college has now reached the total of 35,000*l.*, the following donations having recently been received:—From Mr. W. J. Chrystal, 1000*l.*; Mr. and Mrs. George Morton, 500*l.*; Messrs. W. Teacher and Sons, 500*l.*; Messrs. Alexander Stephen and Sons, Ltd., 500*l.*; the Anchor Line (Henderson Bros.), Ltd., 250*l.*; Messrs. Macfarlane, Lang, and Co., Ltd., 250*l.*; and Mr. James Reid, 250*l.*

THE Civil Service Commissioners announce that an examination will begin on October 28 for the purpose of filling vacancies as assistant examiners in the Patent Office. The examination will be confined in the main to candidates who have served in his Majesty's Forces, and will consist of a qualifying examination followed by interview by a selection board. The subjects of the qualifying examination are English composition, *précis*-writing, general knowledge, and *one* of the following:—General chemistry, electricity and magnetism, or mechanics and mechanism. The limits of age are 20–30. Initial salary 150*l.* a year, together with a war bonus. Copies of the regulations and forms of application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. The last day for making application is September 18.

THE United States General Education Board has granted 16,000 dollars to the National Committee on Mathematical Requirements, appointed by the National Mathematical Association of America, for the purpose of undertaking a study looking to improvements in the mathematical curriculum of the secondary schools of the country. Mathematicians, as well as educators in general, have in recent years criticised the prevailing high-school work in mathematics on the ground that much of the material is of little practical value, and on the further ground that the high-school curriculum in mathematics takes too little account of modern developments in this science. The American Mathematical Association is made up of the leading professors and teachers of mathematics in American colleges and universities. It has appointed to conduct the inquiry a committee composed of four university professors of mathematics and four secondary-school teachers of mathematics. Having no funds, this body applied to the General Education Board for assistance. The board itself will not take any part in the study or make recommendations. Prof. Young, of Dartmouth College, and Prof. Fobert, Technical High School, Chicago, will devote their entire time to the work for a year or more.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 18.—M. Léon Guignard in the chair.—G. **Humbert**: The particular representations of an integer by positive forms of Hermite in an imaginary quadratic body.—H. **Andoyer**: The development of a general function of the radius vector of the eccentric anomaly in elliptic movement.—E. L. **Bouvier** and d'E. **de Charmoy**: Mutation of a Caridina into an Ortmannia, and general observations on the evolutive mutations of fresh-water shrimps of the family of the Atyidæ.—E. **Kogbetliantz**: Ultraspherical series.—R. **Garnier**: Vectorial fields with indeterminate asymptotic directions.—E. **Jouguet**: A problem of generalised hydraulics. Flow of a burning gaseous mixture.—A. **Véronnet**: Ellipsoidal figures of equilibrium of a liquid in rotation; variation of the major axis.—G. **Fayet** and A. **Schaumasse**: The next return of the periodic comet 1911 VII. (Schaumasse). Taking into account the perturbations in the orbit caused by the proximity of the comet to Jupiter in 1913, new elements have been worked out. It should be sought for in the beginning of September.—R. **Baillaud**: An impersonal photographic astrolabe.—P. **Nicolardot**: The action of reagents upon glass-powder. Eight kinds of glass were studied, and the amounts dissolved by pure water and decinormal hydrochloric acid determined for three grades of powder, fine, medium, and coarse.—S. **Posternak**: The saturated sodium salt of inosite hexaphosphate. A correction of data given in an earlier paper.—Ch. **Boulin** and L. J. **Simon**: The evolution of a mixture of methyl sulphate and chlorosulphonic acid.—J. **Bougault** and P. **Robin**: The oxidation of benzaldoxime. This oxime, on treatment with iodine and sodium carbonate, gives benzoic acid, benzaldoxime peroxide, benzoyl-benzaldoxime, and dibenzenyl-oxoazo-oxime.

SYDNEY.

Linnean Society of New South Wales, June 25.—Mr. J. J. Fletcher, president, in the chair.—Dr. A. J. **Turner**: Revision of Australian Lepidoptera. Part vi. (continued). Thirty-two genera and ninety-five species of the subfamily Boarmianæ are recorded or described, five genera and forty species being described as new.—Dr. R. **Greig-Smith**: The germicidal activity of the eucalyptus oils. Part ii. Eucalyptus oils are irregular in their action upon *B. coli communis*, and duplicate experiments may show a considerable amount of variation. Cineol begins to act in about a minute and a half; phenol acts instantly. The curves of cineol and phenol cross in 5 minutes with a dilution of 1 : 75 at 20°. The phenol coefficient of cineol in 15 minutes at 20° is 3·1; it rises to 3·4 in 30 minutes, and then slowly declines to 2·8 in 4 hours. Aromadendral is the most active of the constituents of the oils. The phenol coefficient is 21·1 in 30 minutes. The next most active is piperitone (4·1), and possibly phellandrene. Pinene and sesquiterpene are low (0·8 to 0·5). The rectified oils of *E. cinerea* and *E. Smithii* are more efficient than the crude oils. In the case of the oil of *E. cinerea*, this appears to be due to the hydrolysis of the esters and the subsequent oxidation of the alcohols to aldehydes. Treatment with alkali did not reduce the efficiency of the acid-rectified oil. The addition of acetic acid to the crude oil doubled the germicidal power in the course of 3½ months. The germicidal activity of the rectified and crude oils of *E. cinerea* is proportional to the starch-iodide reaction, and not to the acidity, but this does not hold for the oils as a class. The rectified oil of *E. polybractea* is less efficient than the crude oil. This may be due to the elimination of aromadendral during rectification. The oil of the Braidwood variety of *E. australiana* is the best and cheapest disinfecting oil (phenol coefficient=5·8 in 30 minutes). The oil of *E. cinerifolia* was the second best crude oil tested (phenol coefficient=4·8 in 30 minutes); its activity is probably due to its aromadendral content. As in the case of phenol, the addition of acid to the water used in emulsifying the oils greatly increases the germicidal activity.—T. **Steel**: Water from the roots of the red mallee. A chemical investigation of water from the roots of this plant from Fowler's Bay, South Australia.—Prof. E. D. **Merrill**: The identity of *Polypodium spinulosum*, Burm. f. The author, by comparing Burman's figure with Australian material, concludes that the plant described as *P. spinulosum* from Java represents the W. Australian plant, *Synaphea polymorpha*, R. Br., and that the locality record is an error.

BOOKS RECEIVED.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod. Assisted by Dr. Roy D. Pearce and by others. Pp. xxxii+903. (London: Henry Kimpton, 1919.) 36*s*. net.

The Conditions that Govern Staleness in Bread: Changes of Moisture and Soluble Extract with Age. Investigations and Researches made in the British Army Bakeries in France, 1917–18. By Capt. R. Whymper. (Reprinted from the *British Baker*.) Pp. 72. (London: Maclaren and Sons, Ltd., 1919.) 1*s*.

Board of Agriculture and Fisheries. Fishery Investigations. Series iii. Hydrography. Vol. i. The English Channel. Part i.: Start Point to the Channel Islands. Review of the physical and chemical properties of the surface waters, and the variations of these properties during the thirteen years from 1904 to 1917 inclusive. (London: H.M.S.O., 1919.) 10*s*. net.

Some Questions of Phonetic Theory. By Wilfrid Perrett. Chap. v.: The Perception of Sound. Pp. 39. (Cambridge: W. Heffer and Sons, Ltd., 1919.) 2*s*. net.

The Silk Industry and Trade: A Study in the Economic Organisation of the Export Trade of Kashmir and Indian Silks, with special reference to their Utilisation in the British and French Markets. By Ratan C. Rawlley. Pp. xvi+172. (London: P. S. King and Son, Ltd., 1919.) 10*s*. 6*d*. net.

We Must Discover. Pp. viii+176. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1919.) 3*s*. 6*d*. net.

CONTENTS.

PAGE
An Eighteenth-Century Physician . . . 1
Physics in War . . . 2
Experimental Researches on Glass. By M. W. T. . . . 2
Physical Chemistry. By Prof. W. C. McC. Lewis . . . 3
Our Bookshelf . . . 3
Letters to the Editor:—
The Explosion at Bailleul.—Spencer Pickering, F.R.S. . . . 5
British Well-worms.—Rev. Hilderic Friend . . . 5
The Protection of Our "Key" Industries . . . 5
The Organisation of Research . . . 6
The Bournemouth Meeting of the British Association . . . 7
The Protection of Wild Birds . . . 7
Notes . . . 8
Our Astronomical Column:—
Metcalf's Comet . . . 12
The Recent Shower of Perseids . . . 12
International Standardisation. By R. T. G. . . . 12
Some Indian Sugar-canes and their Origin . . . 14
General Physiology . . . 15
Æther and Matter: Being Remarks on Inertia, and on Radiation, and on the Possible Structure of Atoms. Part I. By Sir Oliver J. Lodge, F.R.S. . . . 15
University and Educational Intelligence . . . 19
Societies and Academies . . . 19
Books Received . . . 20

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THURSDAY, SEPTEMBER 11, 1919.

ZOOLOGY AND HUMAN WELFARE.

Animal Life and Human Progress. Edited by Prof. Arthur Dendy. Pp. ix+227. (London: Constable and Co., Ltd., 1919.) Price 10*s.* 6*d.* net.

THIS volume is the outcome of a series of public lectures organised by Prof. Dendy at King's College, London, in 1917-18 under the auspices of the Imperial Studies Committee of the University of London. The object of the course was to inform the public regarding zoological results already applied in furtherance of human progress, and to emphasise the claims of zoological science to recognition on terms of equality with other departments of learning. The college and the editor are to be congratulated, not only on their courage and public spirit in having, during the dark days of the war, arranged a course which makes so much for enlightenment and for reconstruction, but also on having made the subject-matter accessible to all through the medium of this volume. The lectures are most informing, and if we express regret at the absence of consistently full citation of the authors quoted, this is done in tribute to their permanent value.

Prof. Dendy contributes the preface and an opening lecture on "Man's Account with the Lower Animals." To the weighty material items in that account he adds the pregnant idea that much of our æsthetic sense is founded on insect æsthesis, since the marvellous forms, colours, and fragrances of flowers arose "in the course of evolution in response to what we may fairly call the tastes of insects long before man appeared on the scene." Prof. Bourne adds a thoughtful essay on "Some Educational and Moral Aspects of Zoology." Prof. J. A. Thomson writes with his usual vivid grace and wealth of illustration on "Man and the Web of Life." Mr. Tate Regan discusses "Museums and Research," incidentally putting in a strong plea for the view that evolution has been mainly adaptive, and that a change of structure has followed, not preceded, a change of habits.

"The Origin of Man" is dealt with by Prof. Wood Jones, who concentrates on primitive anatomical features exhibited by man, differences between man and other Primates, certain striking resemblances to Tarsius, and the probable remoteness of origin of the human stock. With perhaps a little special pleading one could use a good many of his data in a thesis having for its subject "Non-Arboreal Man." "Some Inhabitants of Man and their Migrations" is the subject of Dr. Leiper's lecture, which will be read with all the more interest in view of his own recent researches on Bilharzia. In "Our Food from the Sea" Prof. Herdman emphasises the vital importance of sea fisheries, while "Tsetse-Flies and Colonisation" receives exposition from Prof. Newstead.

"I saw before me a great place where men and women were making and imparting knowledge." Thus begins Prof. Punnett's "dream" at the end of his most readable lecture on "The Future of the Science of Breeding." May the dream come true for every branch of zoological science. Meantime we find emphasised, over and over again, in the work before us a sad disproportion between the public support given to the study of animal life and the splendid results this study has achieved and can yet achieve for the furtherance of human progress.

J. F. GEMMILL.

WAR GLEANINGS.

A Vision of the Possible: What the R.A.M.C. Might Become: An Account of some of the Medical Work in Egypt; together with a Constructive Criticism of the R.A.M.C. By Sir James W. Barrett. Pp. xx+182. (London: H. K. Lewis and Co., Ltd., 1919.) Price 9*s.* net.

SIR JAMES BARRETT has added another vigorous and stimulating book to those he has already published dealing with military medical matters in the past war. The book treats mainly of questions which came under his notice whilst serving in Egypt, where he held posts which enabled him to gain a broad outlook, as they gave him an insight into the workings of the military medical organisation, not only at its local centre, but also in many of its peripheral sections. His dicta have therefore the refreshing qualities of first-hand observations in many fields with which he was familiar. It must be added that they are not less dogmatic when relating to spheres with which he was less well acquainted; but there is always a note of sincerity and conviction which compels attention.

The first section gives a general account of the author's activities as an aural specialist, and describes, by means of actual instructions issued, the improvements in the treatment of ear diseases and in the disposal of the men suffering from them which were effected. In this connection stress is rightly laid on the advantages gained by "the educational means adopted. The whole service was taken into confidence, the problem was explained, and the help of the medical officers was invited."

It may be asked why so much education in the treatment of ailments common in the civil population was required by medical men taken for the most part straight from civil practice. This the author explains in a later section of the book, where he says: "The training of the average medical man is intense and narrow; all his energies are concentrated on one problem, doing the best for the sick man professionally. He consequently speculates on remote risks. . . .

 C

With obligation to the State he is not concerned. In the Army, on the other hand, everything must be done for the good of the Service." In other words, a man engaged in a desperate enterprise, such as war, may be allowed in the common interest to take risks, often small, which his medical attendant would not sanction at ordinary times, and some education is required to alter the civil point of view.

With the writer's advocacy of professional conferences and instruction there can be nothing but sympathy; he does not appear to be aware of the developments on these lines, which were so great a feature in other theatres of war, and have assuredly come to stay.

Some 100 pages are taken up in considering the question of boards and the physical classification of recruits and soldiers. They form interesting and instructive reading. The author states: "In general, about one-third of the B class *personnel* who arrived in Egypt were immediately placed in the A category." They were sent to the front and made good. He roundly accuses the boards at home of classifying men too low and of depleting the reserves by an undue number of rejections. It is interesting to recall that a Parliamentary Committee sat to investigate the widespread allegations in this country that home boards had classified the men too high.

But it is in the concluding part of the book, dealing with the organisation of the military medical service and the modifications suggested, that the main interest lies. There is common agreement as to several of the desiderata mentioned. Some are on their way to attainment, whilst others have already been attained.

Allowing for a certain amount of special pleading, the book raises many points of cardinal interest, lucidly, if forcibly, expressed, and there are not many connected with the medical services, either as clinicians or administrators, who will not glean some profit from a perusal of its pages, whilst the general reader will not find it too technical for his enjoyment.

NERVOUS DISORDERS; TWO POINTS OF VIEW.

(1) *What is Psychoanalysis?* By Dr. I. H. Coriat. Pp. 124. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1919.) Price 3*s*. 6*d*. net.

(2) *Traitement des Psychonévroses de Guerre.* Par G. Roussy, J. Boisseau, M. d'Œlsnitz. (Collection Horizon.) Pp. 191. (Paris: Masson et Cie, 1918.) Price 4 francs.

(1) DR. CORIAT'S attempt to collect into one small volume the chief articles of the psychoanalytic faith, and, moreover, to lay them out along the rigid scaffolding of a shorter catechism, is certainly an act of bravery or temerity. The reader is asked to defer his decision between these two descriptions until he has finished this very interesting and challenging small book. For the concreteness—one had almost written the ferro-concreteness—of this exposition cannot fail to delight, at one stroke, the erudite student of Freud, who has long been yearning for some psychoanalytic Baedeker to indicate with a judicious distribution of asterisks the really important halting-places on this perilous journey; the implacable enemy of the new movement, who will surely regard the pages of this book as a conveniently bound packet of targets; and the teacher of psychology, who can now prepare three full lectures on what someone has assured him Freud really means.

Most people must have felt that such a book ought to appear some day, though, perhaps, not everyone would have regarded the present time as suitable. But Dr. Coriat might immediately point out, and with justice, that the procrastinator is a person upon whose mentality more light has been thrown from Vienna than from any other quarter in recent years, and certainly there is little that can be called undecided in the way the present book is written.

The answer to the question "What is Psychoanalysis?" occupies 118 pages, at which stage Dr. Coriat ends, and, one presumes, Dr. Adler and Dr. Jung would desire to begin. For it seems clear that the present answer is the answer of Freud alone. And this is, we think, a pleasing feature, if one could ensure that the book did not fall into the eager hands of the entirely uninitiated. The book is, so to speak, a diagram of Freud's teaching. When we can place by it similar diagrams of Adler's and Jung's theories (drawn very strictly to scale, with the congruent portions clearly indicated) and get them well into our heads, discussions on psychoanalysis may gain in clarity what they will assuredly lose in heat.

But, like many diagrams, the present one often seems to err on the side of too great simplicity, and it is too heavily outlined. The book reads, in fact, far too glibly. It seems scarcely fair to Freud to write without further explanation of the "way that a normal individual conveniently '*forgets*' the unpleasant experiences of his life" (p. 14), and to say dogmatically: "If the nervous symptoms grow worse during the course of the analysis, this must be interpreted as due either to the resistances or to the course of the disease, and not to the treatment" (p. 70); or to ask the question of questions "Can psychoanalysis be harmful?" and to "answer" it by merely remarking that "wild" psychoanalysis can, and that the analyst may fall into errors. What the average man presumably wants to know is whether, in any circumstances, orthodox, thorough-going, complete psychoanalysis can be harmful, and, if so, why? Especially, perhaps, does the average English reader, who has seen the course of the thread linking the writings of McDougall, Shand, and Trotter on one hand with those of Freud and Jung on the other, ask this question. And, so far, it has not been answered.

(2) A conception of quite a different nature is presented in the book by Dr. Roussy and his colleagues on the treatment of the psychoneuroses of war. Their work deals chiefly with those "accidents d'ordre hystérique" which they describe as the most important of the psychoneuroses observed during this war. A comparison of their book with such a treatment as Dr. MacCurdy's in "War Neuroses" (recently reviewed in these columns) provokes the reflection that a wider conception of the war psychoneuroses than that held by these French authors seems to be necessary if medical science is to learn all it can from the experiences of war psychotherapy. The book deals with the causation, treatment, and prophylaxis of these hysterical disorders, and discusses the recent "reflex," "dynamogenic," and "dyskinetic" theories of their nature. It is clearly written and excellently illustrated.

OUR BOOKSHELF.

Memoirs of the Boston Society of Natural History. Vol. viii. No. 3. *Monographs on the Natural History of New England. The Turtles of New England.* By Dr. Harold L. Babcock. Pp. 327–431 + 16 pls. (Boston, Mass.: 1919.)

This is a very interesting and excellently produced monograph dealing with seventeen species out of sixty-one now recognised by American authors. Considering that New England includes the northern limit of distribution of the Chelonians of eastern North America, this is a good number. The author has collected most of the observations published on the life-histories of these species, and such a compilation is a valuable addition to the descriptive and iconographic part of the work.

Objection may be taken to the title of the monograph, as the term "turtle" is usually taken to apply to thoroughly aquatic Chelonians only. As the author tells us, it has been suggested that (1) all Chelonians of the land only should be called tortoises; (2) all Chelonians of fresh water should be termed terrapins; and (3) all Chelonians of the sea should be called turtles. It is somewhat difficult to draw a limit between the two first categories, and one does not quite like the name "terrapin" to be bestowed on the soft-shelled or river Chelonians, the Trionychidæ. Perhaps these might be termed river-turtles in opposition to sea-turtles.

The descriptive part is preceded by an introduction, in which the author deals with Chelonians generally. Three statements call for criticism. (1) The skull is stated to be more solid and compact than in other reptilian orders; but what about crocodiles? (2) Some marine turtles are said to be strictly herbivorous (p. 330); this can only be meant to apply to the green turtle (*Chelone mydas*), which is chiefly, but not exclusively, so; and further on (p. 340) we are told of a specimen in captivity greedily taking large pieces of raw fish. Among the terrapins, *Batagur* and *Dermatemys* are also chiefly herbivorous. (3) Speaking of the longevity of land tortoises, instances of existence for much more than a century might have been given; and to the statement that Gilbert White's famous tortoise (*Testudo ibera*) lived nearly sixty years, "in capitivity" should have been added. A still better record for the same species is furnished by an individual, on which the writer of this notice has reported, that has been kept in Cornwall for ninety-six years.

G. A. B.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Luminous Worms.

The Rev. Hilderic Friend in his letter to Nature of August 7 (p. 446) asks: "Is it possible that light can influence Annelids in some way, and so facilitate sexual processes?" He cites the affirmation of Flaugergues made in 1771 that luminosity disappears in certain cases after copulation.

There is the other way of approaching the subject. We know that the luminous earthworms, with which Dr. Gilchrist has dealt in his recent paper, can be stimulated to luminesce; so may we not ask: Is it possible that sexual processes may facilitate the excretion of the substance or substances to which luminosity is due?

We are acquainted with the fact that in other invertebrate groups muscular contraction, due to a stimulus to the nervous system, will expel the contents of glands secreting the substances essential for the production of light. For example, we know that sometimes excitement due to the attack of enemies will cause phosphorescence in centipedes (Thomas, cited by Dahlgren, Journal of the Franklin Institute, January, 1917, p. 85 of reprint). In a forthcoming paper Dr. Brade-Birks and I shall indicate several other ways in which the same result can be brought about among the Chilopoda.

A careful reading between the lines may show that fear, shock, *and sexual processes* each provide the stimulus to the nervous system which results in the expulsion of the essentials of luminosity by a contraction of the muscles in the case cited by Mr. Friend, and that if that stimulus were sufficient to exhaust the store of secretion the animal mentioned by Flaugergues would, of course, fail to exhibit luminosity again until the secretion had had time to re-accumulate.

S. Graham Brade-Birks.

16 Bank Street, Darwen, Lancashire.

The National Union of Scientific Workers and Research.

One of the chief aims of the National Union of Scientific Workers is "to secure adequate endowment for research and to advise as to the administration of such endowment." A committee of active workers in all the principal subjects has been appointed to consider methods of carrying out this object. While the committee is agreed upon the general aim of making it possible for the scientific worker to make research his profession (subject, of course, to efficiency), concrete suggestions regarding methods of achieving this are essential; and as the committee is a comparatively small body it cannot expect to be acquainted with all the relevant facts concerning the conditions under which research is conducted at present. To overcome this difficulty it is proposed to associate with the committee a number of advisory panels consisting of persons in the principal research centres in the British Isles. Will those workers (whether already members of the Union or not) who would be willing to supply the information required, or to make definite suggestions concerning possible methods of improving these conditions, please communicate with the undersigned or some other member of the committee?

The present committee consists of the following:—Dr. O. L. Brady (Chemistry, Imperial College), Dr. J. W. Evans, F.R.S. (Geology, Imperial College), Mr. W. F. Higgins (Experimental Physics, National Physical Laboratory), Dr. A. Holmes (Geology, Imperial College), Dr. H. Jeffreys (Mathematical Physics, Cambridge), Dr. F. Kidd (Plant Physiology, Cambridge), Dr. M. C. Rayner (Botany, General Branch), Dr. C. Shearer, F.R.S. (Zoology, Cambridge), Mr. E. Sinkinson (Chemistry, Imperial College), Dr. C. West (Plant Physiology, Imperial College), Miss D. M. Winch (Pure Mathematics, Cambridge).

HAROLD JEFFREYS.

St. John's College, Cambridge.

WIRELESS NAVIGATION FOR AIRCRAFT.

THE determination of the position of ships at sea involves dead reckoning and the use of sights on terrestrial or celestial bodies. Dead reckoning methods often give fairly accurate results, even when no sights can be taken. With aircraft, however, drift plays so large a part that dead reckoning methods are not sufficiently trustworthy. Hence the necessity for other methods for determining position.

Directional wireless gives a means of finding one's position under almost any conditions, and thus enables navigation to proceed in cases where it would otherwise be dangerous, such as in fog. It uses chiefly the well-known property of loops, that if the plane of a loop makes an angle θ with the direction of propagation of the waves, the E.M.F. produced in the loop is $E_0 \cos \theta$. The rate of variation of this with θ is greatest when $\theta = 90°$, *i.e.* when the signal strength is a minimum, and bearings have hitherto been obtained by turning the loop until the minimum is obtained.

There are two distinct ways in which this navigation might be effected:—

(1) The aircraft should emit ordinary wireless signals and directional stations on the ground determine various directions of the aircraft, the central ground station working out the position of the aircraft and re-transmitting it to the aircraft. This method has been used considerably by the Germans.

(2) There should be ordinary transmitting stations on the ground which should transmit ordinary wireless signals, and the aircraft should determine bearings of each of these known ground stations, the navigator working out his position from these bearings. This method has very many obvious advantages over the first method, such as the fact that an unlimited number of aircraft can work out their own positions at the same time, and also the fact that in case of warfare the position of the aircraft need not be disclosed to the enemy. This second method was adopted in the R.A.F. to a great extent.

In attempting to place directional gear on aircraft there were considerable difficulties:—(1) There is much extraneous noise on aircraft; (2) the space available on aircraft is not abundant, and in any case it is not easy to get large loops; (3) the possibility that the waves would be deviated in the neighbourhood of the aircraft, thus producing errors which would have to be determined.

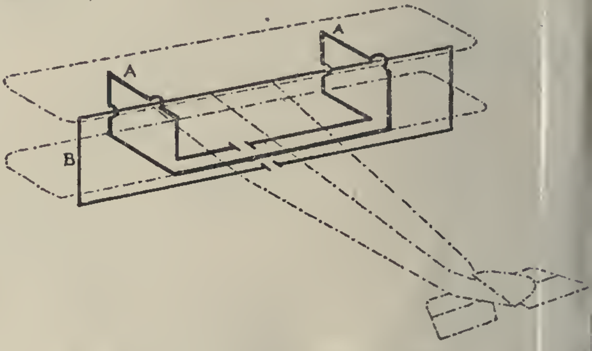

FIG. 1.—A, main aerial; B, auxiliary aerial.

It was obvious that the best amplification of signals that could be obtained would have to be used. Even with the best amplification known, it was found that the extraneous noise was so considerable that the ordinary minimum method of using a loop aerial to find direction was of very little use. Because of the extraneous noise the minimum was considerably widened, and even with powerful signals there might be a region as large as 40° to 60° where no signals at all were obtained. It was hence necessary to devise some method by which signals could be heard whilst the bearing was taken. For this purpose the following method was devised:—

Two loops at right angles are used. These loops are rigidly fixed together and rotate round the same vertical axis. When one of these loops is on its maximum the other will be on the minimum. When the maximum or main coil is used alone, the maximum of the signals is first roughly obtained, and then the second or auxiliary coil is introduced, the connections of this second coil being reversed from time to time. If the main coil is on its maximum the reversal of the auxiliary coil will not alter the strength of the signals, but if the main coil is not correctly on the maximum the reversal of the auxiliary coil will give signals of different intensity; hence the method to employ is to rotate the coils, using the main coil alone until somewhere near the maximum, and then to introduce the auxiliary coil, making the final adjustment so that on reversing the auxiliary coil there is no change in the intensity of the signals. The sensitiveness that can be obtained by this method is under control and depends on the ratio of the area turns of the auxiliary and the main coils. By "area turns" is meant the summation of the areas of the various turns of a loop. If this ratio is of the order of 3 to 1, a bearing can be determined quite easily to within 1°. If this ratio is 10 to 1, the coils are accurate to less than $\frac{1}{4}$°. It is quite simple to show the reason for this theoretically. There are two distinct methods of applying this method to aeroplanes:—

(1) The coils are rigidly attached to the aeroplane and the aeroplane rotated until the correct bearing is obtained. This is called the wing coil system. The main coil is fixed in the fore-and-aft direction on the struts and the wings. The auxiliary coil is athwart-ships on the struts and the wings. Fig. 1 shows diagrammatically how this is done.

(2) The coils are placed in the fuselage of the machine and are rotated independently of the machine. Method (1) has the advantage that stronger signals are obtained and can hence be used for long distances, such as for the cross-Atlantic flight. This method has the disadvantage that it is necessary to deviate the machine from its course to determine any bearing. It has also the advantage that there are no errors due to the deviation of waves.

Method (2) has the advantage that the machine can carry on on a steady course whilst bearings are being taken. It has, however, disadvantages that signals are much weaker and that errors are introduced in the bearings. Such errors are quadrantal in nature and can be determined by swinging the machine and taking bearings on the same station for different directions of the head of the machine.

On aeroplanes the extraneous noise can be divided into two distinct classes: (1) The noise of the engine and the rushing of the wind; (2) the disturbance produced by the magneto.

The noise of the engines can be minimised by increasing the amplification of signals, but magneto noise cannot be eliminated in such a way because, as the amplification is increased, the effect of the magneto disturbance also increases. It was absolutely necessary to determine methods to cut out this magneto disturbance. It was found that the magneto disturbance was principally due to the emission of very short waves of the order of 5 to 30 metres. The most effective method for cutting out these disturbances was completely to shield the magneto system. The magneto leads were made of braided wire, the braiding being earthed every 18 or 24 in. It was also necessary in cases where the engine is not completely cowled to enclose the magnetos and their distributors in metal shields.

A large number of results of determinations of position by wireless bearings have been obtained. The beacon stations used were principally long-wave spark stations (wave-lengths of 2000 metres and upwards), the distances of the beacons being from 10 to 500 miles, and occasionally more distant. Some of the stations used were Poldhu, Paris, and Nauen.

On the ground, when two or more of these beacons were used, the mean error in the determination of position was two miles. In aeroplanes the accuracy was not so good owing to the compass errors, due to the swinging of the compass. The mean error in bearing in the air was $1\frac{3}{4}$°, and the mean error in position when two or more beacons were used was seven miles.

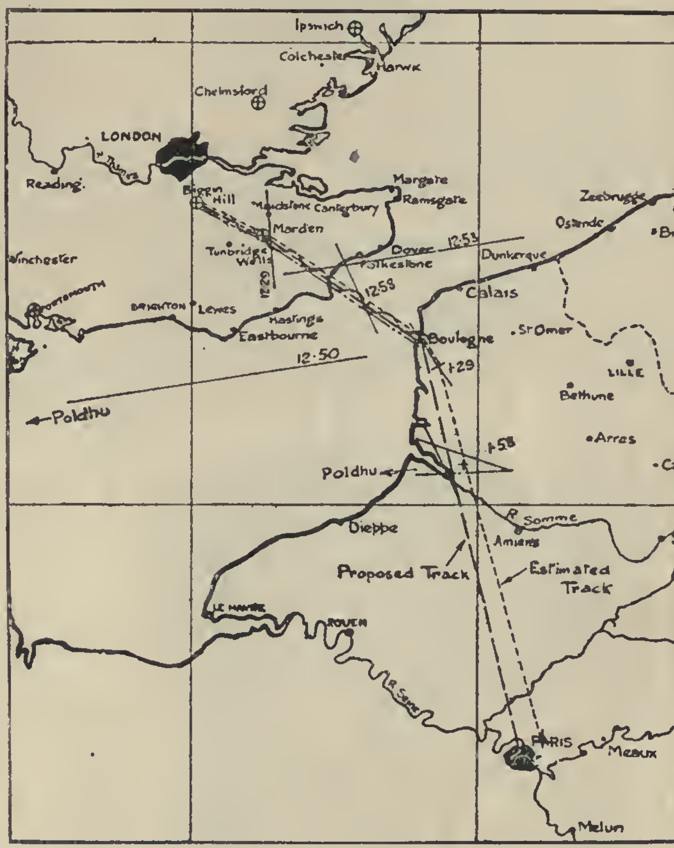

FIG. 2.—Outward journey. Dotted line, thus — ·· — ·· — indicates actual track of machine as followed by map reader.

Long-distance flights have been made in which, under adverse weather conditions and without reference to the ground, by the sole use of directional wireless the machine was navigated with extraordinary accuracy. The details of a flight from Biggin Hill to Paris and back to Brighton are shown in Figs. 2 and 3. The aeroplane was above the clouds half the time, and the navigator was in a position which precluded any possibility of seeing out of the machine. He was, nevertheless, able to direct the course of the machine, forecast the time of arrival half an hour in advance with an error of less than two minutes, and find the force and direction of the wind deflecting the machine from her course from time to time, such predictions being found to be accurate when compared with the meteorological report later in the day.

In certain circumstances excellent results can be obtained when only one beacon station is available. This is especially useful when the beacon is at one's destination, when head bearings alone are used. J. ROBINSON.

FIG. 3.—Return journey. Dotted line, thus — ·· — ·· — indicates actual track of machine as followed by map readers.

PROF. ALEXANDER MACALISTER, F.R.S.

IN the death of Prof. Macalister, at the age of seventy-five, British anatomy loses a singularly gentle and kindly master, who, in a quiet and unobtrusive way, exerted a great influence upon the teaching of his subject during the last fifty-nine years—for he had qualified to practise medicine, and had become a demonstrator of anatomy in the Royal College of Surgeons in Dublin before he was seventeen years of age!—and upon the development of the medical school in Cambridge, where he was professor of anatomy for thirty-six years. While acting as demonstrator in anatomy at the Royal College of Surgeons he was a student at Trinity College; at the age of twenty-five he became professor of zoology there, and eight years later succeeded to the chair of anatomy and chirurgery. At Trinity College he developed that craving for encyclopædic knowledge which throughout his life he was continually striving to satisfy. He was especially devoted to the study of Celtic archæology and ancient Egyptian literature, and in his own subject his wonderful powers of memory and his persistent accumulation of facts by personal observation gave him a knowledge of the details of anatomy and the literature relating to it which was almost uncanny and at times disconcerting to those who sought his advice. For, without intending to discourage youthful adventurers in anatomical research, the formidable record of what had already been accomplished, which he was able to give quite impromptu to one who was contemplating some original investigation, was responsible for bringing to nought not a few budding aspirations. Prof. Macalister never seemed to realise the crushing effects of his vast erudition. In the latter years of his life he often discussed with the writer the efforts he had made to encourage men to do research, and his difficulty in understanding why so little came of it.

When he succeeded to the chair of anatomy in Dublin he took Sir George Humphry, of Cambridge, as his guide and master, and began a series of detailed investigations in comparative anatomy and especially myology; but when he became Humphry's successor he devoted himself more and more to osteology, and to the end of his life he continued to collect data and fill note-book after note-book with the records of his observations and admirable pencil drawings. Unfortunately, only a relatively small proportion of these results have been published. When, from time to time, his friends pressed him to make his work available for other anatomists, he would modestly disclaim that any journal would find space for the contents of his voluminous note-books, or urge that they were always available for anyone to use; and, in fact, he was ever generously ready to give the results of his work to anyone who asked for them. Prof. Macalister spent his life in amassing facts, and avoided generalisation and the formulation of explanations or theories. This thirst for facts and lack of interest in their interpretation is nowhere more clearly displayed than in his choice of subjects for investigation. Perhaps the most striking instance of this is his monograph on the lachrymal bone. In spite of this curious trait, Prof. Macalister was mainly responsible in this country for maintaining an interest in morphology at a time when anatomy was threatened with the fate of being reduced to the mere mechanical craft of the dissecting-room. His text-book on anatomy was the instrument by means of which his influence was extended far and wide, especially among teachers of the subject. The great anthropological collection which he made in Cambridge will always remain as a memorial of his zeal and energy. But to those who have been closely associated with Prof. Macalister either as students or colleagues the recollection that has been imprinted most deeply in their memories is that of a generous and kindly soul who throughout the whole of his long career as a teacher of anatomy continued to perform the duties of a junior demonstrator gently "helping lame dogs over stiles" in the dissecting room.

PROF. L. W. KING.

THE death of Prof. Leonard W. King on August 20 is a serious blow to archæology and to the British Museum. Prof. King had made himself one of the foremost Assyriologists of the day, and his comparatively recent appointment to the chair of Assyriology in the University of London was a recognition of his work that was much appreciated by him, and commended itself wholly to all students of the subject. From the time when, a few years after his appointment to the British Museum in 1893, Mr. King published his first studies in Assyriology, his work has been known by its clarity, sanity, and critical acumen. "Prove all things; hold fast that which is good," may be said to have been his guiding principle in his work. All scientific work was to be criticised fearlessly, and what seemed to his clearly distinguishing mind the true solution of a problem was to be upheld without hesitation. All he sought was the truth, as it seemed probable to him. And no other consideration moved him. He was a fine type of the modern scientific worker in the field of archæology, and the loss to science of such a man in the flower of his age and activity can scarcely be estimated.

Prof. King was born in the year 1869. He was therefore only forty-nine years of age when premature death overtook him, largely as the result of heavy double labour during the war as an official attached to the Intelligence Department of the Admiralty and as student of Assyriology, which adversely affected a system already, as we can see now, severely tried by illness contracted in the course of his excavations for the British Museum at Kuyunjik (Nineveh) several years ago. To outward seeming Prof. King was a man of robust health and physique, but in reality the rigours of archæological work in Assyria under the conditions of fifteen years since had undermined his constitution, and when, in the present year, the results of severe war labour coincided with a recrudescence of old illness, he fell.

Prof. King was a Rugbeian and a King's man. The book in which he first made his mark was "The Life and Letters of Hammurabi," the great law-giver-king of Babylon. His works on the Assyrian language are well known, and as a proficient Semitic scholar his pronouncements on this subject were always worthy of great respect. His real interest, however, lay rather in the elucidation of ancient history by means of the cuneiform inscriptions than in the ancient languages themselves, and a notable contribution to this end is his edition of the Inscriptions of Darius on the Rock of Bisitun (Behistun), which he re-copied and edited, in conjunction with Mr. R. Campbell Thompson, after their joint expedition to the spot on behalf of the British Museum, which was carried out in circumstances of considerable difficulty and hardship. His two more recent works, "The History of Sumer and Akkad" and "The History of Babylon," are the standard histories of those lands in English. It is ever to be regretted that he was not able to bring out the third work of the trilogy he had planned, "The History of Assyria," but the war compelled him to put it by for the time, and then illness stopped all further work. It is to be hoped, however, that he will be found to have left his manuscript sufficiently complete for his publishers to produce the result of his labours.

In his historical books the same clean-cut critical faculty is shown as in his other work. This criticism was welcomed by his friends and fellow-workers in the same and kindred fields, for King's interests were by no means confined to the Land of the Two Rivers. He was keenly interested in Egyptian archæology, but for the study of the hieroglyphs or of Coptic he had no time; the demands of cuneiform were enough for him, for he did all things thoroughly, and never dabbled. In a minor degree the work of his colleagues in the museum on Mycenæan archæology also interested him. His Cambridge training made him somewhat suspicious of the so-called "all-round man"; but he had an interest in all branches of archæology, and read everything that others had written on their several subjects, and his remarks on their work were always of value, and inspired by sound common sense; his comments were always conspicuous for balance and sense of proportion. To other workers in his own field he was always scrupulously courteous and anxious to give credit where it was due; his juniors were always sure to receive their due meed of appreciation and in addition energetic support. He will leave among them a name of happy and grateful memory, while his personal friends feel a very deep and grievous loss. It is always to be regretted that he did not survive to receive the honour of admission to the British Academy, to mark his signal services to his science in this country.

Rugby, King's College, Cambridge, and the British Museum, not to speak of the University of London, have lost in him one of their most distinguished members. H. R. HALL.

THE BOURNEMOUTH MEETING OF THE BRITISH ASSOCIATION.

WRITING on the day before the opening of the meeting at Bournemouth, it is not possible to give exact figures of the number of members and associates enrolled. The number is approximately one thousand, and steadily increasing. All day the Municipal College has been the scene of great activity, and the officials have had hard work to cope with the rush of applications and inquiries. The figures compare very favourably with those of previous years, and, while no new records are likely to be established, it is believed that the attendance will be in excess of that at any meeting held during the war.

Local enthusiasm has been late in manifesting itself, but has now reached a high pitch. The town's privilege in being the scene of so important and in many respects unique a meeting is at last fully appreciated. The greatest interest is being shown in the proceedings of the Association, and a most cordial welcome extended to the distinguished men of science visiting the town. The citizens' lectures arranged in co-operation with the Workers' Educational Association are also likely to be exceptionally well attended.

The great difficulties of securing accommodation have been successfully met, and the many visitors find the arrangements in every way excellent. The careful organisation of the local executive committee in other directions is in evidence on all sides, and its results meet with the keen appreciation of members and associates.

The weather is fine and warm, a fortunate circumstance in view of the numerous sectional excursions to points of interest in the neighbourhood taking place during the week.

Even at this early hour it is possible to pronounce the Bournemouth meeting a decided success.

(*Tuesday evening.*)

The weather to-day has been brilliantly fine, and with Bournemouth looking its best the meeting has opened under the happiest conditions.

More than 1200 tickets have been issued, and many fresh applications are still being received. The section lectures and discussions and the excursions to-day were exceedingly well attended. This evening the Winter Gardens Pavilion was crowded by a keenly appreciative audience on the occasion of the president's inaugural address. The attendances are not so large as at certain meetings held before the war, but they are regarded here as most gratifying and quite equal to expectations.

The interest displayed in the citizens' lectures exceeds all anticipation, and the accommodation provided, based on the experience of previous years, has proved quite inadequate. All the tickets have been disposed of, and large numbers of intending auditors have been disappointed. This points to a useful development of the work of the Association in the future.

All the conditions are exceptionally favourable, and the "Peace" meeting is proving eminently successful in every way.

Prof. W. A. Herdman, who has been general secretary of the Association since 1903, has been elected to fill the office of president for the year 1920–21, beginning with the Cardiff meeting.

INAUGURAL ADDRESS BY THE HON. SIR CHARLES A. PARSONS, K.C.B., M.A., LL.D., D.Sc., F.R.S., PRESIDENT.

THREE years of anxiety and stress have passed since the last meeting of the British Association. The weight of the struggle which pressed heavily upon us at the time of the Newcastle meeting in 1916 had increased so much in intensity by the spring of 1917 that the council, after consultation with the local committee at Bournemouth, finally decided to cancel the summer meeting of that year. This was the first time in the history of the association that an annual meeting was not held.

We all rejoice to feel that the terrible ordeal through which the whole Empire has been passing has now reached its final phases, and that during the period of reorganisation, social and industrial, it is possible to resume the annual meetings of the association under happier conditions. We have gladly and with much appreciation accepted the renewed invitation of our friends and colleagues at Bournemouth.

We are gathered together at a time when, after a great upheaval, the elemental conditions of organisation of the world are still in flux, and we have to consider how to influence and mould the recrystallisation of these elements into the best forms and most economic rearrangements for the benefit of civilisation. That the British Association is capable of exerting a great influence in guiding the nation towards advancement in the sciences and arts in the most general sense there can be no question, and of this we may be assured by a study of its proceedings in conjunction with the history of contemporary progress. Although the British Association cannot claim any paramount prerogative in this good work, yet it can certainly claim to provide a free arena for discussion where in the past new theories in science, new propositions for beneficial change, new suggestions for casting aside fetters to the advancement in science, art, and economics have first seen the light of publication and discussion.

For more than half a century it has pleaded strongly for the advancement of science and its application to the arts. In the yearly volume for 1855 will be found a report in which it is stated that:—"The objects for which the association was established have been carried out in three ways: First, by requisitioning and printing reports on the present state of different branches of science; secondly, by granting sums of money to small committees or individuals, to enable them to carry on new researches; and thirdly, by recommending the Government to undertake expeditions of discovery, or to make grants of money for certain and national purposes, which were beyond the means of the association." As a matter of fact it has, since its commencement, paid out of its own funds upwards of 80,000*l*. in grants of this kind.

Developments Prior to the War.

It is twenty-nine years since an engineer, Sir Frederick Bramwell, occupied this chair and discoursed so charmingly on the great importance of the next-to-nothing, the importance of looking after little things which, in engineering, as in other walks of life, are often too lightly considered.

The advances in engineering during the last twenty years are too many and complex to allow of their description, however short, being included in one address, and, following the example of some of my predecessors in this chair, I shall refer only to some of the most important features of this wide subject. I feel that I cannot do better than begin by quoting from a speech made recently by Lord Inchcape, when speaking on the question of the nationalisation of coal:—"It is no exaggeration to say that coal has been the maker of modern Britain, and that those who discovered and developed the methods of working it have done more to determine the bent of British activities and the form of British society than all the Parliaments of the past hundred and twenty years."

James Watt.—No excuse is necessary for entering upon this theme, because this year marks the hundredth anniversary of the death of James Watt, and in reviewing the past it appears that England has gained her present proud position by her early enterprise and by the success of the Watt steam-engine, which enabled her to become the first country to develop her resources in coal, and led to the establishment of her great manufactures and her immense mercantile marine.

The laws of steam which James Watt discovered are simply these:—That the latent heat is nearly constant for different pressures within the ranges used in steam-engines, and that, consequently, the greater the steam pressure and the greater the range of expansion, the greater will be the work obtained from a given amount of steam. Secondly, as may now seem to us obvious, that steam from its expansive force will rush into a vacuum. Having regard to the state of knowledge at the time, his conclusions appear to have been the result of close and patient reasoning by a mind endowed with extraordinary powers of insight into physical questions, and with the faculty of drawing sound practical conclusions from numerous experiments devised to throw light on the subject under investigation. His resource, courage, and devotion were extraordinary.

In commencing his investigations on the steam-engine he soon discovered that there was a tremendous loss in the Newcomen engine, which he thought might be remedied. This was the loss caused by condensation of the steam on the cold metal walls of the cylinder. He first commenced by lining the walls with wood, a material of low thermal conductivity. Though this improved matters, he was not satisfied; his intuition probably told him that there should be some better solution of the problem, and doubtless he made many experiments before he realised that the true solution lay in a condenser separate from the cylinder of the engine. It is easy after discovery to say, "How obvious and how simple," but many of us here know how difficult is any step of advance when shrouded by unknown surroundings, and we can well appreciate the courage and the amount of investigation necessary before James Watt thought himself justified in trying the separate condenser. But to us now, and to the youngest student who knows the laws of steam as formulated by Carnot, Joule, and Kelvin, the separate condenser is the obvious means of constructing an economical condensing engine.

Watt's experiments led him to a clear view of the great importance of securing as much expansion as possible in his engines. The materials and appliances for boiler and machine construction were at that time so undeveloped that steam pressures were practically limited to a few pounds above atmospheric pressure. The cylinders and pistons of his engines were not constructed with the facility and accuracy to which we are now accustomed, and chiefly for these reasons expansion ratios of from twofold to threefold were the usual practice. Watt had given to the world an engine which consumed from five to seven pounds of coal per horse-power hour, or one-quarter of the fuel previously used by any engine. With this consumption of fuel its field under the conditions prevailing at the time was practically unlimited. What need was there, therefore, for commercial reasons, to endeavour still further to improve the engine at the risk of encountering fresh difficulties and greater commercial embarrassments? The course was rather for him and his partners to devote all their energy to extend the adoption of the engine as it stood, and this they did, and to the Watt engine, consuming from five to seven pounds of coal per horse-power, mankind owes the greatest permanent advances in material welfare recorded in history.

With secondary modifications, it was the prime mover in most general use for eighty years, *i.e.* until the middle of last century. It remained for others to carry the expansion of steam still further in the compound, triple, and, lastly, in the quadruple expansion engine, which is the most economical reciprocating engine of to-day.

Watt had considered the practicability of the turbine. He writes to his partner, Boulton, in 1784:—"The whole success of the machine depends on the possibility of prodigious velocities. In short, without God makes it possible for things to move them one thousand feet per second, it cannot do us much harm." The advance in tools of precision, and a clearer knowledge of the dynamics of rotating bodies, have now made the speeds mentioned by Watt feasible, and, indeed, common, everyday practice.

Turbines.—The turbine of to-day carries the expansion of steam much further than has been found possible in any reciprocating engine, and owing to this property it has surpassed it in the economy of coal, and it realises to the fullest extent Watt's ideal of the expansion of steam from the boiler to the lowest vapour pressure obtainable in the condenser.

Among the minor improvements which in recent years have conduced to a higher efficiency in turbines are the more accurate curvature of the blades to avoid eddy losses in the steam, the raising of the peripheral velocities of the blades to nearly the velocity of the steam impinging upon them, and details of construction to reduce leakages to a minimum. In turbines of 20,000–30,000 h.p., 82 per cent. of the available energy in the steam is now obtainable as brake-horse-power; and with a boiler efficiency of 85 per cent. the thermodynamic efficiency from the fuel to the electrical output of the alternator has reached 23 per cent., and shortly may reach 28 per cent., a result rivalling the efficiency of internal-combustion engines worked by producer-gas.

During the twenty years immediately preceding the war turbo-generators had increased in size from

500 kilowatts to 25,000 kilowatts, and the consumption of steam had fallen from 17 lb. per kw.-hour to 10·3 lb. per kw.-hour. Turbines have become the recognised means of generating electricity from steam on a large scale, although they have not superseded the Watt engine for pumping mines or the drawing of coal, except in so far as it is a means for generating electricity for these purposes. In the same period the engine-power in the mercantile marine had risen from 3900 of the *King Edward* to 75,000 of the *Mauretania*.

As regards the Royal Navy, the engine-power of battleships prior to the war had increased from 12,000 i.h.p. to 30,000 s.h.p., while the speed advanced from 17 knots to 23 knots, and during the war, in ships of the *Queen Elizabeth* class, the power amounted to 75,000 s.h.p., with a speed of 25 knots. In cruisers similar advances were made The i.h.p. of the *Powerful* was 25,000, while the s.h.p. of the *Queen Mary* was 78,000, with a speed of 28 knots. During the war the power obtained with geared turbines in the *Courageous* class was 100,000 s.h.p., with a speed of 32 knots, the maximum power transmitted through one gear-wheel being 25,000 h.p., and through one pinion 15,500 h.p.; while in destroyers speeds up to 39 knots have been obtained. The aggregate horse-power of war and mercantile turbined vessels throughout the world is now about 35,000,000.

These advances in power and speed have been made possible mainly by the successive increase in economy and diminution of weight derived from the replacement of reciprocating engines by turbines direct-coupled to the propellers, and later by the introduction of reduction gearing between the turbines and the propellers; also by the adoption of water-tube boilers and of oil-fuel. With these advances the names of Lord Fisher, Sir William White, and Sir Henry Oram will always be associated.

The Work of Sir William White.—With the great work of the Royal Navy fresh in our minds, we cannot but recall the prominent part taken by the late Sir William White in its construction. His sudden death, when president-elect for 1913, lost to the nation and to the association the services of a great naval architect who possessed remarkable powers of prevision and dialectic. He was Chief Constructor to the Admiralty from 1885 to 1901, and largely to him was due the efficiency of our vessels in the great war.

White often referred to the work of Brunel as the designer of the *Great Eastern*, and spoke of him as the originator of the cellular construction of the bottoms of ships, since universally adopted, as a means of strengthening the hull and for obtaining additional safety in case of damage. Scott Russell was the builder of this great pioneer vessel, the forerunner of the Atlantic liners, and the British Association may rightly feel satisfaction in having aided him when a young man by pecuniary grants to develop his researches into the design and construction of ships and the wave-line form of hull which he originated, a form of special importance in paddle-wheel vessels.

So much discussion has taken place in the last four years as to the best construction of ship to resist torpedo attacks that it is interesting to recall briefly at the present time what was said by White in his Cantor lectures to the Royal Society of Arts in 1906:—"Great attention has been bestowed upon means of defence against underwater torpedo attacks. From the first introduction of torpedoes it was recognised that extreme watertight subdivision in the interior of warships would be the most important means of defence. Experiments have been made with triple watertight skins forming double cellular sides, the compartments nearest the outer bottom being filled, in some cases, with water, coal, cellulose, or other materials. Armour-plating has been used both on the outer bottom and on inner skins." He also alludes to several Russian ships which were torpedoed by the Japanese, and he concludes by saying:—"Up to date the balance of opinion has favoured minute watertight subdivisions and comparatively thin watertight compartments, rather than the use of internal armour, the use of which, of course, involves large expenditure of weight and cost."

The present war has most amply confirmed his views and conclusions, then so lucidly and concisely expressed.

While on the subject of steamships, it may perhaps be opportune to say one word as to their further development. The size of ships had been steadily increasing up to the time of the war, resulting in a reduction of power required to propel them per ton of displacement. On the other hand, thanks to their greater size and more economical machinery, speeds have been increased when the traffic has justified the greater cost. The limiting factor to further increase in size is the depth of water in the harbours. With this restriction removed there is no obstacle to building ships up to 1000 ft. in length or more, provided the volume and character of the traffic are such as to justify the capital outlay.

Tungsten Steel.—Among other important pre-war developments that have had a direct bearing upon the war, mention should be made of the discovery and extensive use of alloys of steel. The wonderful properties conferred upon steel by the addition of tungsten were discovered by Muschet in 1868, who has not been sufficiently credited with his share in making the Bessemer process a practical success, and later this alloy was investigated and improved by Maunsel White and Taylor, of Philadelphia. The latter showed that the addition of tungsten to steel has the following effect:—That after the steel has been quenched at a very high temperature near its melting point, it can be raised to a much higher temperature than is possible with ordinary carbon tool-steel without losing its hardness and power of cutting metal. In other words, it holds the carbon more tenaciously in the hardened state, and hence tungsten-steel tools, even when red-hot, can cut ordinary mild steel. It has revolutionised the design of machine tools, and has increased the output on heavy munition work by 100 per cent., and in ordinary engineering by 50 per cent.

The alloys of steel and manganese with which Sir Robert Hadfield's name is associated have proved of utility in immensely increasing the durability of railway and tramway points and crossings, and for the hard teeth of machinery for the crushing of stone and other materials, and, in fact, for any purposes where great hardness and strength are essential.

Investigation of Gaseous Explosions.—Brief reference must also be made—and it will be gratifying to do so—to the important work of one of the committees of the British Association appointed in 1908, under the chairmanship of the late Sir William Preece, for the investigation of gaseous explosions, with special reference to temperature. The investigations of the committee are contained in seven yearly reports up to 1914. Of the very important work of the committee I wish to refer to one investigation in particular, which has proved to be a guiding star to the designers and manufacturers of internal-combustion engines in this country. The members of the committee more directly associated with this particular investigation were Sir Dugald Clerk, Prof. Callendar, and the late Prof. Bertram Hopkinson.

The investigation showed that the intensity of the heat radiated by the incandescent gases to the walls of the cylinder of a gas-engine increases with the size of the cylinder, the actual rate of this increase being approximately proportional to the square root of the depth of the radiating incandescent gas; the intensity was also shown to increase rapidly with the richness of the gas. It suffices now to say that the heat in a large cylinder with a rich explosive mixture is so intense that the metal eventually cracks. The investigation shows why this occurs, and by doing so has saved enormous sums to the makers of gas- and oil-engines in this country, and has led them to avoid the large cylinder, so common in Germany before the war, in favour of a multiplicity of smaller cylinders.

Science and the War.

In coming to this section of my address I am reminded that in the course of his presidential address to Section G, in 1858, Lord Rosse said:—"Another object of the Mechanical Section of the association has been effected—the importance of engineering science in the service of the State has been brought more prominently forward. There seems, however, something still wanting. Science may yet do more for the Navy and Army if more called upon."

Comparatively recently, too, Lord French remarked: "We have failed during the past to read accurately the lessons as regards the fighting of the future which modern science and invention should have taught us."

In view of the eminent services which men of science have rendered during the war, I think that we may be justified in regarding the requirement stated by Lord Rosse as having at last been satisfied, and also in believing that such a criticism as Lord French rightly uttered will not be levelled against the country in the future.

Though British men of science had not formerly been adequately recognised in relation to war and the safety of their country, yet at the call of the sailors and the soldiers they whole-heartedly, and with intense zeal, devoted themselves to repair the negligence of the past, and to apply their unrivalled powers and skill to encounter and overcome the long-standing machinations of the enemy. They worked in close collaboration with the men of science of the Allied nations, and eventually produced better war material, chemicals, and apparatus of all kinds for vanquishing the enemy and the saving of our own men than had been devised by the enemy during many years of preparation planned on the basis of a total disregard of treaties and the conventions of war.

Four years is too short a time for much scientific invention to blossom to useful maturity, even under the forced exigencies of war and Government control. It must be remembered that in the past the great majority of new discoveries and inventions of merit have taken many years—sometimes generations—to bring them into general use. It must also be mentioned that in some instances discoveries and inventions are attributable to the general advance in science and the arts which has brought within the region of practical politics an attack on some particular problem. So the work of the men of science during the war has perforce been directed more to the application of known principles, trade knowledge, and properties of matter to the waging of war than to the making of new and laborious discoveries; though, in effecting such applications, inventions of a high order have been achieved some of which promise to be of great usefulness in time of peace.

The advance of science and the arts in the last century had, however, wrought a great change in the implements of war. The steam-engine, the internal-combustion engine, electricity, and the advances in metallurgy and chemistry had led to the building up of immense industries which, when diverted from their normal uses, have produced unprecedented quantities of war material for the purposes of the enormous armies, and also for the greatest Navy which the world has ever seen.

The destructive energy in the field and afloat has multiplied many hundredfold since the time of the Napoleonic wars; both before and during the war the size of guns and the efficiency of explosives and shell increased immensely, and many new implements of destruction were added. Modern science and engineering enabled armies unprecedented in size, efficiency, and equipment to be drawn from all parts of the world and to be concentrated rapidly in the fighting line.

To build up the stupendous fighting organisation, ships have been taken from their normal trade routes, locomotives and material from the home railways, the normal manufactures of the country have been largely diverted to munitions of war; the home railways, tramways, roads, buildings and constructions, and material of all kinds have been allowed to depreciate. The amount of depreciation in roads and railways alone has been estimated at 400,000,000*l.* per annum at present prices. Upon the community at home a very great and abnormal strain has been thrown, notwithstanding the increased output per head of the workers derived from modern methods and improved machinery. In short, we have seen for the first time in history nearly the whole populations of the principal contending nations enlisted in intense personal and collective effort in the contest, resulting in unprecedented loss of life and destruction of capital.

A few figures will assist us to realise the great difference between this war and all preceding wars. At Waterloo, in 1815, 9044 artillery rounds were fired, having a total weight of 37·3 tons, while on one day during the last offensive in France, on the British front alone, 943,837 artillery rounds were fired, weighing 18,080 tons—more than 100 times the number of rounds, and nearly 540 times the weight of projectiles. Again, in the whole of the South African War 273,000 artillery rounds were fired, weighing approximately 2800 tons; while during the whole war in France, on the British front alone, more than 170,000,000 artillery rounds were fired, weighing nearly 3,500,000 tons—622 times the number of rounds, and about 1250 times the weight of projectiles.

However great these figures in connection with modern land artillery may be, they become almost insignificant when compared with those in respect of a modern naval battle squadron. The *Queen Elizabeth* when firing all her guns discharges 18 tons of metal and develops 1,870,000 foot-tons of energy. She is capable of repeating this discharge once every minute, and when doing so develops by her guns an average of 127,000 effective h.p., or more than one-and-a-half times the power of her propelling machinery; and this energy is five times greater than the maximum average energy developed on the Western Front by British guns. Furthermore, if all her guns were fired simultaneously, they would for the instant be developing energy at the rate of 13,132,000 h.p. From these figures we can form some conception of the vast destructive energy developed in a modern naval battle.

Engineering and the War.

With regard to the many important engineering developments made during the war, several papers by authorities are announced in the syllabus of papers constituting the sectional proceedings of this year's meeting. Among them are "Tanks," by Sir Eustace d'Eyncourt; "Scientific Progress of Aviation during the War," by L. Bairstow; "Airships," by Lt.-Col. Cave-Brown-Cave; "Directional Wireless, with Special Reference to Aircraft," by Capt. Robinson; "Wireless in Aircraft," by Major Erskine Murray; "Wireless Telegraphy during the First Three Years of the War," by Major Vincent Smith; "Submarine Mining," by Comdr. Gwynne; "Emergency Bridge Construction," by Prof. Ingles; and "The Paravane," by Comdr. Burney. Accordingly, it is quite unnecessary here to particularise further except in the few following instances:—

Sound-ranging and Listening Devices.—Probably the most interesting development during the war has been the extensive application of sound-listening devices for detecting and localising the enemy. The Indian hunter puts his ear to the ground to listen for the sound of the footsteps of his enemy. So in modern warfare science has placed in the hands of the sailor and soldier elaborate instruments to aid the ear in the detection of noises transmitted through earth, water, air, or æther, and also in some cases to record these sounds graphically or photographically, so that their character and the time of their occurrence may be tabulated.

The sound-ranging apparatus developed by Prof. Bragg and his son, by which the position of an enemy gun can be determined from electrically recorded times at which the sound-wave from the gun passes over a number of receiving stations, has enabled our artillery to concentrate their fire on the enemy's guns, and often to destroy them.

The French began experimenting in September, 1914, with methods of locating enemy guns by sound. The English section began work in October, 1915, adopting the French methods in the first instance. By the end of 1916 the whole front was covered, and sound-ranging began to play an important part in the location of enemy batteries. During 1917 locations by sound-ranging reached about 30,000 for the whole Army, this number being greater than that given by any other means of location. A single good set of observations could be relied upon to give the position of an enemy gun to about 50 yards at 7000 yards' range. It could also be carried on during considerable artillery activity.

The apparatus for localising noises transmitted through the ground has been much used for the detection of enemy mining and counter-mining operations. Acoustic tubes, microphones, and amplifying valves have been employed to increase the volume of very faint noises.

For many years before the war the Bell Submarine Signalling Co., of which Sir William White was one of the early directors, used submerged microphones for detecting sound transmitted through the water, and a submerged bell for sending signals to distances up to one mile. With this apparatus passing ships could be heard at a distance of nearly a mile when the sea was calm and the listening vessel stationary.

Of all the physical disturbances emitted or produced by a moving submarine, those most easily detected, and at the greatest distance, are the pressure-waves set up in the water by vibrations produced by the vessel and her machinery. A great variety of instruments have been devised during the war for detecting these noises, depending on microphones and magnetophones of exceedingly high sensitivity. Among them may be particularly mentioned the hydrophones devised by Capt. Ryan and Prof. Bragg, being adaptations of the telephone transmitter to work in water instead of air. These instruments, when mounted so as to rotate, are directional, being insensitive to sound-waves the front of which is perpendicular to the plane of the diaphragm, and giving the loudest sound when the diaphragm is parallel to the wave-front.

Another preferable method for determining direction is to use two hydrophones coupled to two receivers, one held to each ear. This is called the biaural method, and enables the listener to recognise the direction from which the sound emanates.

When the vessel is in motion or the sea is rough, the water noises from the dragging of the instrument through the water and from the waves striking the ship drown the noises from the enemy vessel, and under such conditions the instruments are useless. The assistance of eminent biologists was of invaluable help at this juncture. Experiments were made with sea-lions by Sir Richard Paget, who found that they have directional hearing under water up to speeds of six knots. Also Prof. Keith explained the construction of the hearing organs of the whale, the ear proper being a capillary tube, too small to be capable of performing any useful function in transmitting sound to the relatively large aural organs, which are deep set in the head. The whale therefore hears by means of the sound-waves transmitted through the substance of the head. It was further seen that the organs of hearing of the whale to some degree resembled the hydrophone.

The course now became clear. Hollow towing bodies in the form of fish or porpoises were made of celluloid, varnished canvas, or very thin metal, and the hydrophone suitably fixed in the centre of the head. The body is filled with water, and the cable towing the fish contains the insulated leads to the observer on board the vessel. When towed at some distance behind the chasing ship disturbing noises are small, and enemy noises can be heard up to speeds of fourteen knots, and at considerable distances. Thermionic amplifying valves have been extensively used, and have added much to the sensitiveness of the hydrophone in its many forms.

After the loss of the *Titanic* by collision with an iceberg, Lewis Richardson was granted two patents in 1912 for the detection of above-water objects by their echo in the air, and under-water objects by the echo transmitted through the water. The principles governing the production and the concentration of beams of sound are described in the specification, and he recommends frequencies ranging from 4786 to 100,000 complete vibrations per second, and also suggests that the rate of approach or recession from the object may be determined from the difference in the pitch of the echo from the pitch of the blast sent out. Sir Hiram Maxim also suggested similar apparatus a little later.

The echo method of detection was not, however, practically developed until French and English men of science, with whom was associated Prof. Langevin, of the Collége de France, realising its importance for submarine detection, brought the apparatus to a high degree of perfection and utility shortly before the armistice. Now with beams of high-frequency sound-waves it is possible to sweep the seas for the detection of any submerged object, such as icebergs, submarines, surface vessels, and rocks; they may also be used to make soundings. It enables a chasing ship to pick up and close in on a submarine situated more than a mile away.

The successful development of sound-ranging apparatus on land led to the suggestion by Prof. Bragg that a modified form could be used to locate under-water explosions. It has been found that the shock of an explosion can be detected hundreds of miles from its source by means of a submerged hydrophone, and that the time of the arrival of the sound-wave can be recorded with great precision. At the end of the war the sound-ranging stations were being used for the detection of positions at sea required for strategical purposes. The same stations are now being used extensively for the determination of such positions at sea as light-vessels, buoys which indicate channels, and obstructions such as sunken ships. By this means ships steaming in fog can be given their positions with accuracy for ranges up to 500 miles.

Among the many other important technical systems and devices brought out during the war which will find useful application under peace conditions as aids to navigation I may mention directional wireless, by which ships and aircraft can be given their positions and directed, and on this subject we are to have a paper in Section G.

Leader-gear, first used by the Germans to direct their ships through their minefields, and afterwards used by the Allies, consists of an insulated cable laid on the bottom of the sea, earthed at the further end, through which an alternating current is passed. By means of delicate devices installed on a ship, she is able to follow the cable at any speed with as much precision as a railless electric 'bus can follow its trolley-wire. Cables up to fifty miles long have been used, and this device promises to be invaluable to ships navigating narrow and tortuous channels and entering or leaving harbours in a fog.

Aircraft.—It may be justly said that the development in aircraft design and manufacture is one of the astonishing engineering feats of the war. In August, 1914, the British Air Services possessed a total of 272 machines, whereas in October, 1918, just prior to the armistice, the Royal Air Force possessed more than 22,000 effective machines. During the first twelve months of the war the average monthly delivery of aeroplanes to our Flying Service was 50, while during the last twelve months of the war the average deliveries were 2700 per month. So far as aero-engines are concerned, our position in 1914 was by no means satisfactory. We depended for a large proportion of our supplies on other countries. In the Aerial Derby of 1913, of the eleven machines that started, not one had a British engine. By the end of the war, however, British aero-engines had gained the foremost place in design and manufacture, and were well up to requirements as regards supply. The total horse-power produced in the last twelve months of the war approximated to eight millions of brake-horse-power, a figure quite comparable with the total horse-power of the marine-engine output of the country.[1]

Much might be written on the progress in aircraft, but the subject will be treated at length in the sectional papers. In view of the recent trans-Atlantic flight, however, I feel that it may be opportune to make the following observations on the comparative utility of aeroplanes and airships for commercial purposes. In the case of the aeroplane, the weight per horse-power increases with the size, other things being equal. This increase, however, is met to some extent by a multiplicity of engines, though in the fuselage the increase remains.

On the other hand, with the airship the advantage increases with the size, as in all ships. The tractive effort per ton of displacement diminishes in inverse proportion to the dimensions, other things, including the speed, being the same. Thus an airship of 750 ft. length and 60 tons displacement may require a tractive force of 5 per cent., or 3 tons, at 60 miles per hour; and one of 1500 ft. in length and $8\times60=480$ tons displacement would require only $2\frac{1}{2}$ per cent. $\times$ $480=12$ tons at the same speed, and would carry fuel for double the distance.

With the same proportion of weight of hull to displacement, the larger airship would stand double the wind-pressure, and would weather storms of greater violence and hailstones of greater size. It would be more durable, the proportional upkeep would be less, and the proportional loss of gas considerably less. In other words, it would lose a less proportion of its buoyancy per day. It is a development in which success depends upon the project being well thought out and the job being thoroughly well done. The equipment of the airsheds with numerous electric haulage winches, and all other appliances to make egress and ingress to the sheds safe from danger and accident, must be ample and efficient.

The airship appears to have a great future for special commerce where time is a dominant factor and the demand is sufficient to justify a large airship. It has also a great field in the opening up of new countries where other means of communication are difficult. The only limitation to size will be the cost of the airship and its sheds, just as in steam-vessels it is the cost of the vessels and the cost of deepening the harbours that limit the size of Atlantic liners.

Such developments generally take place slowly, otherwise failures occur—as in the case of the *Great Eastern*—and it may be many years before the airship is increased from the present maximum of 750 ft. to 1500 ft. with success, but it will assuredly come. If, however, the development is subsidised or assisted by the Government, incidental failures may be faced with equanimity and very rapid development accomplished.[2] In peace-time the seaplane, aeroplane, and airship will most certainly have their uses. But, except for special services of high utility, it is questionable whether they will play more than a minor part as compared with the steamship, railway, and motor transport.

Electricity.—The supply and use of electricity has developed rapidly in recent years. For lighting it is the rival of gas, though each has its advantages. As a means of transmitting power over long distances it has no rival, and its efficiency is so high that, when generated on a large scale and distributed over large areas, it is a cheap and trustworthy source of power for working factories, tramways, suburban railways, and innumerable other purposes, including metallurgical and chemical processes. It is rapidly superseding locally generated steam-power, and is a rival to the small- and moderate-sized gas and oil engines. It has made practicable the use of water-power through the generation of electricity in bulk at the natural falls, from which the power is transmitted to the consumers, sometimes at great distances.

Fifteen years ago electricity was generated chiefly by large reciprocating steam-engines, direct-coupled to dynamos or alternators, but of late years steam turbines have in most instances replaced them, and are now exclusively used in large generating stations because of their smaller cost and greater economy in fuel. The size of the turbines may vary from a few thousand horse-power up to about 50,000 h.p. At the end of last year the central electric stations in the United Kingdom contained plant aggregating 2,750,000 kilowatts, 79 per cent. of which was driven by steam turbines.

Much discussion has taken place as to the most economical size of generating stations, their number,

[1] See Lord Weir's Paper read at the Victory Meeting of the North-East Coast Institution of Engineers and Shipbuilders, July, 1919.

[2] The literature on this subject includes an article which appeared in *Engineering* on January 3, 1919.

the size of the generating units, and the size of the area to be supplied. On one hand, a comparatively small number of very large or super-stations, instead of a large number of moderate-sized stations dotted over the area, results in a small decrease in the cost of production of the electricity, because in the super-stations larger and slightly more economical engines are employed, while the larger stations permit of higher organisation and more elaborate labour-saving appliances. Further, if in the future the recovery of the by-products of coal should become a practical realisation as part of the process in the manufacture of the electric current, the larger super-stations present greater facilities than the smaller stations. On the other, super-stations involve the transmission of the electricity over greater distances, and consequently greater capital expenditure and cost of maintenance of mains and transmission apparatus, and greater electrical transmission losses, while the larger generating unit takes longer to overhaul or repair, and consequently a larger percentage of spare plant is necessary.

The greatest element in reducing the cost of electricity is the provision of a good load factor; in other words, the utilisation of the generating plant and mains to the greatest extent during the twenty-four hours of each day throughout the year. This is a far more important consideration than the size of the station, and it is secured to the best advantage in most cases by a widespread network of mains, supplying a diversity of consumers and users, each requiring current at different times of the day. The total load of each station being thus an average of the individual loads of a number of consumers is, in general, far less fluctuating than in the case of small generating and distributing systems, which supply principally one class of consumer—a state of affairs that exists in London, for instance, at the present time. It is true that there may be exceptional cases, such as at Kilmarnock, where a good load factor may be found in a small area, but in this case the consumers are chiefly mills, which require current for many hours daily.

There is no golden rule to secure cheap electricity. The most favourable size, locality, and number of generating stations in each area can only be arrived at by a close study of the local conditions, but there is no doubt that, generally speaking, to secure cheap electricity a widespread network of mains is in most cases a very important, if not an essential, factor.

The electrification of tramways and suburban railways has been an undoubted success where the volume of traffic has justified a frequent service, and it has been remarkable that where suburban lines have been worked by frequent and fast electrical trains there has resulted a great growth of passenger traffic. The electrification of main-line railways would no doubt result in a saving of coal; at the same time, the economical success would largely depend on the broader question as to whether the volume of the traffic would suffice to pay the working expenses and provide a satisfactory return on the capital.

Municipal and company generating stations have been nearly doubled in capacity during the war to meet the demand from munition works, steel works, chemical works, and for many other purposes. The provision of this increased supply was an enormous help in the production of adequate munitions. At the commencement of the war there were few steel electric furnaces in the country; at the end of last year 117 were at work, producing 20,000 tons of steel per month, consisting chiefly of high-grade ferro alloys used in munitions.

The Future.

The nations which have exerted the most influence in the war have been those which have developed to the greatest extent their resources, their manufactures, and their commerce. As in the war, so in the civilisation of mankind. But, viewing the present trend of developments in harnessing water-power and using up the fuel resources of the world for the use and convenience of man, one cannot but realise that, failing new and unexpected discoveries in science, such as the harnessing of the latent molecular and atomic energy in matter, as foreshadowed by Clerk Maxwell, Kelvin, Rutherford, and others, the great position of England cannot be maintained for an indefinite period. At some time more or less remote—long before the exhaustion of our coal—the population will gradually migrate to those countries where the natural sources of energy are the most abundant.

Water-power and Coal.—The amount of available water-power in the British Isles is very small as compared with the total in other countries. According to the latest estimates, the total in the British Isles is less than 1,500,000 h.p., whereas Canada alone possesses more than 20,000,000 h.p., of which more than 2,000,000 h.p. have already been harnessed. In the rest of the British Empire there are upwards of 30,000,000 h.p., and in the remainder of the world at least 150,000,000 h.p., so that England herself possesses less than 1 per cent. of the water-power of the world. Further, it has been estimated that she only possesses 2½ per cent. of the whole coal of the world. To this question I would wish to direct our attention for a few minutes.

I have said that England owes her modern greatness to the early development of her coal. Upon it she must continue to depend almost exclusively for her heat and source of power, including that required for propelling her vast mercantile marine. Nevertheless, she is using up her resources in coal much more rapidly than most other countries are consuming theirs, and long before any near approach to exhaustion is reached her richer seams will have become impoverished, and the cost of mining so much increased that, given cheap transport, it might pay her better to import coal from richer fields of almost limitless extent belonging to foreign countries, and workable at a much lower cost than her own.

Let us endeavour to arrive at some approximate estimate of the economic value of the principal sources of power. The present average value of the royalties on coal in England is about 6*d.* per ton, but to this must be added the profit derived from mining operations after paying royalties and providing for interest on the capital expended and for its redemption as wasting capital. After consultation with several leading experts in these matters, I have come to the conclusion that about 1*s.* per ton represents the pre-war market value of coal in the seams in England.

It must, however, be remembered that, in addition, coal has a considerable value as a national asset, for on it depends the prosperity of the great industrial interests of the country, which contribute a large portion of the wealth and revenue. From this point of view the present value of unmined coal seems not to have been sufficiently appreciated in the past, and that in the future it should be better appraised at its true value to the nation.

This question may be viewed from another aspect by making a comparison of the cost of producing a given amount of electrical power from coal and from water-power. Assuming that 1 h.p. of electrical energy maintained for one year had a pre-war value of 5*l.*, and that it requires about eight tons of average coal to produce it, we arrive at the price of 6s. 3d. per ton, *i.e.* crediting the coal with half the cost. The capital required to mine eight tons of coal a year in England is difficult to estimate, but it may be taken approximately to be 5l., and the capital for plant and machinery to convert it into electricity at 10l., making a total of 15l. In the case of water-power the average capital cost on the above basis is 40l., including water rights (though in exceptionally favoured districts much lower costs are recorded).

From these figures it appears that the average capital required to produce electrical power from coal is less than half the amount that is required in the case of water-power. The running costs, however, in connection with water-power are much less than those in respect of coal. Another interesting consideration is that the cost of harnessing all the water-power of the world would be about 8,000,000,000l., or equal to the cost of the war to England.

Dowling has estimated the total coal of the world as more than seven million million tons, and whether we appraise it at 1s. or more per ton its present and prospective value is prodigious. For instance, at 6s. 3d. per ton it amounts to nearly one hundred times the cost of the war to all the belligerents.

In some foreign countries the capital costs of mining are far below the figures I have taken, and, as coal is transportable long distances and, generally speaking, electricity is not so at present, therefore it seems probable that capital will in the immediate future flow in increasing quantity to mining operations in foreign countries rather than to the development of, at any rate the more difficult and costly, water-power schemes. When, however, capital becomes more plentiful the lower running costs of water-power will prevail, with the result that water-power will then be rapidly developed.

As to the possible new sources of power, I have already mentioned molecular energy, but there is another alternative which appears to merit attention.

Bore Hole.—In my address to Section B in 1904 I discussed the question of sinking a shaft to a depth of twelve miles, which is about ten times the depth of any shaft in existence. The estimated cost was 5,000,000l., and the time required about eighty-five years.

The method of cooling the air-locks to limit the barometric pressure on the miners and other precautions were described, and the project appeared feasible. One essential factor has, however, been queried by some persons: Would the rock at the great depth crush in and destroy the shaft? Subsequent to my address I wrote a letter to NATURE, suggesting that the question might be tested experimentally. Prof. Frank D. Adams, of McGill University, Montreal, acting on the suggestion, has since carried out exhaustive experiments, published in the *Journal of Geology* for February, 1912, showing that in limestone a depth of fifteen miles is probably practicable, and that in granite a depth of thirty miles might be reached.

Little is at present known of the earth's interior, except by inference from a study of its surface, upturned strata, shallow shafts, the velocity of transmission of seismic disturbances, its rigidity and specific gravity, and it seems reasonable to suggest that some attempt should be made to sink a shaft as deep as may be found practicable and at some locality selected by geologists as the most likely to afford useful information.

When we consider that the estimated cost of sinking a shaft to a depth of twelve miles, at present-day prices, is not much more than the cost of one day of the war to Great Britain alone, the expense seems trivial as compared with the possible knowledge that might be gained by an investigation into this unexplored region of the earth. It might, indeed, prove of inestimable value to science, and also throw additional light on the internal constitution of the earth in relation to minerals of high specific gravity.

In Italy, at Lardarello, bore-holes have been sunk which discharge large volumes of high-pressure steam, which is being utilised to generate about 10,000 h.p. by turbines. At Solfatara, near Naples, a similar project is on foot to supply power to the great works in the district. It seems, indeed, probable that in volcanic regions a very large amount of power may be, in the future, obtained directly or indirectly by boring into the earth, and that the whole subject merits the most careful consideration.

While on the subject of obtaining power, may I digress for a few moments and describe an interesting phenomenon of a somewhat converse nature, *i.e.* that of intense pressure produced by moderate forces closing up cavities in water?

A Committee was appointed by the Admiralty in 1916 to investigate the cause of the rapid erosion of the propellers of some of the ships doing arduous duties. This was the first time that the problem had been systematically considered. The Committee found that the erosion was due to the intense blows struck upon the blades of the propellers by the nuclei of vacuous cavities closing up against them. Though the pressure bringing the water together was only that of the atmosphere, yet it was proved that at the nucleus 20,000 atmospheres might be produced.

The phenomenon may be described as being analogous to the well-known fact that nearly all the energy of the arm that swings it is concentrated in the tag of a whip. It was shown that when water flowed into a conical tube which had been evacuated a pressure of more than 140 tons per square inch was recorded at the apex, which was capable of eroding brass, steel, and, in time, even the hardest steel. The phenomenon may occur under some conditions in rivers and waterfalls where the velocity exceeds 50 ft. per second, and it is probably as great a source of erosion as by the washing down of boulders and pebbles Then again, when waves beat on a rocky shore, under some conditions, intense hydraulic pressures will occur, quite sufficient of themselves to crush the rock and to open out narrow fissures into caves.

Research.—The whole question of the future resources of the Empire is, I venture to think, one which demands the serious attention of all men of science. It should be attacked in a comprehensive manner, and with that insistence which has been so notable in connection with the efforts of British investigators in the past. In such a task some people might suggest we need encouragement and assistance from the Government of the country. Surely we have it. As many here know, a great experimental step towards the practical realisation of Solomon's House as prefigured by Francis Bacon in the *New Atlantis* is being made by the Government at the present time. The inception, constitution, and methods of procedure of the Department, which was constituted in 1915, were fully described by Sir Frank Heath in his paper to the Royal Society of Arts last February, and it was there stated by Lord Crewe that, so far as he knew, this was the only country in which a Government Department of Research existed.[3]

It is obvious that the work of a Department of this kind must be one of gradual development with small beginnings in order that it may be sound and

[3] The Italian Government are now establishing a National Council for Research, and a Bill is before the French Chamber for the establishment of a National Office of Scientific, Industrial, and Agricultural Research and Inventions.

lasting. The work commenced by assisting a number of researches conducted by scientific and professional societies which were languishing as a result of the war, and grants were also made to the National Physical Laboratory and to the Central School of Pottery at Stoke-on-Trent. The grants for investigation and research for the year 1916–17 totalled 11,055*l*., and for the present year are anticipated to be 93,570*l*. The total income of the National Physical Laboratory in 1913–14 was 43,713*l*., and, owing to the great enlargement of the laboratory, the total estimate of the Research Department for this service during the current year is 154,650*l*.

Another important part of the work of the Department has been to foster and to aid financially associations of the trades for the purpose of research. Nine of these associations are already at work; eight more are approved, and will probably be at work within the next two months; and another twelve are in the earlier stage of formation. There are also signs of great increase of research by individual factories. Whether this is due to the indirect influence of the Research Department or to a change in public opinion and a more general recognition of the importance of scientific industrial research it is difficult to say.

The possibility of the uncontrolled use on the part of a nation of the power which science has placed within its reach is so great a menace to civilisation[4] that the ardent wish of all reasonable people is to possess some radical means of prevention through the establishment of some form of wide and powerful control. Has not science forged the remedy by making the world a smaller arena for the activities of civilisation, by reducing distance in terms of time? Alliances and unions, which have successfully controlled and stimulated republics of heterogeneous races during the last century, will therefore have become possible on a wider and grander scale, thus uniting all civilised nations in a great league to maintain order, security, and freedom for every individual and for every State and nation liberty to devote their energies to the controlling of the great forces of Nature for the use and convenience of man, instead of applying them to the killing of each other.

Many of us remember the president's banner at the Manchester meeting in 1915, where Science is allegorically represented by a sorrowful figure covering her eyes from the sight of the guns in the foreground. This year Science is represented in her more joyful mien, encouraging the arts and industries. It is to be sincerely hoped that the future will justify our present optimism.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS.

Agriculture.

IN his address to Section M, Prof. Somerville pointed out that during the war the area of land in the United Kingdom under grass was reduced by more than three million acres, with a corresponding increase of the area under tillage crops. Even were this increase of cultivated land maintained there would still remain more than 30 million acres under permanent and temporary grass, exclusive of about 16 million acres of mountain land used for grazing. Several attempts have been made to discover a relationship between the botanical composition and the feeding properties of permanent pastures, but the results have been largely negative; neither has it been possible by chemical analysis to differentiate between grass of poor and of high quality. The only trustworthy test of quality that can be applied would appear to be through the agency of animals consuming the produce of the meadows or pasturing the fields. This work was initiated at Cockle Park in Northumberland in 1897, and has been extended to some twenty other experimental stations in various parts of the United Kingdom and in New Zealand. It has been conclusively proved that poor grass land is susceptible of rapid and profitable improvement, especially through the agency of phosphates. In many cases the stock-carrying capacity of land has been more than doubled, while the progress of the individual animals has also been largely increased, so that the output of meat or milk from land suitably manured has often been trebled or quadrupled with advantage to the nation and substantial profit to the farmer. One conspicuous result of experiments on manuring-for-meat has been the long-continued action of dressings of phosphate, 200 lb. per acre of phosphoric acid in the form of basic slag still producing very marked effects at the end of nine years. Nitrogen, potash, and lime as an addition to phosphates have been tried at several stations, but in most cases with comparatively little effect. Indirect manuring through feeding stock with cake has also given unsatisfactory results.

Research during recent years has been directed towards discovering how the marked improvement secured by an initial dressing of phosphate can be maintained, and it has been found that in no way can the maintenance of fertility of pasture be better secured than by means of supplementary dressings of phosphate.

Anthropology

Prof. Arthur Keith, as president of Section H, devoted his address to "The Differentiation of Mankind into Racial Types." It was maintained that an overwhelming majority of anthropologists were convinced that all varieties of living human races were descendants of a common ancestral stock, and that some varieties had departed less from the original pattern than others. There was no agreement, however, as to how the differentiation had come about. Natural and sexual selection were certainly parts of the evolutionary machinery which had given the Negro, the Chinaman, and the European their distinctive features of face, skull, and body, and also certain characteristics of mind, but it was clear that they did not constitute the whole of the machinery. Nothing was more desired by anthropologists at the present time than a rational explanation of how mankind has come by its racial characteristics.

There were many indications that the key to such problems was to be obtained by a close study of the disturbances or disorders which occasionally affect the development and growth of the human body. The disorders of growth are of many kinds; some are definitely proved to result from a functional derangement of one or more of the glands of internal secretion—the pituitary, thyroid, pineal, adrenal, and genital glands. In a manner which we are only beginning to perceive, the functions carried on in these glands regulate, not only the dimensions of the body, but also the shape and size of each individual part.

The machinery of race differentiation is resident in the growth-controlling glands of the body. The mistake is sometimes made of regarding each gland as carrying on a simple function, whereas each carried on a multitude of functions. Substances contained in the secretion of the pituitary gland not only could affect the size and proportion of the body, but also might pick out and emphasise the growth of one or

[4] For instance, it might some day be discovered how to liberate instantaneously the energy in radium, and radium contains 2,500,000 times the energy of the same weight of T.N.T.

more physiological systems. The same was true of the thyroid. The racial features of the Mongolian type were simulated by growing Europeans who were affected by deficiency disorders of the thyroid gland. The features of the Negro could best be accounted for by the nature of the growth-regulating mechanism centred in the thyroid and suprarenal glands. European features were connected with a dominance in the functions of the pituitary. As we came to understand the machinery of growth, matters which now puzzle us about the differentiation of varieties and species of mankind would disappear.

Botany.

Sir Daniel Morris began his address to Section K by remarking that since the Association met at Newcastle in 1916 there has been decided progress in every branch of science, and also a fuller recognition of the value of science and education as means whereby the material interests of the world may be enlarged. A new branch of botany has lately come into prominence as one of the results of the devotion to nature study and the contemplation of the characteristic features of vegetation as we find it distributed over the world's surface. Ecology is capable of enormously extending the outlook of botany, and it has so largely added to the interest of field work that we may wonder that the phenomenon of vegetation so long displayed before our eyes had not suggested its sociological aspects long ago. It is hoped ecology will mitigate some of the admitted drawbacks of purely laboratory work and revive the old natural history spirit of former days.

Travelling somewhat outside the scope of previous addresses, an attempt was made to summarise the results of the many efforts to promote not only the interests of the homeland, but of the Empire as a whole. The establishment of an Imperial Department of Agriculture in the West Indies, followed by similar highly equipped departments in India and in such tropical colonies as Ceylon, Mauritius, Federated Malay States, Fiji, and in East and West Africa, has greatly advanced scientific research on the applied side in connection with sugar, cotton, indigo, rice, india-rubber, and other important industries. The admirable work done by Biffen at Cambridge and the Howards in India in raising new and improved varieties of wheats clearly demonstrates the value of thorough acquaintance with pure botany as a qualification for grappling with questions of economic importance.

As the result of Biffen's plant-breeding work at Cambridge, new wheats have been produced and grown over extensive areas in the eastern counties that have yielded crops at the rate of 50 to 60 bushels per acre. In one instance an area of a little over twenty-seven acres has yielded 2072 bushels, or an average of 77 bushels per acre. This is to be compared with the average yield of wheat in this country at about 32 bushels per acre. The new wheats are not only more productive, but are less liable to disease, and the quality of the flour is superior to that of ordinary English wheats. In regard to India it is estimated that the Pusa wheats raised by the Howards will shortly be established over five million acres, and it is anticipated that they will bring in an increase in the value of the agricultural produce of India, in one crop only, of 75 lakhs of rupees or five millions sterling.

Henry's researches in regard to hybrid trees and his elaborate investigation into the history of the London plane were generally regarded as valuable contributions to science. It was claimed in the case of many trees that it is possible to produce much greater bulk of timber in a given time; while, according to Dawson, the common belief that quickly grown timbers are of an inferior quality is said not to hold good in respect of any quality in ash, oak, and walnut.

It is widely felt that the most pressing of all investigations at the present time is the study of plant diseases. The recently established Institute for Plant Pathology at Rothamsted may be the means of introducing entirely new methods in mycological investigations.

It was further suggested that all research work should be organised on the broadest possible lines and combine the biological services of the whole Empire. We have a first step in this direction in the Imperial Bureau of Entomology with its headquarters at the British Museum. Those acquainted with the efficient work done by this bureau, and the valuable publications issued by it, will heartily welcome the establishment of the proposed Imperial Bureau of Mycology, at Kew, to carry on work on similar lines.

Chemistry.

The periodic law, of which this year may be regarded as the jubilee of its announcement by Mendeléeff, formed the chief subject of the address in Section B by Prof. P. P. Bedson. After dealing with the inception of this law, its utility as a means of classifying the elements, and the revision of the atomic weights demanded by it, the influence of the discovery of argon, helium, and the allied elements was reviewed, as also the important part that the knowledge of the properties of helium has played in the elucidation of the remarkable properties of radium and other radio-active elements. Some of the speculations as to the composite nature of the elements were described, and allusion was made to the confirmation of such conceptions provided by the investigations of Sir J. J. Thomson on the discharge of electricity through gases. Amongst other matters relating to the elements dealt with in the address are the deductions drawn by the late Lieut. Moseley from the examination of the X-ray spectra of the elements, which make it possible to assign a number to an element, the atomic number, which corresponds with its position in the table of the elements based upon their arrangement in the order of the atomic weights. Further, attention was directed to the remarkable facts brought to light by the investigations in radio-activity, especially the existence of elements which are indistinguishable by chemical properties, yet possess slightly different atomic weights. The concluding section of the address was concerned with some points arising from the work of chemists during the war and the awakening of the public and the Government to the importance of the chemical industries.

Economic Science and Statistics.

In the presidential address to Section F, Sir Hugh Bell reviewed the economic situation brought about by the war. Attention was directed to the extent and nature of the devastation the war has produced and the extinction of vast quantities of the wealth accumulated in the past. He commented upon the light-hearted way in which, not only during the war, but also before its outbreak, the national expenditure had been increased. A distinction was drawn between pre-war expenditure for useful purposes and the absolute waste of the greater part of the war expenditure. The address dealt with the various suggestions which have been made to cope with the situation. It was urged that none of these provides a real remedy which will assist in slowly re-accumulating the wealth which has been destroyed. This, it was contended, is the essential problem of the moment.

Sir Hugh Bell discussed questions of taxation, and distinguished between imposts of a confiscatory character, which are suggested in some quarters, and those which do not fall into this class. He pointed out the difficulties of graduation, though he accepted taxation of this character. He proceeded briefly to sketch the progress of the National Debt for the past hundred years, and to examine the change which has taken place in the foreign investments of the country since the outbreak of war. Claims on the national purse were discussed. The case of housing was dealt with, and also that of the railways. It was urged that both these must be treated from the economic viewpoint, and specially that the railways cannot be allowed to become a charge on the State.

The way in which human activities are applied to production was stated, and an endeavour made to distinguish among these. It was pointed out that the only way in which the desires of various classes can be gratified is by their having something to offer in exchange for these additional gratifications, and the necessity for greater output was insisted upon. Reference was made to the figures disclosed by the Census of Production and the examination of these by Prof. Bowley and Mr. H. G. Williams.

The difficulty of drawing a line between capital and labour was pointed out and the dependence of all classes on capital was stated. Reference was made to the proposals for nationalisation, and the difficulties of any such solution were mentioned. A distinction was drawn between the political freedom acquired within the last hundred years with comparative ease and the economic freedom now sought, which it is maintained will be much less easy to accomplish.

None of the remedies proposed touches the difficulty. We must obtain a larger product if we are to have more to divide. None of the short cuts now proposed will lead us to our goal. Can we convince those most deeply interested of the truth of this? The task is not an easy one, for promises without end are made to accomplish what is desired without pursuing the patient and laborious course which alone can lead to a happy solution.

None of these things can be accomplished by Acts of Parliament. Statutory prices and statutory hours offer no solution—rather increase the evil than lessen it. There is no royal road by which we can travel to a solution. We must by patience and mutual forbearance seek to alter the present hostile attitude.

EDUCATIONAL SCIENCE.

Sir Napier Shaw's address to Section L had for its subject "Educational Ideals and the Ancient Universities." It started from the principle that the character of the education of the country depends upon the ideals which are displayed by the universities, particularly by the ancient Universities of Oxford and Cambridge. It showed that those ideals are confused and indistinct on account of the traditional system of government of the universities and colleges under which the university has no voice in the selection of the students who are to enjoy the privileges of membership. Students are presented to the university by the colleges which hold entrance examinations of their own, or even make use of university examinations for the purpose, while the university itself has no examination for entrance. The control of the university by the colleges impresses the competitive ideal upon the whole system. The position of the university was regarded as being as hard as that of Portia in the lottery of the caskets imposed as a condition by her father's will. The ideals of the universities were reviewed, and found to be splendid so far as the ethical side is concerned, because that depends upon success in fair competition between students and between colleges; but, so far as the intellectual side is concerned, the ideals were found to be vague and unsatisfactory because of the competition between the colleges which is so successful on the social or ethical side. Sir Napier Shaw reached the conclusion that the educational system cannot become ideal until the traditional government is modified in such a way as to give the university, as distinguished from the colleges, more control over its own destiny.

ENGINEERING.

The address of Prof. Petavel to Section G included a brief outline of the part played by engineering during the war and some discussion of the problems involved in industrial and economic reconstruction. The feature of the day is an insistent craving for better and easier conditions of life, and this aim can be attained by increased production. The industrial development obtained during the war by standardisation and systematic organisation, the rapid progress which resulted from the stimulus to research and invention, and the immediate application of the results, indicate the path to be followed. Complete success, however, requires the willing co-operation of all classes of the population, and this can be achieved only if each individual knows that his reward will depend on, and be commensurate with, his efforts.

GEOGRAPHY.

Prof. L. W. Lyde's address to Section E was on "International Rivers," mainly from the political and historical points of view, nearly all international problems to-day being explicitly or implicity dependent on access to the ocean. The word "river" by itself suggests a physical unit, on which a political unit may be appropriate; but the qualifying word "international" suggests regional relations, not local unity. In the United States and Australia it has been found necessary for the Commonwealth to have supreme power over the regulation of the rivers (for irrigation), and no individual State has any local standing or riparian claim against the Commonwealth.

The same principle should hold in Europe for navigation, at least on all important rivers. Freedom of navigation is really dependent on the administration, as has been proved on the Danube between different nations, and on the Rhine between different parts of the same nation, Prussia having persistently hampered the development of other German States. As international rivers are *world*-features, their world-relation is the first consideration, and it demands world-control, *i.e.* control by a body consisting of non-riparian as well as riparian Powers. This is really in the interest also of the *weaker* riparian States, as proved on the Danube.

France has a very honourable record, and Holland a very tarnished one, in relation to the problem. Once on the Rhine, France declared and worked for real freedom of the river—in 1792 and following years; and it was only while France was submerged after 1815 that the good work was undone. Holland was able, meanwhile, to neutralise all the advantages granted by France. By legal quibbles and "voluntary negligence" she has completely crippled Belgian use of the Maas, the Terneuzen Canal, and the Scheldt—showing a pardonable human selfishness, but an unpardonable blindness to her own ultimate advantage.

GEOLOGY.

Dr. J. W. Evans in his address to Section C considered, in the first place, the methods by which the progress of geological research could be promoted most effectively. He emphasised the need for a large and widely distributed body of workers to carry on geological research, and discussed the means by which a wider interest in geology might be stimulated. Dr. Evans thought that much might be done to popularise the work of the Geological Survey. He advocated the issue of cheap colour-printed editions of the 6-in. maps of agricultural as well as of mining areas, with sections on the same scale, which would be more easily understood than maps and sections on smaller scales. A simple explanatory pamphlet should be published for each map, describing briefly and in popular language the meaning of the geological colouring and symbols employed, the nature of the rocks and their relation to agriculture, water-supply, and other economic questions. If these and other measures suggested involved some extra expense, it would be well worth while if it enabled the fullest advantage to be taken of the expenditure incurred in any event by the Survey. Dr. Evans contended that those engaged in genuine geological research should be assisted by concessions in the matter of railway fares. He advocated a systematic underground survey by means of deep borings, and the investigation of the geological configuration of the sea-bottom. The address then discussed in some detail the application of experimental methods to the determination of the conditions under which igneous and metamorphic rocks have been formed. The possibility was also suggested of obtaining further information as to the structure of the earth's crust by means of observations of vibrations originated by artificial explosions, and reflected from subterranean surfaces of discontinuity.

Mathematical and Physical Science.

In his presidential address to Section A, Prof. A. Gray dealt in the main with the utilisation of scientific knowledge and the employment of scientific men in the conduct of the war. He directed attention to the fact that the organisers of the details of our share of the defence against the German attack were without scientific knowledge, and therefore unfitted to counter the assaults of a war machine perfected by decades of hard work in a country where every available agency had been carefully organised to ensure success and victory. Our military chiefs—the War Office Staff and the rest—seemed to have no idea except the naïve and simple one of destroying Germans by rifles, machine-guns, etc., which in point of fact were, to a great extent, non-existent.

Prof. Gray proceeded to describe a scheme of organisation and registration of scientific workers which he believes might have been adopted early in the progress of the war, and still advocates for future eventualities. He then dealt with the entire ignorance of science, apparently even contempt for science, which characterises the statesmen of this country. This he attributes in great measure to our present fashionable but archaic system of education, which takes no account of entirely new provinces of knowledge, and leaves the members of the well-to-do and upper classes quite untrained as regards one side of their minds, and therefore destitute of scientific imagination. Glaring examples of this deliberate neglect of science were cited. The remedy proposed is a radical improvement of our educational system, which ought to be helped and stimulated more by the concerted action of scientific men themselves.

The methods of encouraging and testing inventions during the war were criticised, and a better system was advocated. A strong plea was advanced for an organisation of scientific workers to secure for themselves proper recognition and proper reward for their labour. If care is not taken, a new era of exploitation of the men with ideas will begin, and will be worse than the former one.

The organisation of research was also shortly discussed, and the distinction between industrial and purely scientific research emphasised. The importance of leaving the latter perfectly untrammelled by bureaucratic control was insisted upon

The remainder of the address was devoted to some details of methods of dynamical teaching and with some recent results of physical research.

Physiology.

The president of Section I, Prof. D. Noël Paton, considered the possibility that the guanidin part of the protein molecule exercises a physiological action, just as the amino-acids manifest a physiological action in stimulating the metabolism and increasing the production of heat.

The probable liberation of guanidin from protein and its formation from substances in the egg were considered. The existence of free guanidin or methyl-guanidin in muscle and its physiological action in stimulating the outgoing neurons of the spinal cord and the neuro-myal junctions were dealt with. Its increase in tetania parathyreopriva and in idiopathic tetany with the production of their characteristic symptoms was described.

The fate of the free guanidin or methyl-guanidin was discussed, and the probability of its being detoxicated by synthesis into creatin was supported by the experimental investigations carried out along with Wishart, which showed that the creatin of muscle is increased after intravenous injection of guanidin sulphate. The significance of urinary creatin was then considered in the light of these conclusions. The advantages of studying this on such animals as birds where creatin alone is present were pointed out, and in the light of Prof. Paton's previous work the conclusion was arrived at that, in fasting, the creatin excreted is an index of the breakdown of muscle, and that by considering the creatin excretion along with the excretion of total nitrogen an estimate may be formed of the relative extent to which muscle and other tissues are being disintegrated. The evidence as to the fate of creatin in the normal animal on an adequate supply of carbohydrates seemed to indicate that creatin may again be built into the substance of muscle, that it may act as an anabolite.

Zoology.

The presidential address by Dr. Dixey in Section D began with a brief reference to the effect of the war upon scientific research and upon the estimation in which scientific subjects are held by the general public. It was urged that while the general attention is more easily attracted by the achievements of applied science, the claims of science for its own sake should not be overlooked. A more assured place for scientific subjects in a general education was advocated, and it was suggested that much time might be gained by an improvement in the present methods of instruction; particularly in the teaching of classics.

The main part of the address was devoted to a discussion of certain features of insect mimicry, with especial reference to certain groups of butterflies inhabiting New Guinea and some of the Malayan Islands. The verification of a prediction made fifty years ago by Alfred Russel Wallace was noted, and attention was directed to the geographical element in the phenomena that have to be explained. The parallelism between the respective species of two distinct genera was illustrated and discussed, and instances were adduced of a mimetic form uniting in its own aspect the warning colours, or "aposemes," of two distinct models. Various objections to the theories of Bates and Müller were noticed, and it was contended that the facts at present known are more favourable to an explanation based on the principle of natural selection than to any other as yet offered. It was admitted that this involves the recognition of adaptation as influencing the development of the colour patterns in question, and it was allowed that the pursuit of the "new teleology" may, like other biological speculations, have been here and there carried too far.

The address ended by emphasising the value of scientifically managed collections of insects in their bearing upon biological problems.

NOTES.

WE are informed that the office of Scientific Attaché at the American Embassy is being closed; the question of the closing being permanent or not is, however, under discussion, and it is possible that the office may re-open in the course of a few months. The Scientific Attaché in London has been the representative of the Research Information Service of the U.S. National Research Council, and the Service will in future be glad to receive communications addressed c/o the National Research Council, 1023 Sixteenth Street, Washington, D.C., U.S.A.

WE learn from *Science* that an American Meteorological Society is in course of formation, and that it will be definitely organised at the meeting of the American Association at St. Louis in December next. The purpose of the society is to fill the need for an easy interchange of ideas among those interested in atmospheric phenomena and their effects on man, and thereby to promote instruction and research in these subjects. It is pointed out that these objects may be brought about by general meetings with the American Association and local meetings at other times; by the use of the *Monthly Weather Review* as a medium for the publication of meteorological and climatological articles; and by the issue of a monthly leaflet containing news, announcements, notes, and queries.

No one is better qualified than Lord Walsingham to express the high estimation in which the late Frederick Du Cane Godman was held by all who knew him, whether in his scientific or in his private capacity. The appreciation of his lamented friend, which has been reprinted by Lord Walsingham from the Proceedings of the Entomological Society of London, speaks in fitting terms of the immense service rendered to the systematic study of natural history by the zeal and generosity of Godman. The sixty-three volumes of the "Biologia Centrali-Americana," the whole expense of which was borne by him, is a splendid monument to the labours of this great naturalist and of his friend and associate, Osbert Salvin. All those who were ever in his company will agree with Lord Walsingham that "there was a peculiar charm of personality which pervaded his whole nature; a generous sympathy with all those whose tastes, pursuits, or studies were kindred to his own; a genuine desire to help, encourage, and enlighten their efforts, and to contribute to the objects for which they were striving." It is intended to establish a memorial to Godman in connection with the British Museum, of which he was an active and efficient trustee.

PRIOR to the war the Wireless Society of London appointed an advisory committee to assist the officials of the Post Office in sifting their numerous applications for licences and recommending those which should be accepted. We now learn from the hon. secretary of the society that the offer of the services of the committee has again been accepted in the same capacity. Several questions in connection with the proposed new licences have still to be decided, particularly with respect to transmitting, but we gather that the genuine experimenter and the amateur who is prepared to conform to reasonable regulations may depend upon the society doing all that can be done at the moment to further their interests.

IN the *Queensland Geographical Journal*, issued in a single number for the years 1916–18, Mr. R. H. Mathews describes the ceremony of initiation, known as Dyer-va-val, amongst the Birdhawal Tribe, whose hunting grounds were situated in the north-east corner of the State of Victoria. There are interesting points of resemblance to the similar rite practised by the aborigines of some northern rivers of New South Wales. During the long course of instruction, which began when the novices were separated from their mothers until they were finally recognised as men, they were taught which foods were lawful and which were taboo. On certain occasions they were taken to the place where the women were assembled, when their mothers and other female relatives gave them vegetable food, and authorised them to eat a particular vegetable from that time onward. On another day, the boys were brought up, and the women gave them water in a native vessel, after which they could drink from any stream in the tribal territory.

THE United States National Museum possesses a considerable collection of examples of ecclesiastical art, a catalogue of which has been prepared by the assistant curator, Mr. I. M. Casanowicz, and issued as No. 2287 in vol. lv., Proceedings of the Museum. The pamphlet is something more than a catalogue, as the compiler has collected a considerable amount of information on the subject. He divides the catalogue into: (1) Ecclesiastical Art of the Roman Catholic Church; (2) of the Eastern Church; (3) of the Armenian Church. With this is given a collection of illustrations of the more important exhibits. Much further material, we are told, remains in storage owing to lack of space.

AN exceptionally interesting bionomic study of a group of insects is found in Mr. John J. Davis's "Contributions to a Knowledge of the Natural Enemies of Phyllophaga" (Bull. Illinois Nat. Hist. Survey, vol. xiii, art. 5). This is a genus of chafers which in North America have much the same economic importance as the cockchafers and their allies have in Europe, the adult beetles eating leaves and the larvæ devouring roots. Black digger-wasps (Tiphia) "are without doubt the most efficient and abundant of the many parasites known to attack Phyllophaga," but the Tiphiæ are themselves parasitised by larvæ of bombylid flies. In his elucidation of such life-relations the author gives much information on the structure and habits of parasitic and predaceous insects of various orders. The importance of birds and mammals (including the domestic pig and the notorious skunk) as devourers of the "white grubs" is also illustrated.

THOSE fascinating tunicates, the Salpidæ, form the subject of an important recent memoir by Maynard M. Metcalf (Bull. 100, U.S. Nat. Mus., vol. ii, part 2), who gives anatomical details of the nervous system and musculature in many species, a "taxonomic study" of the whole family, and an interesting discussion on their distribution. He believes that "while the comparative anatomy of the adult tunicata tells us little of the origin of the Doliolidæ and Salpidæ, the comparative study of the manner of budding gives us reason for believing that Doliolum arose from Pyrosoma-like ancestors . . . and that from Doliolum-like ancestors arose the Salpidæ."

A BRIEF systematic paper of exceptional distributional interest has lately been published by Prof. C. Chilton in the *Ann. Mag. Nat. Hist.* (9), vol. iii., pp. 376–386. He identifies specimens of a sandhopper collected at Picton, New Zealand, with Fritz Müller's *Orchestia tucuranna* from South Brazil—a species known to some naturalists not specialists in the Amphipoda through references in Müller's "Facts and Arguments for Darwin," published in 1869. Another South American Orchestia, *O. chiliensis,* had previously been recognised by Prof. Chilton on the New Zealand coasts.

THE U.S. Department of Agriculture has published (Bull. 780) a pamphlet on Nosema-disease in bees by G. F. White, who gives interesting facts as to the resistance of Nosema spores to heat, drying, and other adverse conditions. His observations as to the occurrence of Nosema in North America and its effect on bees that harbour it will be valuable for comparison by workers in these countries, though he believes that "it is not possible to state whether the Isle of Wight disease and Nosema disease [as present in America] are one and the same disorder." He strangely neglects the work of Fantham and Porter on the subject, barely referring to their papers of 1911 (*Proc. Zool. Soc. Lond.*) and 1912 (*Suppl. Journ. Board Agric.*), and ignoring their subsequent publications.

THE Carnegie Institution of Washington has recently published the first volume of a memoir entitled "The Cactaceæ: Descriptions and Illustrations of Plants of the Cactus Family," by N. L. Britton and J. N. Rose. The systematic study of succulent plants, such as the Cactaceæ, is beset by many formidable difficulties. As a consequence, such study is far from general. Fortunately these difficulties have always proved attractive to a select band of workers gifted with that infinite capacity for taking pains which the peculiar exigencies of the case demand. Among early authors who have earned renown in this exacting field we may recall the names of A. P. De Candolle with his artist colleague P. J. Redoute, of Adrian Henry Haworth, and of Prince Salm-Reifferschied-Dyck. The fit, if few, who labour in this particular field to-day include no one whose name is more honoured than that of the veteran Mr. N. E. Brown. The volume now issued as Publication No. 248 of the Carnegie Institution shows that this chosen band of workers has been augmented by the addition of two worthy recruits. Their handsome and craftsmanlike treatise, which deals with the tribes Pereskieæ and Opuntieæ, is illustrated by thirty-six plates, of which twenty-eight are coloured, and by 302 text-figures, many of them reproduced from photographs. The thorough manner in which the attendant difficulties have been overcome by the careful study of type-specimens and original descriptions, by the extensive collection of living and of herbarium material, and by prolonged field-observation, deserves the highest commendation. The excellence of the illustrations and the lucidity of the descriptions render the work one of the most important contributions yet made to the taxonomy and natural history of a family of succulent plants. It should make relatively simple what has hitherto been an exceedingly difficult task to the botanist and to the cultivator. Both should now be able to identify with some confidence many of the cactaceous plants grown in European plant-collections, and to discard from their lists a host of superfluous names which have long encumbered our catalogues. Grower and systematist alike will look forward with keen expectation, and, indeed, with something like impatience, to the appearance of the further volume in which our authors are to deal with the Cereæ, the last of the three tribes that compose the Cactaceæ.

THE Tyndall lectures delivered by Prof. John Joly before the Royal Institution in April, 1918, have now been published in pamphlet form with the title "Scientific Signalling and Safety at Sea." The lectures were devoted to two of the most urgent problems which confront a sailor, viz. the determination of his position upon near approach to the coast, and the means of avoiding collision at sea, when owing to thick weather, fog, or snow visibility is very low. Until recent years the only aids the sailor had were untrustworthy fog-signals, the use of the lead, and the use of his steam-whistle. Sound is conveyed in a very capricious way through the atmosphere. Apart from the effects of wind, which causes sound to carry badly or to be inaudible owing to the noise and uproar around a ship, large areas of silence are often found in different directions and at different distances from a fog-signal station in calm weather. In spite of these circumstances, these time-honoured methods have been of inestimable value. Prof. Joly suggests that the time has now come when the resources of science should be invoked to supplement the older methods. He advocates the use of "synchronous signalling"—this is, the use of signals propagated in different media, but timed so as to start at the same instant. The particular system recommended is the combination of wireless signals with under-water sound signals. Both methods of signalling are practically independent of atmospheric conditions, and have a much greater range than air-borne signals. The difference between their speeds of propagation suffices to determine the *distance* of the source and the use of either a radio-goniometer or a directional hydrophone enables the *direction* of the source to be ascertained. It is pointed out that the necessary wireless apparatus is now available, and, thanks to the efforts of the Submarine Signal Co., efficient under-water signalling apparatus, such as the submarine bell, Fessenden oscillator, hydrophones, etc., are also obtainable commercially. Several interesting applications of the synchronous signalling method are given, and the pamphlet is to be commended to all who have an interest in those who go down to the sea in ships.

SUMMER weather has this year at times proved very disappointing, although August, which is the general holiday month, was for the most part particularly fine. August was the warmest summer month; the mean temperature at Greenwich was 64·9°, which was 6° warmer than July and 4·5° warmer than June. The mean maximum temperature in August was 75·6°, and there were eleven days with the highest day temperature above 80°, whilst in July the thermometer failed to touch 80°, and in June that reading was only attained on four days. The mean temperature at Greenwich for the whole summer was 61·4°, which is 1° warmer than the summer last year and nearly 3° warmer than in 1916. It is 3·4° cooler than the memorable summer of 1911, which was more abnormal than any summer of recent years; when in both July and August the mean maximum or day temperature was 81°. The weekly weather reports published by the Meteorological Office show that the warmest summer weather occurred during the week ending August 16, when the mean temperature was 3° to 5° F. above the normal, and the maximum day readings exceeded 80° over the whole of England. The total rainfall for the three summer months at Greenwich was 6·03 in., which is 0·6 in. less than the normal for sixty years. The wettest month was July with 2·26 in., and in August the fall was 2·20 in. The summer rainfall was 3 in. less than in 1918, and 4·7 in. less than in 1917; it was more than in 1911, 1913, and 1914. In 1903 the summer rainfall amounted to 16·17 in. Rain fell in all on thirty-four days, and of these July had fifteen wet days. The duration of bright sunshine at Greenwich for the three months was 591 hours. July was the least sunny with 119 hours, which is less than one-half of the sunshine in June and very little more than one-half of that in August.

"NEWTON'S Interpolation Formulas," by Mr. Duncan C. Fraser, originally published in the Journal of the Institute of Actuaries, has been issued as a separate pamphlet. It brings together the whole of Newton's work on interpolation by means of formulæ of finite differences. The three main sources are Newton's short treatise, "Methodus Differentialis," a letter written in 1875 to J. Smith, and Lemma No. 5 in Book iii. of the "Principia." These are supplemented by a letter from Leibnitz to Oldenburg (1672–3) and two letters from Newton to Oldenburg to be communicated to Leibnitz (1676). These letters show that Newton was in possession of the methods of calculation many years before 1711, when the "Methodus Differentialis" was first published. Mr. Fraser gives an English translation of the treatise, correcting some errors and adding useful comments. The pamphlet should be in the hands of all interested in the theory of series and in their use for calculation. It demonstrates that Newton at the age of twenty-three had worked out for himself all the methods of computation now in use, with the exception of calculating machines; and the idea of these, we are reminded, originated with Newton's contemporary, Pascal.

PROF. D. E. SMITH has successfully "filled a gap" by writing a booklet on the early history of numbers that will be the delight of the young, and will prove a "mine of interesting information" to many of their elders. Even as a mere "reader" his charmingly written and beautifully illustrated "Number Stories of Long Ago" (Messrs. Ginn and Co., 48 cents) is well calculated to sow the good seed. Where it falls on fruitful soil the results may not indeed be immediately manifest, but may ultimately astonish that large section of the community who hold that all that deals with number is inherently unattractive, or even repulsive, to mortals. The text also contains problems and tricks designed to amuse and instruct. To these a key, "Number Puzzles before the Log Fire," has been issued by the publishers, price 6*d*. Here we find in disguise many friends, both old and new—echoes from Diophantus, Achilles, and the "turtle," down to products of our modern civilisation, such as :—"A man with $1 wanted $1.25. He pawned the $1 for 75 cents, and then sold the pawnticket for 50 cents. Who lost?" Or again :—"In a certain town 3 per cent. of the inhabitants are one-legged, and half of the others go barefoot. How many shoes are necessary?" It is no doubt well for the civilisation of the future that the answer is "As many shoes as there are people in the town."

IN the Journal of the Franklin Institute for July Prof. A. E. Kennelly and Mr. E. Velander describe a new form of rectangular component alternating-current potentiometer which consumes little power and avoids the use of electromagnetic phase-shifting devices. It is constructed on the principle introduced by Larsen in 1910—that is, it measures the alternating potential required by balancing it against the fall of potential down a non-inductive resistance through which an auxiliary alternating current is passing, and a mutual inductance the primary of which is in series with the resistance. The balance is obtained by means of a vibration galvanometer. The mutual inductance consists of forty-one double coils arranged to form a toroid with a wooden core. The resistance is wound so as to be free from inductance and capacitance. The instrument may be used up to a frequency of 2000. During its use by the inventors the importance of reducing the mutual capacitance between the two windings of the inductance coil has been emphasised.

ALTHOUGH the greatest care is used in the selection of wood for the spars of aeroplane wings, it is not always possible to detect the presence of a "pocket" of resin in the place of sound wood-fibre in some important part of a spar. On this account the United States Forest Service has instituted at its laboratory at Madison a series of tests of the effects of such "pockets" on the strength of spars, and the results of the work already done are summarised in an article by Mr. J. R. Watkins in the August issue of the Journal of the Franklin Institute. Spars 6 ft. long of spruce and Douglas fir of I section, with "pockets" of known size in flanges or web, were tested under load against sound spars. A "pocket" 5–6 in. long, ⅛ in. wide, and 1 in. deep in the compression flange diminishes the strength considerably. "Pockets" up to 4 in. long in the tension flange have little effect on the strength, but in the web produce a serious decrease of the strength of the spar in horizontal shear. On the whole, the author concludes that small "pockets" produce effects less than has been supposed.

AMONG the forthcoming science books in the new announcement list of *Messrs. Longmans and Co.* are :—"The Feeding of Nations: A Study in Applied Physiology," Prof. E. H. Starling; "Modern Science and Materialism," H. Elliot; "The Elements of Physics," R. A. Houstoun; "Life in Early Britain: A Survey of the Social and Economic Development of the People of England from Earliest Times to the Norman Conquest," N. Ault, and a new impression of "The Profitable Culture of Vegetables, for Market Gardeners, Small Holders, and Others," T. Smith.

Messrs. Macmillan and Co.'s autumn list of announcements which has just been issued contains many books of scientific interest, *e.g.* "Catalysis in Theory and Practice," E. K. Rideal and Dr. H. S. Taylor; "Alcohol: Its Production, Properties, Chemistry, and Industrial Applications; with chapters on Methyl Alcohol, Fusel Oil, and Spiritous Beverages," C. Simmonds; "Science and Fruit Growing. Being an account of the results obtained at the Woburn Experimental Fruit Farm since its foundation in 1894," the Duke of Bedford and S. Pickering; a new edition—the fourth—of "Mendelism," Prof. R. C. Punnett; "Essays on the Surgery of the Temporal Bone," Sir Charles A. Ballance, with the assistance of Dr. C. D. Green, 2 vols.; "An Introduction to Anthropology: A General Survey of the Early History of the Human Race," Rev. E. O. James; "The Ila-speaking Peoples of Northern Rhodesia," Rev. E. W. Smith; "Among the Natives of the Loyalty Group," Mrs. E. Hadfield; "Through Deserts and Oases of Central Asia," Miss E. Sykes and Sir Percy Sykes; "Implication and Linear Inference," Dr. B. Bosanquet; "The Idea of Progress: An Inquiry into its Origin and Growth," Prof. J. B. Bury; "Mind Energy," Prof. H. Bergson, translated, in collaboration with the author, by Prof. H. Wildon Carr; "Geology of India for Students," D. N. Wadia; "Aircraft in Peace," Dr. J. M. Spaight; "England," edited by F. Muirhead (The Blue Guides); "Highways and Byways in Northumbria," P. A. Graham, illustrated by Hugh Thomson, and a new edition of "The Handbook to Cyprus," H. C. Luke and D. J. Jardine.

MR. F. EDWARDS, 83 High Street, Marylebone, W.1, has just issued an interesting list (No. 393) of some four hundred books, engravings, and original drawings relating to India. While not mainly devoted to science, it contains particulars of many scientific publications, and is worth perusal. We notice that Mr. Edwards has for sale the Sanskrit library of Prof. J. Ebbeling, consisting of about five hundred volumes.

ERRATUM.—On p. 18 of NATURE of September 4, col. 1, line 9, for "m equal to $\pi a^3\rho$" read "m equal to $\frac{4}{3}\pi a^3\rho$."

OUR ASTRONOMICAL COLUMN.

COMET NOTES.—There does not seem to be any reasonable doubt of the identity of Metcalf's comet (1919 *b*) with that of Brorsen. The following were the elements deduced for Brorsen's comet after the former apparition:—

$$T = 1847 \text{ Sept. } 9{\cdot}5427$$
$$\left.\begin{aligned}\omega &= 129^\circ\ 23'\ 17''\\ \Omega &= 309^\circ\ 48'\ 49''\\ i &= 19^\circ\ 8'\ 25''\end{aligned}\right\} 1847{\cdot}0$$
$$e = 0{\cdot}97256$$
$$a = 17{\cdot}7795$$
$$\text{Period} = 74{\cdot}97 \text{ years}$$
$$\log q = 9{\cdot}6883$$

The actual period is 72y. 37d., nearly three years shorter than that formerly taken as the most probable. e and a will need modification in consequence, but $\log q$ will not be much affected.

As new elliptical elements are not yet to hand, the ephemeris has been continued from the parabolic elements given last week.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Sept. 15 ...	12 29 21	52 42	9·9341	9·4396
17 ...	12 17 17	47 36	9·9163	9·4789
19 ...	12 8 36	43 11	9·8979	9·5179
21 ..	12 2 8	39 18	9·8788	9·5560
23 ...	11 57 11	35 52	9·8590	9·5937

The comet will probably be some 24′ south of these positions.

Another comet (1919*c*) was announced in Europe as having been discovered by M. Borelly on August 23. It subsequently appeared that Mr. Metcalf found it a day earlier. Possibly it will be known by their joint names.

Miss Vinter-Hansen and Mr. Fischer-Petersen have deduced the following orbit from observations on August 24, 25, and 26:—

$$T = 1919 \text{ Dec. } 19{\cdot}125 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 176^\circ\ 15{\cdot}61'\\ \Omega &= 110^\circ\ 35{\cdot}08'\\ i &= 47^\circ\ 21{\cdot}24'\end{aligned}\right\} 1919{\cdot}0$$
$$\log q = 0{\cdot}17608$$

Error of middle place (observed *minus* computed) +0·02′, 0·00′.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Sept. 10 ...	14 34 23	19 26		
14 ...	14 41 37	17 44	0·2987	0·3957
18 ...	14 49 5	16 0		
22 ...	14 56 46	14 16	0·2838	0·3918

The magnitude on September 22 is given as 8·7m. It is slowly brightening.

Mr. Burnet desires to point out that in the occultation of a faint star by Jupiter for which his prediction was lately given in this column, the date should read September 14d. 15h., not 15d. 15h. That is, in civil reckoning it is at 3 a.m. on September 15.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A LIMITED number of grants-in-aid to persons employed in chemical works in or near London desirous of extending their knowledge of chemistry will shortly be made by the Salters' Institute of Industrial Chemistry. Applications must be made before September 20 to the Director of the institute, Salters' Hall, St. Swithin's Lane, E.C.4.

THE University of Queensland is seeking for a lecturer of geology to act under the direction of the professor of geology and mineralogy. The appointment is for five years, and the commencing salary will be at the rate of 400*l.* per annum. Applications must be forwarded to reach the Registrar of the University of Queensland, Brisbane, not later than November 15 next. Each applicant must state his age, supply full particulars as to his teaching experience and general qualifications, and furnish certified copies of his certificates and testimonials. A recent photograph should also be forwarded. If not resident in Australia, 50*l.* travelling expenses will be granted to the successful applicant.

THE new session of Battersea Polytechnic opens on Tuesday, September 23, and particulars of all the courses are given in the Calendar of the Polytechnic, obtainable on application to the Secretary, Battersea Polytechnic, London, S.W.11. The courses include the following:—Full day and evening courses in preparation for the University of London Intermediate and Final Degree Examinations (internal and external) in science, engineering, and music; day courses in mechanical, civil, electrical, and motor engineering; architecture and building; chemistry; gas engineering and manufacture; paper-making and wholesale stationery work; mathematics; physics; teachers' courses in domestic science; courses for sanitary inspectors and health visitors, and in art and crafts. Evening courses in mechanical and electrical engineering, mathematics, physics, chemistry, hygiene and physiology, photography, art and crafts, languages, domestic science, music, physical training, and general subjects.

THE report of the Librarian of Congress (U.S.A.), now before us, deals with the fiscal year ending June 30, 1918. The influence of the war on the library at Washington reproduces fairly closely the experience of the libraries in this country. There has been some falling off in accessions due to the closing of the book markets of the world, and also a change in the character of the library work. Workers new to their task have invaded the reference department with inquiries of a novel character which have thrown a great strain upon the energies of a depleted staff, some cases apparently revealing the deficiencies of the library. That again is an experience common to us all. But "the apex of our curve of stress," says the report, "has also shifted from morning to evening and from week-days to Sundays through the presence here of thousands of new Government employees, who can come to us only after their office-hours are over," the average of Sunday readers per hour being three times greater than the week-day average. Thus there is no "early closing" movement in the United States as the result of war conditions. The Oriental division reports that in consequence of the break-up of the European centres of Jewish learning and the increased immigration of Jewish settlers in the United States, Hebrew literature is reviving, and a great strain has been thrown upon the services of the Oriental department by its new *clientèle*. The report is well indexed. When will our Departments take the hint and supply proper indexes to the reports issued under their authority?

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 25.—M. Léon Guignard in the chair.—A. **Lacroix**: Report on the creation of an international council of scientific research by the Conference of the Allied and Associated Academies held at Brussels, July 18–28 last.—G. **Humbert**: The representations of an integer by positive forms of Hermite in an imaginary quadratic body.—G. **Bigourdan**: The work of La Caille, particularly at the observatory of the Mazarin College.—N. E. **Nörlund**: An equation of finite differences.—P. **Lévy**: The notion of the mean in the functional domain.—Ch. **Platrier**: Interior forces in an isotropic homogeneous body in elastic equilibrium.—B. **Baillaud** (telegrams): Two discoveries of comets, one by Metcalf at Harvard Observatory, the other by Borrelly at Marseilles.—M. **Giacobini**: Observations of the Metcalf and Kopff comets made at the Paris Observatory with the east tower equatorial of 40 cm. aperture.—P. **Chofardet**: Observations of the Kopff periodic comet and the Metcalf comet (1919*b*) made with the bent equatorial at the Besançon Observatory.—Ch. **Mangin** and L. J. **Simon**: The preparation of cyanogen chloride by Held's method. Cyanogen chloride can be prepared by the action of chlorine upon the double cyanide of sodium and zinc in nearly quantitative yield.—Ch. **Pussenot**: Remarks on a recent submersion of the coasts of Morbihan.—A. **Guébhard**: The prism formation of basalt.—P. **Parmentier**: Irrigation in Syria and Palestine. A new method of applying water directly to the roots is suggested in the place of the usual methods of irrigation or surface watering. Great economy in water (85 per cent.) is claimed for the method.—Em. **De Wildeman**: *Macaranga soccifera*. A discussion of the relation of this plant with ants.—A. **Paillot**: Karyokynetosis: a new reaction of natural immunity observed in the caterpillars of the Macrolepidoptera.

CAPE TOWN.

Royal Society of South Africa, July 16.—Dr. L. Péringuey in the chair.—Dr. L. **Péringuey**: Bushman engravings. A preliminary account of the author's investigations of various Bushman engravings, and consideration of the theories which may be advanced as to their significance.—Dr. R. W. **Shufeldt**: Comparative study of certain cranial sutures in the primates. The paper is based upon the examination and comparison of several thousand human skulls in the collections of the department of physical anthropology of the United States Natural History Museum and the entire collection of skulls of primates in the divisions of mamals of the same institution.

BOOKS RECEIVED.

Shropshire: The Geography of the County. By Prof. W. W. Watts. Pp. x+254. (Shrewsbury: Wilding and Son, Ltd., 1919.) 2*s*. 6*d*. net.

In the Wilds of South America: Six Years of Exploration in Colombia, Venezuela, British Guiana, Peru, Bolivia, Argentina, Paraguay, and Brazil. By Leo E. Miller. Pp. xiv+428. (London: T. Fisher Unwin, Ltd., 1919.) 21*s*. net.

A Treatise on British Mineral Oil. Foreword by Sir Boverton Redwood, Bart. Editor: J. Arthur Greene. Contributors: E. H. Cunningham-Craig, W. R. Ormandy, and others. Pp. xi+233+viii plates. (London: Charles Griffin and Co., Ltd., 1919.) 21*s*. net.

A Simple and Rapid Method of Tide Prediction (including Diurnal Time and Height Inequalities). By Sgt. M. E. J. Gheury. Pp. 53. (London: J. D. Potter, 1919.) 5*s*.

Mineral Resources of Georgia and Caucasia: Manganese Industry of Georgia. By D. Ghambashidze. Pp. 182. (London: George Allen and Unwin, Ltd., 1919.) 8*s*. 6*d*. net.

A Manual of the Electro-Chemical Treatment of Seeds. By Dr. Charles Mercier. Pp. viii+134. (London: University of London Press, Ltd., 1919.) 3*s*. 6*d*. net.

Secrets of Animal Life. By Prof. J. Arthur Thomson. Pp. viii+324. (London: Andrew Melrose, Ltd., 1919.) 7*s*. 6*d*. net.

Prof. Montgomery's Discoveries in Celestial Mechanics. By L. A. Redman. Pp. 34. (San Francisco: Pernau-Walsh Printing Co., 1919.)

Race and Nationality: An Inquiry into the Origin and Growth of Patriotism. By Dr. John Oakesmith. Pp. xix+300. (London: William Heinemann, 1919.) 10*s*. 6*d*. net.

The Simple Carbohydrates and the Glucosides. By Dr. E. Frankland Armstrong. Third edition. (Monographs on Biochemistry.) Pp. x+239. (London: Longmans, Green, and Co., 1919.) 12*s*. net.

CONTENTS.

PAGE
Zoology and Human Welfare. By Dr. J. F. Gemmill . . . 21
War Gleanings 21
Nervous Disorders: Two Points of View 22
Our Bookshelf 23
Letters to the Editor:—
Luminous Worms.—Rev. S. Graham Brade-Birks . . 23
The National Union of Scientific Workers and Research.—Dr. Harold Jeffreys 23
Wireless Navigation for Aircraft. (*Illustrated.*) By Capt. J. Robinson, R.A.F. 24
Prof. Alexander Macalister, F.R.S. 26
Prof. L. W. King. By H. R. Hall 27
The Bournemouth Meeting of the British Association 28
Inaugural Address by the Hon. Sir Charles A. Parsons, K.C.B., M.A., LL.D., D.Sc., F.R.S., President 28
Summaries of Addresses of Presidents of Sections 36
Notes 40
Our Astronomical Column:—
Comet Notes 43
University and Educational Intelligence 43
Societies and Academies 44
Books Received 44

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THURSDAY, SEPTEMBER 18, 1919.

SCIENCE AND SOCIALITY.

Annals of the Philosophical Club of the Royal Society, written from its Minute Books. By Prof. T. G. Bonney. Pp. x+286. (London: Macmillan and Co., Ltd., 1919.) Price 15s. net.

THE Royal Society is not only our most eminent body of men of science, but also one of the oldest and perhaps the most illustrious of all the learned academies of the world. To be elected into the number of its Fellows has always been regarded by the cultivators of science in this country as one of the highest distinctions to which they can aspire. To "shine in the dignity of F.R.S." was a coveted honour in the days of the "Dunciad," and is in even higher repute to-day. The recent publication of two volumes, however, shows that this "dignity" has from the first been combined with the saving grace of strong social and convivial instincts. The first of these volumes, "Annals of the Royal Society Club" (reviewed in NATURE of August 30, 1917), showed that the philosophers, while they doubtless conducted their scientific investigations and discussions with all the zeal and solemnity credited to them, were at the same time fond of the free, personal intercourse of the dinner-table. In true English fashion, they met in some tavern, and after two or three hours of pleasant talk, adjourned to the meeting of the society; or, if that meeting took place earlier in the day, they dined together after the scientific discussions were over. There is, indeed, some reason to believe that the Royal Society itself may have been actually born in a coffee-house. We know how much Samuel Pepys enjoyed these prandial meetings. It was not, however, until after his time that the choicer spirits formed themselves into a dining fraternity, with formal rules and a limited membership, the president of the society being chairman. They sat down weekly before a portentous bill of fare and with the spirit of true deipnosophists,

> Tried all *hors-d'œuvres,* all liqueurs defined,
> Judicious drank, and greatly daring dined.

Thus arose the "Royal Society Club" in the early part of the eighteenth century. Since then, while one generation has followed another, and Presidents and Fellows in long succession have come and gone, the Club still flourishes more vigorously than ever. It has migrated from tavern to tavern, from the City westwards to the precincts of Burlington House, and has learnt to dine from a less ample and miscellaneous cuisine, now still further retrenched by the war and the high cost of food. Yet it still maintains the hospitality which has always been one of its prominent features.

After the Royal Society Club had lived for rather more than a century, a number of the younger and more actively scientific Fellows of the Society began to be increasingly dissatisfied with the way in which the elections into the membership were conducted, and they put such pressure on the council as eventually to lead to a complete and salutary reform of that and other grievances. These ardent innovators, having purged the Society in 1847, may have thought of directing the tide of purgation into the Club. Any serious change in that social institution, however, even if considered desirable, would not have been easy of accomplishment. The triumphant reformers included in their number some nine members of the Club, but years would obviously have to pass before the rest of the active brigade could obtain admission. Besides, the atmosphere of the Club may have been too close and conservative for the comfort of the innovators, who would not be likely to find there much sympathy with their iconoclastic determination to keep a vigilant eye upon the doings of the council. They accordingly resolved to found a new dining confraternity, which was ultimately named the Philosophical Club, the history of which has now been compiled by Prof. Bonney in the second of the two volumes above referred to.

The aims for which this fresh organisation was created were more ambitious than those of its forerunner, and went much beyond social intercourse among members. In the language of its founders it was meant "to promote as much as possible the scientific objects of the Royal Society; to facilitate intercourse between those Fellows who are actively engaged in cultivating the various branches of natural science and who have contributed to its progress; to increase the attendance at the evening meetings [of the Society]; and to encourage the contribution and discussion of papers." Its numbers were limited to forty-seven, all of whom must be Fellows of the Royal Society and likewise authors of a paper published in the Transactions of one of the Chartered Societies, or of some work of original research in natural science. It was further provided that at least thirty-five of them must be resident within ten miles of the London General Post Office. They dined once a month at half-past five o'clock, and adjourned at a quarter past eight, when they were each expected to attend the meeting of the Society, unless unavoidably prevented. Perhaps the rule which most strongly marked them off from the older club was that which formally excluded all strangers from their meetings, with the exception of scientific foreigners temporarily visiting this country. Thus from the genial hospitality which had always distinguished the Royal Society Club and had been so useful in bringing men of letters, of art, of politics, of the Navy and Army, of public life, and of commerce and industry into contact with the men of science, the Philosophical Club, in its zeal for the prosecution of science, deliberately separated itself. Possibly to make amends for this abnegation of variety from the outside, it was customary for the chairman to invite the members present to make communications to the meeting on any subject of special

D

scientific interest, and the treasurer was instructed to record such communications in the minutes.

The two clubs continued for fifty-four years to live apart and in amity. But the fervid reforming zeal of the younger fraternity, having gained its first object, and having no obvious cause for further activity, gradually slackened. Many Fellows of the Society were members of both clubs, and it slowly dawned upon even the most conservative intellects that the co-existence of two dining clubs in connection with the same society was inconvenient and unnecessary. At last, in the summer of 1901, the Philosophical was formally incorporated with the Royal Society Club.

The "Annals" of the older corporation having been published in the summer of 1917, it was unanimously decided that the history of the younger fraternity should also be put into the more durable form of print, and that the task of compiling the narrative should be entrusted to Prof. Bonney, who happened to be the oldest surviving member of the dissolved club. It required no little courage to undertake this labour, and the veteran professor deserves the best thanks of the united Club and of the public for having accomplished it. His volume of "Annals of the Philosophical Club" is divided by him into two sections. The first of these, dealing with the business done at the meetings, in chronological order from the beginning to the close, shows from year to year the organisation and work of the club, the gradual disappearance of the old members and the advent of their successors. To the minutes that record these particulars the editor has added a short but adequate biographical notice of each of the new members.

The second and more interesting and important section contains the reports of the verbal "communications" made at the meetings, in chronological order, from May 6, 1847, when the institution was fairly started on its career, down to the time of the amalgamation of the two clubs. It was these communications which gave its distinctive character to the Philosophical Club, and it was well that this feature of its existence should be faithfully recorded. Prof. Bonney must have had difficulty in choosing how best to deal with them. He finally decided to place them all together by themselves in his second section, keeping them in chronological order under the dates of the successive meetings at which they were made. He has given us the whole available material, and has evidently treated it with the most patient care, taking infinite pains to verify and illustrate the text. Nevertheless, as a matter of convenient and effective arrangement we venture to think that it would have made the book more attractive had the two sections been fused into one continuous narrative—in other words, had the "communications," instead of being divorced from the account of the business meetings, been inserted, where they were actually made, after the business. At many meetings there was no business, and no mention of these meetings was required in section i. of the volume, but on turning to section ii. we may find for the same year a succession of meetings recorded, at which various communications were made. Thus the whole doings of the club in the year 1867 are comprised in eight lines in the first section, while in the second section reference is made to seven meetings in that year, each marked by communications which occupy in all four pages of the volume. Again, the business transacted in 1869 is summed up in two short lines, while in the second section the communications made at no fewer than eight meetings in that year cover three pages. We feel that the intercalation of these statements and discussions in the account of the more formal business would have gone far to relieve the narrative of the history of the club in section i., which, save for the editor's luminous little biographies, is confessedly of only limited interest.

Section ii. forms a truly remarkable record of the after-dinner talk of a body of the foremost men of science of our time. The topics mentioned or discussed range over the whole realm of Nature, from the centre of the earth to the furthest nebula. We are let, as it were, into the private study or the laboratory of the scientific worker; we are permitted to hear the earliest outlines of a discovery from the lips of the man who made it; we seem to be in the highest or inner council of science, listening to the words of its most trusted leaders. The entries are sometimes provokingly brief, yet so interesting that had one been there the temptation would have been great to ask the speaker to go on, or to request the treasurer to report the communication in full. The whole collection of communications is an amazing *olla podrida*, to be read only in little snatches at a time, and bearing somewhat the same relation to the speakers and their audience that the crushed and faded flowers of a herbarium do to their beauty as they lived. The perusal of it, however, cannot but impress on the reader a profound respect for the Philosophical Club and a conviction that this club must have been an institution of great scientific driving power and that when it was amalgamated with the Royal Society Club it introduced fresh healthy blood into the older corporation. Its "Annals," therefore, well deserved to be compiled, and the volume in which Prof. Bonney has told the story will take its place among the permanent records of the progress of science in the nineteenth century.

ARCH. GEIKIE.

BOTANY OF CULTIVATED PLANTS.

The Botany of Crop Plants. A Text and Reference Book. By Prof. W. W. Robbins. Pp. xx+681. (Philadelphia: P. Blakiston's Son and Co., 1917.) Price 2 dollars net.

IN the prefatory words of the author, "the issuance of this book has been stimulated in part by the expressed need . . . for a text or reference book which will give the student a knowledge of the botany of common orchard, garden, and field crops. . . ." A text-book which achieved this object would be indeed a boon, for, with the exception of Percival's "Agricultural Botany," we know of no book which treats of economic plants in such a way as to expound the principles of botanical science and to provide knowledge directly useful to the person interested in the cultivation of food crops.

The method adopted by the author is to give a rapid exposition of botanical principles—histological, physiological, genetical, and morphological—in the course of sixty-seven pages, and then to treat in some detail the series of crop plants of field, garden, and orchard.

This method is open to the fatal objection that it evades the first duty of the teacher, which is so to select and present common facts that the essential generalisations, which cohere them into a scientific system, either suggest themselves to the student's mind, or, at all events, appear natural and convincing when the teacher, as is often the case, is compelled by the defectiveness of his method, or the indifference of his students, to expound them.

Instead of attempting this the author is content to hand out the usual stock of botanical facts. He begins by talking about undifferentiated plants and a thallus (p. 1), tells the student in p. 2 that the tendril of a pea is morphologically a leaf, and a potato tuber a modified stem, when, of course, the duty of the teacher is to promote the discovery by the student of these facts, and thereby to stimulate interest, illustrate morphological principles, and train the eye and mind to see essential things.

Histology is dealt with in chap. ii. in six pages, and the student is told sundry facts—that leucoplasts and chloroplasts exist, that protoplasm is a "proteid" and that it feels slimy, that the cell-wall may contain lignin, suberin, cutin, and pectin. Even in the general introduction it is evident that the mind of the writer is set on the "practical" economic part which is to come later. Thus (p. 25) he asserts as a general truth that many new varieties of fruit are bud varieties, that a certain branch on a tree is seen to possess peculiarities, and that it is taken off and propagated as a new variety. A more misleading statement, if intended to be of general application, it would be hard indeed to make. It would be interesting to know what variety of apple, pear, plum, currant, raspberry, or gooseberry is known to have arisen by bud variation!

Part ii., which consists of nearly 600 pages, contains much useful information with respect to the botany of cultivated plants. Members of the Gramineæ—cereal and other—are treated of at length and well, though from the teacher's point of view the work is too full for a text-book, and not full enough for a work of reference—for example, Mendelism is dealt with in half a page (p. 421), and, needless to say, the few words devoted to this all-important subject are not adequate to impress the student with the value of this method of genetical research.

The book contains much miscellaneous information which may perhaps interest the American student—that 44 million pounds of dried apples were produced in the United States in 1909, and that in 1915 more than 230 million bushels of apples were produced in that country; but, so far as may be discovered, nothing is said on the fascinating subject of pruning, which might, if scientifically treated, be the means of illustrating many important principles of physiology. Excellent as is much of the matter which it contains, this volume does not, in our opinion, give agricultural and horticultural teachers or students what they want—a new presentation of botanical principles based on the study of those plants among which they have to work. F. K.

OUR BOOKSHELF.

Practical Pyrometry: The Theory, Calibration, and Use of Instruments for the Measurement of High Temperatures. By E. S. Ferry, G. A. Shook, and J. R. Collins. Pp. vii + 147. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 7s. net.

The subject of pyrometry, so important nowadays in many industrial processes, is not as yet overburdened with literature of the text-book description. The present volume contains in a small compass most of the information required for an intelligent understanding of the principles and instructions as to the correct methods of manipulation of pyrometers, including the mathematical theory. Descriptions of historical interest only, with which such books are often burdened, are omitted, and the subject-matter is well chosen to give helpful instruction.

A separate chapter is devoted to each of the four principal types of pyrometer—namely, the resistance, thermo-electric, radiation, and optical pyrometers—with a preliminary chapter on the standard temperature scales. The best chapter in the book is that on optical pyrometry; the principles and construction of the various varieties are very clearly described and in a more thorough manner than is usual in text-books.

Exception might be taken to the omission of some of the simpler forms of pyrometer, such as the water pyrometer and the mercurial expansion and sentinel types. These appeal to many manufacturers, especially where great accuracy is not required, and guidance as to their use would therefore be acceptable.

The book is written for three classes of readers—college students, technically trained men who deal with processes requiring high-temperature measurements, and less trained observers who may make the measurements. To this end the more mathematical portions, such as Foote's mathematical investigation of cold junction error, and the more mathematical treatment of optical pyrometers, might with advantage have formed separate appendices for particular study, rendering the text clearer for the less technical reader.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Sea-fishery Investigations and the Balance of Life.

The impression that Prof. McIntosh's address, published in Nature of July 3 and 10, must leave upon the minds of readers unfamiliar with the history and progress of sea-fishery research must be that there has been a great deal of misdirected energy during the past fifteen or twenty years in the attempt to gain control of the output of the sea by the application of science to sea-fishery problems. If, as Prof. McIntosh still maintains, the prodigality and bounty of Nature mock all human efforts to modify the natural course of events in the sea for good or ill, it becomes surely a national duty to oppose all further applications for national expenditure upon sea-fishery investigations. As this, judging from his concluding paragraph, is not the aim which Prof. McIntosh has in view, it seems desirable to inquire a little more closely into the basis for his views, and to give at least the broad outlines of the superstructure of knowledge which has been reared above the basis of that fundamental work of his own, which has been a source of legitimate pride to himself as of appreciation by his successors and colleagues.

I think it will be conceded that the leading features of Prof. McIntosh's expressed views are, broadly speaking, as follows:—(1) The fecundity of sea-fishes is so great, and the ultimate food-supply for the fishes themselves is so completely independent of human influence that the idea of exterminating any species of food-fish—or even of seriously diminishing its total numbers—by intensive fishing is chimerical; (2) so long as man fails to make any serious impression upon the multitudes of young fishes, there is no need for anxiety; (3) no serious inroad upon the numbers of young fishes has hitherto been made; (4) therefore all is well, the fears of the pessimists are pointless, the claims of the optimists are established.

As Prof. McIntosh and "J. J." have been good enough to assign me the *rôle* of arch-pessimist, I may as well clear the ground by the remark that, when I approached the study of sea-fishery problems twenty years ago, the dominating question was: Is the practice of sea-fishing affecting the yield of the fishing grounds, or is it not? It was a case of *absolute stability* versus *depletion or impoverishment.* When, therefore, I find a tendency to re-define the question as being one of *slight deterioration* versus *extinction,* I demur. If I am to be dubbed a pessimist, that word must be understood to mean a person who, twenty years ago, urged that the "bottom fisheries" were not in a stable condition, not "holding their own," but showing clear signs of progressive impoverishment; and this was explained as meaning that "the rate at which sea (food) fishes multiply and grow, even in favourable seasons, is exceeded by the rate of capture" ("Impoverishment of the Sea," p. 8).

Passing on to points (2), (3) and (4), and restricting myself to plaice, as a test-case, the following quotations from Prof. McIntosh's recent articles are relevant:—"Plaice have been taken from the North Sea from time immemorial, and yet are *distributed* to-day over its entire area, while their tiny young swarm on every suitable sandy or muddy beach" (i., p. 356); "the removal of the larger fishes by intensive fishing is the rule, but the gaps thus made *are filled later* by the swarms of the smaller" (p. 357); "The idea that the North Sea can be fished out is chimerical, for even if all were gone over thrice or more frequently a year, such *could not produce depletion or exhaustion* of its fisheries—plaice included" (ii., p. 377); and, *à propos* of the International Council's findings with regard to the plaice question: "In other words, all that can be said is that the plaice are not less numerous, but . . . they are smaller—*a finding which leaves the plaice* in safety" (*l.c.*).

Putting these ideas together, it is plain that Prof. McIntosh regards the progressive diminution in the available numbers of the larger fish as negligible, and the continuous lowering of the average size as of no significance, so long as there are plenty of little fishes on the beaches. He ignores the evidence that the rate of growth of these little fishes and their rate of emigration to the offshore grounds no longer keep pace with the rate of capture. He treats the over-fishing problem as one of reproduction and numbers to the exclusion of rate of capture, rate of growth, and actual size attainable.

Apply this principle to agriculture, and consider what our meat-supply would be if the farmers killed all their cattle as calves except the minimum breeding stock necessary to keep up the number of—calves; or if, when thinning their turnips, they had regard, not to the production of the greatest possible weight, but merely to the production of that minimum number of mature plants which should give them seed sufficient for the next sowing!

Prof. McIntosh asks: "Where have the melancholy anticipations of the pessimists been demonstrated; where has the serious diminution of any food-fish occurred; where have the principles enunciated in 'The Resources of the Sea' been traversed by the International Fisheries Council?" (i., p. 355). The answer to the open mind is "on every page."

And what are the practical conclusions of "vigorous optimism"? "Let the authorities and the public place implicit confidence in the resources of the ocean and the ways of Nature therein" (ii., p. 378); "Be vigilant in guarding the national trust!" (*l.c.*). One may well ask of what comfort is the "marvellous plenitude and endurance of the sea-fishes" if they become measurably smaller year by year, or the "prodigality of Nature in their vast abundance and variety" if codlings are to represent cod, and plaice and lemon soles be replaced by dabs and long-roughs. And does "vigilance" consist in ignoring the plainest evidence accumulated by other people, while we sing hymns of praise to Pan or Poseidon? Let us turn now to the superstructure.

The qualitative basis of sea-fishery science, to which no one contributed more effectively than the veteran professor at St. Andrews, already shows the outlines of a quantitative structure upon it. Some of these outlines are still mere scaffolding, but the broad features of the building are discernible.

The idea of boundless prodigality, with its "chains of life" from diatoms to fishes, is not the end but the beginning. It is being steadily replaced by the conception of a balance or equilibrium of life, the two sides of which are the world of plant-life and small invertebrates on the one hand, and the world of fish-life on the other. The former has hitherto been beyond the influence of man, though subject to fluctuations in its total quantity in consequence of annual fluctuations of temperature, sunshine, and similar factors known to influence plant production, and, indirectly, the invertebrate and small vertebrate forms immediately dependent for subsistence upon the former. The fish-world, on the other hand, while undergoing annual and cyclical fluctuations in quantity depending on those of the plant side, is also subject to the influence of man's fishing operations. These do not necessarily diminish the total yield of fish: on the contrary, they are probably powerless to affect the general balance, so far as total productivity is concerned. But the elimination of the larger fishes favours the survival of increasing numbers of the small, since the stock of food remains practically unchanged, while the enemies and competitors of the small are progressively reduced. It follows that the total *numbers* of the young of a given species may be appreciably *increased* as a result of fishing operations, through the progressive diminution of their infantile mortality.

Thus while the total quantity (weight) of the fish-side of the balance of life probably remains constant, its character may deteriorate sensibly. This deterioration is manifested not merely in the substitution of large numbers of small fish for smaller numbers of large fish of the same species, but also in the increasing survival of relatively small and worthless species which partly fill the gaps made by the progressive elimination of their larger competitors, *e.g.* dabs and long-rough dabs in lieu of plaice and lemon soles. Signs of this aspect of deterioration have been noticed in many areas, *e.g.* the Scottish bays, the Devon bays, Dogger Bank, etc.

In the case of plaice, the young of which are restricted to the coastal margins, while the adults range freely within 30 fathoms or so, the general tendency of intensive fishing is (*a*) to deplete the total density of plaice on the offshore grounds, and (*b*) to increase the number of small plaice along the shores. Thus large areas offshore have been opened up for the multiplication and growth of relatively worthless dabs, while the increasing accumulations of the young inshore have set up conditions of over-crowding, impoverished growth, and delayed emigration to the offshore waters.

The growth of a quantitative science of fish-life is thus tending to the production of a co-ordinated body of knowledge capable of deductive application to special practical and administrative problems. The continued growth of this knowledge is of the first importance for the development of the sea-fisheries. Without it administrators are at the mercy of every passing cry and excited agitation; with it, they will be enabled not merely to estimate more accurately the value of particular suggestions, but themselves to inaugurate a new era in the rational exploitation of the hitherto untamed forces of the sea. It should be needless to add that the value of particular investigations will have to be judged in future, not from the point of view of the mere resourcefulness of the sea, but from consideration of the extent to which they furnish means for intelligently controlling it. Walter Garstang.

August 27.

"Impoverishment" dies hard, and there is much glamour around it. My able friend, Prof. Garstang, commenced his campaign by showing that the great increase in the number of boats was accompanied by a diminished catch in each, and that, therefore, there were fewer fishes to catch than formerly, a view which did not survive publication. His modified "Balance of Life" will not rescue the Council from its responsibility on the question of "impoverishment."

The idea of gaining control of the "output" of the sea, as in a mine or quarry, is a novel way of dealing with the ponderous remit from the Government.

Prof. Garstang, like the Council, stakes his position on the plaice, an old tale, and one which is not proven. Large plaice do not frequent, as a rule, the areas of the smaller, and therefore the size is often a question of locality. For generations the same North Sea bay, as, for instance, St. Andrews, will produce the same sizes of plaice. Besides, adult plaice are not caught napping when they see a trawl coming: hence the well-known increase of the catch at night.

The "measurably smaller fishes year by year" probably refers to the boxes at Grimsby and other ports, an uncertain basis for generalisations. Again, are the herrings, gadoids, gurnards, mackerel, breams, wolf-fishes, and frog-fishes, the turbot, soles, and dabs, getting smaller year by year? It is a mistake to aver that dabs and long-rough dabs have anywhere usurped the areas of the "vanished" plaice.

No possible comparison can be made between human agencies in the hands of the farmer (*in re* cattle and turnips) and the ways of Nature in the sea. Such would not even fit the seals and the whales. The native farm-weeds, such as "quicken" and "knot-grass," are sufficient to illustrate Nature's powers.

The facts given in the "Resources of the Sea" (a second edition of which is ready for the press), stand in little need of a "superstructure or co-ordinated body of knowledge capable of deductive application to special administrative problems."

Truly, every encouragement is needed for scientific fisheries researches in marine laboratories and elsewhere. W. C. McIntosh.

DR. A. G. VERNON HARCOURT, F.R.S.

By the death of A. G. Vernon Harcourt, on August 23, in his eighty-fifth year, there has passed away a chemical teacher endeared to many generations of Oxford students, a singularly skilful experimenter, and a pioneer in the new domain of physical chemistry. He was one of the first who planned experiments to enable him to follow the course of a chemical change, to measure the velocity of a reaction, and to study the conditions that determine it; he rebelled against the idea that chemists had to concern themselves only with the preparation of new substances and the elucidation of their properties—for him the interesting thing was *how* the change happened, not what was the result.

Starting with Brodie, first as his pupil and then as his assistant, Harcourt began his researches with the exact determination of the oxygen absorbed by the metals potassium and sodium—allowing air to enter slowly into a flask containing the pure liquid metal heated in an atmosphere of nitrogen. In this first paper one can see that it is the initiation and progress of the oxidation that interest him. "Soon after the dry air has begun to mix with the nitrogen, the grey film which covers the molten metal changes to a deep blue; the surface gradually becomes roughened by little wrinkles and projections, and a moment arrives when a single spluttering spark appears at one point and a dust of white oxide rises. . . . At the point where the spark appears the blue crust becomes white, and this change passes in a moment over its whole extent."

In 1859 Harcourt was elected Lee's reader in chemistry and a senior student of Christ Church, but it was not until some years after his appointment that he began his work in the Lee's laboratory. Meanwhile he had started those researches on the rate of chemical change which—in conjunction with those of Berthelot in France and those of Guldberg in Norway—were to establish on a quantitative basis Berthollet's law of mass action. In the interpretation of his results Harcourt was associated with William Esson, whose special mission in Oxford seemed to be—as the writer knew him—to illuminate mathematically the obscure records of chemical velocities. Harcourt and Esson first studied the reaction between oxalic acid and potassium permanganate in acid solution. They found that the rate of change varied with the amount of manganous sulphate formed, and that the reaction was probably *nil* in the complete absence of manganous salt; but, once started, the velocity would increase to a maximum and then slack off—the curve representing the course of the change having a point of contrary flexure. They liken their curves to those obtained by Bunsen and Roscoe in the course of photochemical induction—thus suggesting that the "inductive period" in the union of hydrogen and chlorine was due to the action of another substance, a suggestion which finally was proved to be correct. Seeking for a less complicated reaction, Harcourt found that in dilute solutions hydrogen peroxide decomposed hydrogen iodide with velocities that could be easily followed, and the amount of change could be accurately ascertained. The method of carrying out the experiment in a stream of carbon dioxide, and the device by which the iodine liberated was reconverted into iodide by the successive additions of exactly equal drops of concentrated thiosulphate, show Harcourt at his best as an experimenter. The time-intervals between the successive appearances of the iodine proved that the velocity of the change varied directly with the quantities of each of the reacting substances—when the other conditions were kept constant. The rates found, however, do not prove that the change is necessarily a trimolecular one as Harcourt supposed:—

$$H_2O_2 + 2HI = 2H_2O + I_2.$$

The change most probably takes place in two stages, each of which is di-molecular; but, one stage being much faster than the other, the observed rates follow the simple law.

In studying the effect of temperature on the rate of this reaction Harcourt and Esson arrived at a zero of chemical action in wonderful agreement with the absolute zero calculated from physical data.

Harcourt was so strongly convinced that chemical change followed mechanical laws that his laboratory became a centre where the experiments of Bunsen and his school on "chemical induction" and "sprungweise" explosions were repeated and criticised.

Harcourt's work as one of the metropolitan gas referees led him to take up the investigation of sulphur impurities in coal gas and to design a new standard of light—the Pentane standard. His method of converting carbon disulphide into the easily removed hydrogen sulphide has only recently been adopted on a large scale in the South Metropolitan Gas Works through the energy and skill of Dr. Carpenter, but its success seems assured. The 10-candle Pentane lamp is not only the official British standard, but also as a practical unit is not approached by the German amyl acetate lamp.

Few men have been so completely happy in their work, or lived so much in the lives of their students. The writer, whose good fortune it was to fall under his influence at Oxford, has to acknowledge that he owes his career to Harcourt's affectionate interest and to his example.

H. B. D.

DR. CHARLES A. MERCIER.

It is not possible to give, in a few words, more than a mere indication of the value of the late Dr. Mercier's scientific work. With a rare, natural capacity for clear thinking, as well as for acquiring and retaining knowledge, he was a master of luminous and logical expression in speech and writing. These qualities inform all his many and various works, whether of purely scientific or mainly literary nature. Some of his books deal with the practical aspects of his professional speciality—insanity—such as the management of asylums, instructions to nurses, etc.; and others, like his essays on "Temperaments," treat of psychology and conduct for the general reader, as well as for the expert. But the main works, on which his reputation will rest, are scientific studies of the nervous system in health and disease, and include specially the whole subject of the causes, conditions, and expressions of mental action, normal and morbid. He was, as a student, much influenced by the writings of Herbert Spencer, and by the personal teaching of Dr. Hughlings Jackson, and their influence is seen in many of his works; but no less evident is his originality of thought, as especially seen in some of his more recent publications, which indicate strongly a marked change of attitude towards the so-called "Lamarckian" doctrine of biological evolution to which at first he strongly adhered. Like his two chief teachers, he made much use of the deductive step in reasoning, but he did not often fail to verify his conclusions by further evidence before adopting them. Judged from the scientific viewpoint, some of his most important works—*e.g.* on the "Nervous System and the Mind," on "Psychology, Normal and Morbid," and those dealing with insanity, may be considered as holding the highest rank among books of this kind, and as at least equal in value (though greatly differing in certain respects) to the now classical works of the late Dr Henry Maudsley, his illustrious senior and contemporary, on the "Physiology and Pathology of Mind," "From Organic to Human," "Body and Mind," etc.

Dr. Mercier's work, "The New Logic," has not pleased some professorial logicians, but, as a handbook of logical reasoning for scientific students, it is of great value. Nor does it appear that his criticisms of the prevalent logic of the schools have been materially shaken, or that his acute comments on Mill's "Canons of Induction" have ever been refuted. His two important books on "Criminal Responsibility" and "Crime and Criminals" are written with much knowledge and careful thought, and form together one of the most notable contributions in the English language to the psychology of criminals and to the nearly allied subject of criminal jurisprudence.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

BEFORE the delivery of Sir Charles Parson's presidential address to the British Association last week, Sir Arthur Evans, the retiring president, announced that it was proposed to present an address to the King. The announcement was received with much satisfaction, and the address, which is as follows, was enthusiastically approved :—

Your Majesty,—On the occasion of the outbreak of the great war we, the members of the British Association for the Advancement of Science, at that time assembled in our eighty-fifth congress, gave an unanimous expression to our devoted loyalty to your Majesty's person, which your Majesty was graciously pleased to acknowledge.

To-day, once more assembled in our eighty-seventh congress, it is our heartfelt desire, on the victorious conclusion of the war and the formal proclamation of peace, to renew those assurances, and to express in more than a formal manner our high sense of the example of self-sacrificing devotion to the service of the country that has been so simply offered by your Majesty throughout this long and arduous struggle.

We are painfully aware, indeed, that, in spite of the decision in the field, the period of stress is by no means over. We cannot, from our special point of view, be blind to the extent to which the bitter emergencies of war-time have been prejudicial to those ideas and methods which it is our mission to promote. But in the not less arduous struggle that lies before us to regain the stable paths of peace we are heartened by the knowledge that the same wise and conciliating influence and high example that was of such sovran help to the British people in war-time will still be with them.

In vacating the presidential chair Sir Arthur Evans referred to the unprecedented period of three years during which he had occupied it, and he added :—

Let it at once be said that, though the public meetings of the association have been suspended, its organisation was constantly directed, at times in conjunction with other bodies like the Royal Society, towards rendering active assistance to the Government of our country in its hour of need. This has been the case, not only in fields of activity such as chemistry and engineering or the conservation of fuel and other economic objects—in matters, that is, that had a more direct bearing on the emergencies of the struggle—but I think I may say, to a greater or less degree, in every section of our body.

That expert assistance, as we know, has not always been welcomed by the powers-that-be. The dire necessities of war-time have led to rough-and-ready expedients altogether foreign to scientific method, and often conflicting with the most elementary knowledge. On every hand we see improvised controls as unscientific as they are arbitrary. We witness the constant overriding of expert experience by a new-fangled bureaucracy. At every turn we are met with a mischievous interference with natural laws and the perpetuation of uneconomic devices under conditions that no longer even palliate them. Though formal peace has been proclaimed, we are confronted by an evil heritage of war, and at no time has the British Association had more urgent occasion to inculcate those scientific methods and ideas by which alone the country can hope to regain its equilibrium.

The attendance at the meeting numbered nearly 1500, which is about the same as that at Manchester in 1915, and must be regarded as very satisfactory after so long an interval since the last assembly at Newcastle, where the attendance was only 826. A noteworthy point of the Bournemouth meeting was the large attendances in all the sections, several of which were uncomfortably filled on more than one occasion. This is a sign both of activity and interest, and it suggests that most of those who attended the meeting this year are concerned directly or indirectly with the advancement of science. In this, as in other respects, the meeting differed somewhat from those of former years, and marked a promising beginning of a new era.

A Committee appointed by the Council reported upon various matters relating to the working of the Association, and the report was adopted with slight changes by the General Committee. The fee for new life members is to be 15*l.* instead of 10*l.*, and for annual membership 1*l.* 10*s.* instead of 1*l.*, the right to receive the annual volume being included in both cases. The class of associateship has been abolished. The General Committee decided that after the Cardiff meeting next year, which will be held from a Tuesday to the following Saturday, the old plan of meeting from Wednesday to Wednesday shall be followed. When the Association was founded the meetings began on Wednesdays because the old stage coaches took about a couple of days to bring members to them from other towns, but though this condition no longer holds good there was a general feeling that the week-end break which a Wednesday to Wednesday meeting gives has advantages from the point of view of social intercourse, and that the Association could profitably revert to it. A preferable plan would be to consult the Local Committee as to which of the two periods—Tuesday to Saturday or Wednesday to Wednesday—would best suit the town and district in which a meeting was being arranged instead of laying down a hard-and-fast rule for all meetings.

The question of the position of the Association as regards grants for scientific research was raised in the report of the special Committee referred to, and was discussed at a meeting of the General Committee. During its existence the Association has voted from its funds more than 80,000*l.* to its research committees, and it is scarcely too much to say that every pound of this large sum has been well expended. The grants are allocated each year by the Committee of Recommendations, which usually consists of the presidents and recorders of the various sections, together with the general officers. Every research committee has thus to present its case for support to an expert body of adjudicators which frequently devotes several hours to dividing up the 1000*l.* or so available at the end of each meeting into grants of 5*l.* and upwards for research committees put forward by the sectional committees. It has been suggested that in view of other claims upon the revenue of the Association the funds devoted to purposes connected with research should be more closely limited to incidental expenses inasmuch as other funds are now available to assist research itself. However this may be, the principle by which men of science themselves allocate grants in aid of research, as they do at a British Association meeting, is generally accepted to be the best, whether the funds are their own contributions or are entrusted to them for research purposes. The Association is, therefore, to continue the present system by which grants are allocated by the Committee of Recommendations, but the list of grants so made is afterwards to be submitted to the Department of Scientific and Industrial Research, which will select subjects it can support, and will relieve the Association of the financial obligations relating to such subjects.

It remains to be seen whether this method will provide the most effective link between the Department and the Association. A joint Committee, consisting of four members appointed by the General Committee, and four by the Council, is to inquire into the whole matter of the existing provision of grants in aid of scientific research and the organisation of research. No change in the Association's method is contemplated, but there is a feeling that a useful purpose would be served by a survey of what is now being done to promote research through grants in aid by various societies and other bodies, the methods by which such grants are allocated, and the conditions to be fulfilled by the recipients.

Next year's meeting is to be held at Cardiff under the presidency of Prof. W. A. Herdman, who has been succeeded as general secretary by Prof. J. L. Myres. An invitation to meet in Edinburgh in 1921 was unanimously accepted by the General Committee. The new members of the Council of the Association are: Prof. A. Fowler, Dr. E. H. Griffiths, Prof. A. W. Kirkaldy, and Dr. W. H. R. Rivers.

SECTION A.

MATHEMATICAL AND PHYSICAL SCIENCE.

OPENING ADDRESS BY PROF. A. GRAY, M.A., LL.D., F.R.S., PRESIDENT OF THE SECTION.

I HAVE devoted some little time to the perusal of the addresses of my predecessors in this chair. These have a wide range. They include valuable philosophical discussions of the nature of scientific knowledge and expositions of scientific method, as well as highly instructive *résumés* and appreciations of the progress of mathematics and physics. But as this is the first meeting of the British Association since the conclusion of peace, I have decided to disregard in the main these precedents, and to endeavour to point out, in the first place, some of the lessons which the war has, or ought to have, taught our country and those who direct its policy, and in particular ourselves, whose vocation it is to cultivate and to teach mathematical and physical science.

Before proceeding with this task I must refer to the loss which physical science and the British Association have suffered this year through the deaths of Prof. Carey Foster and Lord Rayleigh. Both these great physicists were regular in attendance at the meetings of the association, and they will be greatly missed.

What Carey Foster was as a man of science, as a teacher, and as a friend of all students of physics has been worthily set forth in the columns of NATURE with all the knowledge and affectionate reverence of one who was at once his pupil and his fellow-worker at University College. To that eloquent tribute I will not, though I knew Carey Foster well, venture to add a word.

It is not for me to appraise here the work of Lord Rayleigh. But I may say that for something like half a century his name has stood, not only for things that are great in physical discovery, but for sanity of judgment and clarity, elegance, and soundness of treatment of outstanding and difficult problems of mathematical physics. His researches, too, in experimental science have been fruitful in results of the utmost importance in chemistry as well as in physics. With him there was no shirking of the toil of monotonous and systematic observation from day to day in the pursuit of the greatest attainable accuracy; take, for example, his work on electrical units. But his influence on applied mathematics has also been enormous, and places him for all time in the foremost rank of the great physical mathematicians, at the head of which stands Isaac Newton. One has only to read his treatise on "The Theory of Sound" and his papers on optics and wave theory to find some of the most striking examples in all scientific literature of the working of a mind, not only of the first order of originality, but imbued with a feeling for symmetry of form and clearness of exposition.

Lord Rayleigh's genius was, it seems to me, essentially intuitive and practical. Though he was not given to any striving after the utmost rigidity of formal proof—which, as he himself remarked, might not be more but less demonstrative to the physicist than physical reasons—no man made fewer mistakes. He is gone, but he has left an inspiring example to his order and to his countrymen of a long life consecrated to the object for which the Royal Society, of which he had been the honoured president, was founded: the furtherance of natural knowledge.

The part which physical science has played in the conduct of the war on our side has been an important one, but it has by no means been so decisive as it might and ought to have been. And here lie the lessons which I think we can draw from the terrible events which have taken place. Some few people, mostly hostile to or jealous of science, whose vision of facts and tendencies seems to me to be hopelessly obscured by prejudice, would try to impose on the advance of natural knowledge and the supposed increased influence of scientific ideas on the minds of men, or, perhaps more precisely, on the diminution of the study of the so-called humanities, the sole or the main responsibility for the outbreak of war.

It seems to me that a good many people allow themselves to be misled by a name. The name "humanity" is given in the Scottish universities to the department of the Latin language and literature, and in a wider usage the study of Latin and Greek is referred to as that of *litterae humaniores*. But I am not aware that there is any more humanity, in the common acceptance of the term, about these studies than there is in many others. And experience has shown that the assertion that these studies have a special refining influence, while the pursuit of science has a brutalising tendency, is based on ignorance and partiality. The truth is that the man who knows nothing of science, and he who has neglected the study of letters, are both imperfectly educated.

Well, the accusation I refer to may be dismissed without argument. This is certainly not the time or the place for a discussion of the causes of the war, or of the ethics of the extraordinary methods introduced into warfare by our enemies. But one thing I will say in this connection. Even poison gas is innocent in itself, and it occurs as a product in perfectly indispensable and eminently useful chemical processes. The extraordinary potency of scientific knowledge for the good of civilised mankind is frequently conjoined with a potency for evil; but the responsibility for an inhuman use of it does not lie with the scientific investigator. The guilt lies at the door of the High Command, of the high and mighty persons, themselves in feeling and temper utterly unscientific, who approved and directed the employment of methods of attack which destroyed the wounded and helpless, and wrecked for ever the health of many of those who emerged alive from the inferno.

As regards the help which British science was able to render in the defence against the German attack and the operations which followed when the fortune of war changed so dramatically, and the enemy was driven back towards the chain of fastnesses from behind which he originally emerged, one or two obvious reflections must have occurred to everyone. In one form or another these have been referred to by various writers, but I may recall one or two of them; for as a people we are incorrigibly forgetful, and appear to be almost incapable of profiting from experience, which, according to the Latin proverb, teaches even fools.

Nearly twenty years ago the urgent necessity for the reorganisation of our military machinery had been, in the view of civilians at least, who had to bear the cost of the war in South Africa, demonstrated *ad nauseam*, but nothing of real importance in the way of reforming the War Office seems to have been done. The shocks we had received were forgotten, and soon the nation returned to its insular complacency, the old party cries resounded in the market-place, the hacks of party politics again resumed their occupation of camouflage and hoodwinking, and the country drifted on towards its fate.

All this time an enormously powerful war machine was being built up on the Continent, and its different parts tested so far as that could be done without actual warfare. The real object of these preparations was carefully veiled by an appearance of frankness and professions of goodwill, though it was revealed every now and then by the indiscretions of the German military caste. To these indications and to others the country, ostrich-like, closed its eyes.

Now it is often alleged that men engrossed in the pursuit of science are unbusinesslike, but I think that if there had been any truly scientific element in the *personnel* of the Government (there never is by any chance), attention would have been directed at a much earlier period to our hopeless state of unpreparedness for the storm which was gradually gathering against us on the other side of the German Ocean. In discussions of our unpreparedness the emphasis has been placed on our lack of arms and munitions. But important as these are, the entire absence of a scientific organisation to guide us in the exigencies of a defensive war with the most scientific and most military nation of Europe was even more serious.

It is this deficiency in our organisation—a deficiency the avoidance of which would have had no provocative effect whatever—which concerns us here very specially. It is, moreover, a deficiency which, in spite of the lessons they have received, has, I fear, not yet been brought home to our military chiefs. When war broke out nothing had been done to ensure the utilisation for special service, in the multitude of scientific operations which war as carried on by the German armies involved, of the great number of well-trained young scientific men available in the country. The one single idea of our mobilisers was to send men to the trenches to kill Germans, and for this simple duty all except certain munition workers and men in the public services were summoned to the Army. Some modifications were made afterwards, but I am speaking of the failure of prevision at the outset. The need of men for special service, the inevitable expansion of the Navy for patrol and other purposes and the like, were, if they were thought of at all, put aside, without regard to the difficulties which would inevitably arise if these matters were delayed. Even how the new soldiers were to be trained, almost without rifles or machine-guns, to meet the Germans in the field nobody knew. And I for one believe that but for the vigour and energy of Lord Kitchener, and the almost too late expression of conviction of our danger, and consequent action, by one outstanding politician, all would have been lost. We worried through, but at a loss of life and treasure from which it will take us long to recover, and which I could wish seemed to weigh more heavily on the minds and consciences of politicians.

The Germans, I believe, had a complete record, not only of all their men fitted only for the rank-and-file, but also of all who had been trained to observe and measure. For the use of even the very simplest apparatus of observation a certain expertness in reading graduated scales, and generally a certain amount of trained intelligence, is required. For this the laboratories of Germany amply provided, and the provision had its place in the enemy's mobilisation. Our people apparently did not even know that such a need existed or might arise.

In a letter which I sent to the council of the Royal Society at the end of 1915 I ventured to propose that the Royal Society might set on foot an organisation of some such character as the following:—First, a central committee should be established, in some degree representative of the different centres of scientific teaching and work in pure and applied science. Then this committee should nominate representatives at each centre, at least one at each university or college, and one at the headquarters of each local society, such, for example, as the Institution of Engineers and Shipbuilders of Scotland and the similar society which represents the North-East of England and has its offices at Newcastle-upon-Tyne. This arrangement, it was hoped, would enable the central committee to obtain readily information as to what men were available, and would therefore do something to bring the schools of science, and all the great workshops and laboratories of applied science, into co-operation. Thus could be formed at once a list of men available for particular posts, for the task of solving the problems that were certain to arise from day to day, and for the special corps which it was soon, if dimly, perceived were a necessity. Some such linking-up of London with the provinces is really indispensable. The districts of, for example, the Tyne and the Clyde are too much ignored in almost all Government action of a general kind.

My letter was printed and sent out to some prominent men, by whom its proposals were highly approved. A conference on its subject was held in London, and two special committees were appointed. I was a member of one of these, the principal duty of which was to provide scientific men for special service. It included representatives of the various great departments actively engaged in the conduct of the war. For some reason or other, which I never learned, the committee after a week or two ceased to be called, and I believe that little was done in comparison with what might have been accomplished. It was certainly not because such a committee would not work. Everybody was most willing, with proper notice, to attend such meetings as were involved, and to take any amount of personal trouble; moreover, the scheme was such as to provide that there should always be a nucleus of members in London to consult and act in any emergency.

I may briefly refer to one or two examples of the chaos which prevailed and the attempts that were made to cope with it. Very soon after the formation of the first Kitchener Army the organisation of the different corps apparently became a source of anxiety to the War Office. It began to be seen that officers in sufficient numbers could not possibly be obtained by the usual channels, so the expedient (a poor one by itself) was hit upon of placing the nominations to commissions in one at least of the two great scientific corps of the Army—the Royal Engineers—in the hands of the presidents of certain technical institutions which have their headquarters in London. These gentlemen, with the help of the official secretaries, no doubt did the best they could, but a very regrettable, though perfectly natural, amount of strong feeling was evoked among the young scientifically educated men in the provinces, who were keenly anxious to join this corps. The Engineers, I may scarcely say, is no refuge for men who are in the least concerned about their personal safety, for the percentage of casualties among engineers on active service was notably higher than in the regiments of the line. Over and over again young engineers came to me and complained that under the arrangements made they had no chance of obtaining commissions or of qualifying as cadets, and begged me to write to the authorities. Of course, young graduate engineers do not, as a rule, join societies such as the Institutions of Civil, Mechanical, or Electrical Engineers until they have made their way to some little extent and begun to earn a little money.

The procedure I have indicated had in time to be relaxed, but such a central committee as I suggested, with antennæ stretching out to the educational and technical centres of the country, would, I am sure, have recruited the Engineers quickly with the best possible material for officers to be found in the country, to the satisfaction of all concerned. It may be said that full information regarding every man in the country was in the hands of the authorities. In a sense, this was true; the information existed in millions of returns and thousands of pigeon-holes, but no attempt was made, or could be made, by office staffs in London, enormous as these quickly became, to digest and utilise it.

A large number of engineers and physicists and many others of mechanical skill and aptitudes found congenial occupation in the Royal Naval Air Service and the Royal Flying Corps; but even there, where things could be better done, since a new force had to be brought into existence, arrangements were to a considerable extent haphazard and ill thought out. Excellent self-sacrificing service was rendered by many who risked and gave their lives, and of what was done we may well be proud. But from a scientific point of view there is room for great improvement. The hasty and ill-considered —as I think—amalgamation of these two branches of the Air Service, in which naval traditions were sacrificed to those of the War Office, which deserved no such deference, will certainly have to be undone in the near future or very greatly transformed. To anyone who considers the possibilities and probabilities of warfare in the future, it appears clear that this country will have to depend more and more upon its Navy, and that an Air Service Corps will be the companion of every division of our Fleet, with landings on the warships. Thus a new and highly scientific Service, which will have to be to a great extent naval, will be brought into existence.

Well, then, to return for a moment to my proposal to the Royal Society, why should the organisation which I suggested in 1915 not be established now? I wish all success to the League of Nations, but we shall prove ourselves even greater fools than we have been in the past if we do not use all possible means to prepare ourselves against eventualities. One attempt by our enemies outside our own borders to hold us to ransom has failed. Can we be so sure that no other attempt will ever be made, or that no *casus belli* between ourselves and another great nation will ever arise? This, I notice, is beginning to be assumed even in the midst of the welter of confusion and unrest that exists, and, among others, by just the very people who used to teach that the possibility of war was a great illusion.

The formation of a record of scientific graduates for special service ought not to be difficult. The material already in great measure exists. Each university and college has its roll of graduates or diploma-holders; and with slightly more detailed entries these rolls would give the record. Each graduate of a university is kept track of through the necessity for keeping the electoral roll up-to-date, and it ought to be possible to devise a means of maintaining touch with the diploma-holder. If each university or college were a local centre of the central committee, the making of the roll of graduates would be achieved at the different local headquarters, and would be a valuable supplement to the O.T.C. work now undertaken so willingly and done so well. The Government machinery which manages the O.T.C. movement might control the keeping of the register which I have suggested.

I turn now to another side of scientific work during the war. It was my lot to serve for nearly three years on the Inventions Panel of the Ministry of Munitions, and as the result of that experience I venture to make some observations on the utilisation of scientific knowledge and genius in the production of inventions useful for the public service. We had an enormous multitude of inventions to consider, and the Panel was divided into Committees for this purpose. For each invention or proposal a file or *dossier* was prepared and most carefully kept. There were also present at the meetings of the Panel very efficient officers representing different branches of the Service. Everything received careful attention, and for the ability and fairness with which the initial examination was made by the corps of examiners, and the *précis* of the invention presented, I have great admiration. Much has been said about the inefficiency and the mistakes of various Government Departments during the war. The Ministry of Munitions Inventions Department was, so far as I could see, eminently well managed.

Many of the so-called inventions were not inventions at all. Some were not at all new; in other cases an idea only was mooted. Could so-and-so not be done? and so on, and the Department was supposed to be grateful for the idea, and to do the rest, besides rewarding the proposer. A favourite notion, which illustrates the diffusion of scientific knowledge among different classes of people, was that of taking a magnet—any magnet—up on an aeroplane, and using it to attract Zeppelins and other aircraft. Others suggested electromagnets fed by machines which would have involved carrying into the air on an aeroplane a fully equipped power-house! Another favourite notion, inspired, no doubt, by a certain sensational type of article in the fiction magazines, was that of rays charged in some way with electricity, or some other mysterious agency, and therefore intensely destructive.

But there was a residuum of valuable inventions which fully justified the existence of the Department. These were recommended for further consideration by the various departments of the Services or by General Headquarters. It by no means followed that all that came to this stage received careful further consideration. Everybody was very hard worked, and many were overdriven. And it was by no means certain that when important approved appliances were sent to G.H.Q. a thoroughly well-informed and capable officer would in all cases have the duty of explaining and showing their action. The absence of such an officer, I am sure, often resulted in delay and serious error, and, I fear, also in the rejection of what was in itself exceedingly good, but was not understood. People who knew nothing about the matter took charge, and ordered things to be done which brought disaster to the apparatus. I know of one very important machine which was ruined, with much resulting delay. A brigadier or major-general with a confidence born of blank ignorance ordered a motor-generator to be put on town electric mains, and, of course, burnt it out.

Then, again, we were told that G.H.Q. did not want this or that, and here, as in all human affairs, mental inertia certainly played a considerable part. The willingness, however, of some Departments to adopt at once a device captured from the enemy was pathetic. Often quite clumsy and relatively inferior contrivances were adopted in the midst of hesitation about our own. Anything German of this sort some people assumed must be good—a foolish idea, the result of want of confidence, often well founded, I am afraid, in their own judgment. It is legitimate to copy from the enemy, and in several important things we have not been slow to do so.

The delays that occurred were to some of us at home, who were anxiously dealing with all kinds of contrivances, exceedingly exasperating. Some were undoubtedly unavoidable, but others were, as I have indicated, far otherwise. Deficiency in scientific education was the cause. It is to enforce the need for such education that I refer to such matters at all. The "playing fields of Eton" are all very well. I for one do not scoff at what the old saying stands for, but scientific laboratories and good intelligent work in them are indispensable. A man who directs in whole or in part a great machine must know something of its structure and capabilities.

I feel bound to allude to another aspect of the inventions business which, to my mind, was very serious. In doing so, however, I wish it to be clearly understood that I am criticising a system, and in no way here referring to particular individuals concerned in its administration. Various inventions which had passed satisfactorily the first examinations by responsible judges were submitted to technical departments at home to be subjected to practical tests. These inventions were frequently proposed solutions of problems on which technical officers, of the departments required to conduct the tests, had long been engaged. It was natural, indeed inevitable, that some of these officers should have come to regard the solving of these problems as their own special job, and so did not much welcome the coming of the outside inventor. Then, no doubt, they often felt that they were just on the point of arriving at a solution—a feeling that certainly could not facilitate the avoidance of delay. It was manifestly most unfair to ask them to judge the work of the outside inventor, or to place in their hands details of his proposals, for exactly the same reason which in civil life restrains a man from acting as a juror in a case in which he is personally interested. Nobody of good sense feels offended when attention is directed to such a rule in practice.

Thus I have no hesitation in expressing the opinion that a testing board of practical, well-qualified physicists and other experts, with a properly qualified staff, should be formed for the purpose of carrying out all tests of inventions. No insuperable difficulty would, I believe, be experienced in forming such a board. It should be formed carefully, not by more or less casual nomination of one another by a few persons. Expert knowledge of a subject should be a necessary qualification; the so-called "open mind" of the much-lauded but untrained practical man is not worth having. But on that board neither inside nor outside inventors of the same kind of appliances should have any place, though, of course, consultation with the author of an invention under test would be absolutely necessary. Also those actually carrying out the tests and those collating the results should not be men in any way in the employment of, or under the supervision of, inventors, whether "outside" or "inside." It is imperative in the interests of the country that delay in such matters should be avoided, and that all such work should be done without fear or favour.

The value of university and college men trained in science has been thoroughly proved in the Artillery, the Engineers, and in their offshoots, the Special Sound-ranging and Survey Corps, though its recognition by the authorities of Whitehall has been scanty and grudging. Some of the old-fashioned generals and staff officers could not be got to see the use of men who had not been trained to field exercises by a long course of drill. What is the good of officers, they said, who are not skilled leaders of men? This is the old crude idea again of destroying Germans with rifles, bayonets, and hand-grenades. The falsity of these antiquated notions has now, I believe, been amply demonstrated.

The objection to these men, however, lies a good deal deeper. Even those scientifically educated officers who came into the new armies when they were formed, and were trained by the service of years of warfare superadded to the initial course of drill, have been demobilised in a nearly wholesale manner, without the least regard to even very exceptional qualifications. Many of these were, it seems to me, the very men who ought, above all, to have been retained in the Service. Now (though, as I write, improved regulations are being issued) they are to a great extent to be replaced by the public school-*cum*-Sandhurst young gentlemen, who, it appears, are the "pukka" officers *par excellence*.

The old system of the rule of politician chiefs whose only or main function is to sign the edicts of heads of departments seems to have returned in full force, and the coming of the cleansing Hercules that many people desire for the War Office does not seem to be within the bounds of possibility.

The real cause of the prevailing neglect of science, with all its pernicious results, is that almost all our political leaders have received the most favoured and fashionable form of public school education, and are without any scientific education. An education in classics and dialectics, the education of a lawyer, may be a good thing—for lawyers; though even that is doubtful. For the training of men who are to govern a State the very existence of which depends on applications of science, and on the proper utilisation of available stores of energy, it is ludicrously unsuitable. We hear of the judicial frame of mind which lawyers bring to the discussion of matters of high policy, but in the majority of scientific cases it is the open mind of crass ignorance. The result is lamentable; I myself heard a very eminent counsel declare in a case of some importance, involving practical applications of science, that one of Newton's laws of motion was that "friction is the cause of oscillations"! And the helplessness of some eminent counsel and judges in patent cases is a byword.

As things are, eminence in science is no qualification; it would even seem to be a positive disqualification for any share in the conduct of the affairs of this great industrial country. The scientific sides of public questions are ignored—nay, in many cases our rulers are unconscious of their existence. Recently in a discussion on the Forestry Bill in the House of Lords a member of that illustrious body made the foolish assertion that forestry had nothing to do with science; all that was needed was to dig holes and stick young trees into them. Could fatuity go further? This hereditary legislator who, as things are, has it in his power to manage, or mismanage, the conversion into available energy of the radiation beneficently showered on a certain area (his area) of this country of ours does not seem to be aware that the growing of trees is a highly scientific industry; that there are habits and diseases of trees which have been profoundly studied; that, in short, the whole subject of sylviculture bristles with scientific problems, the solutions of which have by patient labour been to a considerable extent obtained.

Take also the case of the dyes industries. The publicists and the good business men—the supermen of the present age—who wish to control and foster an industry which owes its very existence to an English chemist, refuse to have on the committee which is to manage this important affair any man of scientific eminence, and no remonstrance has any effect. These great business men are, as a rule, not scientific at all. They are all very well for finance; in other respects their businesses are run by their works-managers, and, in general, they are not remarkable for paying handsomely their scientific assistants.

I myself once heard it suggested by an eminent statesman that an electrical efficiency of 98 per cent. might by the progress of electrical science be increased fourfold. This, I am afraid, is more or less typical of the highly educated classical man's appreciation of the law of conservation of energy; and he is—save the mark!—to be our Minister or Proconsul and the conservator of our national resources. It is not surprising, therefore, that in connection with a subject which for several weeks occupied a great space in the newspapers, and is now agitating a large section of the community, the nationalisation of our coal-mines, there was not a single word, except perhaps a casual vague reference in the report of the chairman, to the question which is intimately bound up with any solution of the problem which statesmen may adopt—I mean the question of the economic utilisation, in the interests of the country at large, of this great inheritance which Nature has bestowed upon us. In short, are Tom, Dick, and Harry, if we may so refer to noble and other coalowners, and to our masters the miners, to remain free to waste or to conserve at their own sweet will, or to exploit as they please, this necessity of the country's existence?

The fact is that until scientific education has gone forward far beyond the point it has yet reached, until it has become a living force in the world of politics and statesmanship, we shall scarcely escape the ruin of our country. The business men will not save us; as has been said with much truth, the products of modern business methods are, to a great extent, slums and millionaires. It lies to a great extent with scientific men themselves to see that reform is forthcoming; and more power to the British Science Guild and to any other agency which can help to bring about this much-needed result.

While scientifically educated men, whether doing special work or acting as officers, have been held of far slighter account in the Services than they ought to have been, for physicists as such there has been little or no recognition, except, I believe, when they happened to be ranked as research chemists! How did this happen? Why, the various trades asserted themselves, and the result was a sufficiently long list of "reserved occupations"—a list remarkable both for its inclusions and for its exclusions. There was, for example, a class of "opticians," many of whom have no knowledge of optics worth mentioning. They are merely traders. One of these, for example, the proprietor of a business, made a plaintive appeal to myself as to how he could determine the magnifying powers of certain field-glasses which he wished the Ministry of Munitions to purchase. But for a young scientific man, even if he were an eminent authority on theoretical and practical optics, but who was not in the trade, there was no place.

Research chemists received their recognition in consequence of the existence of the Institute of Chemistry. I am extremely glad to find that something is now being done to found an Institute of Physics. I hope this movement will be successful, and that it will be thoroughly practical and efficient. I hope its president and council, its members and its associates, will be jealous for science, and especially for physics. It ought to be a thoroughly hard-working body, without any frills, destitute of work value. They have an example in the General Medical Council, which has so effectively cared for the interests of the medical profession.

I am glad that something is being done at last for the organisation of scientific research. This movement has started well in several, if not in all, respects, and I wish it all success. There are, however, one or two dangers to be avoided, and I am not sure—I may be much too timid and suspicious—that they are fully recognised, and that the result will not be too much of a bureaucracy. Somehow or other I am reminded by the papers I have seen of the remark of a poor man who, asking charity of someone in Glasgow, was referred to the Charity Organisation Society of that city. "No, thank you," he said; "there is a good deal more organisation than charity about that institution." So I hope that in the movement on foot the organisation will not be more prominent than the science, and the organisers than the scientific workers.

There is, to my mind, too much centralisation aimed at. Everything is to be done from London;

a body sitting there is to decide the subjects of research and to allocate the grants. There may be a good deal to be said for that in the case of funds obtained in London. But apparently already existing local incentives to research work are to be transferred to London. The Carnegie Trust for the Universities of Scotland, soon after its work began, inaugurated a scheme for research work in connection with these universities. The beneficiaries of the Trust, it is well known, must be students of Scottish nationality. The action of the Trust has been most excellent, and much good work has been done. Now, so far as chemistry and physics are concerned, it has been proposed, if not decided, to hand over to the organisation in London the making of the awards, a process of centralisation that will probably not end with these subjects. I venture to protest against any such proceeding. The more incentives and endowments of research that exist and are administered in the provinces the better. Moreover, this is a benefaction to Scottish students which ought not to be withdrawn and merged in any provision made for the whole country, and administered in London by a bureau which may know little of the Scottish universities or of Scottish students. The bureau might, with equal justice or injustice, be given command of the special research scholarships of all the universities both in England and Scotland, and administer them in the name of the fetish of unification of effort. I do not know, but can imagine, what Oxford and Cambridge and Manchester and Liverpool would say to that. But even Scotland, where of course we know little or nothing about education of any kind, may also have something to say before this ultra-centralisation becomes an accomplished fact.

There is, it seems to me, another danger to be avoided besides that of undue centralisation in London. In most of the statements I have seen regarding the promotion of research work, the emphasis seems to be on industrial research—that is, in applied science. This kind of research includes the investigation of physical and chemical products of various kinds which may be used in arts and manufactures, and its deliberate organised promotion ought to be a commercial affair. I observed, by the way, with some amusement, that according to the proposals of one committee for applied science, which is prepared to give grants and premiums for researches and results, the professor or head of a department, from whom will generally come what are most important, the ideas, is to have no payment. He is supposed to be so well paid by the institution he belongs to as to require no remuneration for his supervision of the committee's researches. And the results are to be the sole property of the committee!

There is in this delightfully calm proposal at least a suggestion of compulsion and of interference with institutions and their staffs which ought to be well examined. Also some light is thrown on the ideas of such people as managing directors of limited liability companies, who are members of such a committee, as to what might reasonably be expected of men of high attainments and skill whose emoluments taken all round are, on the whole, miserably insufficient.

I think that it is in danger of being forgotten that, after all, pure science is by far the most important thing. Most of the great applications of science have been the products of discoveries which were made without any notion of such an outcome. Witness the tremendous series of results in electricity of which the beginning was Faraday's and Henry's researches on induction of currents, and the conclusion was the work of Hertz on electric waves. From the first came the production and transmission of power by electricity; from the last the world has received the gift of wireless telegraphy. I am not at all sure whether the great men who worked in the sixty or seventy years which I have indicated would have always received grants for proposed researches, which to many of the good business directors and other supermen serving on a great bureau of investigation, had such then existed, would have appeared fantastic and visionary. In research, in pure science at least, control will inevitably defeat itself. The scientific discoverer scarcely knows whither he is being led; by a path he knows not he comes to his own. He should be free as the wind. But I must not be misunderstood. Most certainly it is right to encourage research in applied science by all available and legitimate means. But beware of attempting to control or "capture" the laboratories of pure science in the universities and colleges of the country. Let there be also ample provision for the pursuit of science for its own sake; the return will, in the future as in the past, surpass all expectation.

I had intended to say something about scientific education as exemplified by the teaching of physics. I have left myself little time or space for this. I cannot quite pass the matter over, but I shall compress my remarks. In the first place, I regard dynamics, especially rotational dynamics, as the foundation of all physics, and it is axiomatic that the foundation of a great structure should be soundly and solidly laid. The implications of dynamics are at present undergoing a very strict and searching examination, and now we may say that a step in advance has been taken from the Newtonian point of view, and that a new and important development of dynamics has come into being. I refer, of course, to the new theories of relativity which are now attracting so much attention. I hope to learn from the discussions, which we may possibly have, something of the latest ideas on this very fundamental subject of research. It is a matter for congratulation that so many excellent accounts of relativity are now available in English. Some earlier discussions are so very general in their mathematical treatment and notation as to be exceedingly difficult to master completely. I have attacked Minkowski's paper more than once, but have felt repelled, not by the difficulties of his analysis, but by that of marshalling and keeping track of all his results. Einstein's papers I have not yet been able to obtain. Hence it is a source of gratification to have Prof. Eddington's interesting report to the Physical Society and the other excellent treatises which we have in English. But continual thought and envisaging of the subject is still required to give anything approaching to instinctive appreciation such as we have in ordinary Newtonian dynamics. I venture to say that the subject is pre-eminently one for physicists and physical mathematicians. In some ways the new ideas bring us back to Newton's point of view as regards so-called absolute rotation—a subject on which I have never thought that discussions of the foundations of dynamics had said absolutely the last word. I, for one, still cling to the æther, and am strongly of opinion that the whole subject of æther and matter and electrons require much more complete physical treatment than it has yet received from relativists.

The better the student of physics is grounded in the older dynamics, and especially in the dynamics of rotation, the sooner will he be able to place himself at the new point of view, and the sooner will his way of looking at things begin to become instructive.

With regard to the study of physics in our universities and colleges, I had written a good deal. I have put that aside for the present, and will content myself with only a few general observations. First, then, it would, I think, be conducive to progress if it were more generally recognised that dynamics is a physical subject, and only secondarily a mathematical one. Its study should be carried on in the departments of physics, not in those of mathematics or in separate departments of applied mathematics. It is, or ought to be, essentially a subject of the physical lecture-room and the physical laboratory. The student should be able to handle rotating bodies, to observe and test the laws of precession and nutation—to work himself, in a word, into an instinctive appreciation of at least the simpler results of rotational theory. He should learn to think in vectors, without necessarily referring either to Hamilton or to Grassmann. Some people appear to censure the use of vector ideas without the introduction at the same time of some form of vector notation. I do not feel drawn to any system of vectors in particular—all have their good points, and in some ways for three-dimensional work the quaternion analysis is very attractive—but vector *ideas* are of the very utmost importance.

Hence I deprecate the teaching, however elementary, which as a beginning contents itself with rectilineal motion. The true meaning of rate of change of a directed quantity, even of velocity and acceleration, is missed, and instead of having laid a foundation for further progress the teacher, when he desires to go beyond the mere elements, has practically to relay his foundations; has, in fact, to extract imperfect ideas from his pupils' minds and substitute new ones, with the result that a great deal of avoidable perplexity and vexation is produced. The consideration of the manner of growth of vectors—the resultant vector or it may be component vectors, according to convenience—is the whole affair. As an illustration of what I mean, take this:—A vector quantity has a certain direction, and also a magnitude L. It is turning in a certain plane with angular speed ω. This turning causes a rate of production of the vector quantity about a line in that plane and perpendicular to the former, and towards which the former is turning, of amount $L\omega$. Thus a particle moving in a curve with speed v has momentum mv forwards along the tangent at the position of the particle. The vector is turning towards the principal radius (length R) of curvature at the point at rate v/R. Hence towards the centre of curvature momentum is growing up at time-rate mv^2/R.

Dealt with in this way, with angular momentum instead of simple momentum, the motions of the principal axes of a rigid body give the equations of Euler instantly and intuitively, and all the mind-stupefying notions of centrifugal couples and the like are swept away.

With regard to mathematics, the more the physicist knows the better, and he should continually add to his store by making each physical subject he takes up a starting-point for further acquisition. Some very philistine notions as to mathematics prevail, and are very mischievous. For example, I once heard an eminent practical engineer declare that all the calculus an engineering student requires could be learned in an hour or two. This is simply not true, nor is it true, as some exponents of ultra-simplicity seem to suggest, that the professional mathematical teacher wilfully makes his subject difficult in order to preserve its esoteric character. Like the engineer or physicist himself, he is not always so simple as he might be; but the plain truth is that no good, progressive mathematical study can be carried out without hard and continued application of the mind of the student to the subject. And why should he depend on the mathematical reader? Let him be his own teacher! There are plenty of excellent books. If he has a determination to help himself he will, if he makes a practice of reserving difficulties and returning to them, find them vanish from his path.

As I have said, I am specially interested in rotational dynamics. In the course of the war I have been appalled by the want of appreciation of the principles of this subject which, in spite of considerable acquaintance with the formal theory, seemed to prevail in some quarters. I do not refer to mistakes made by competent people—it is human to err—but to the want of appreciation of the true physical meaning of the results expressed by equations. A gyrostat, as ordinarily considered, is a closed system, and its dynamical theory is of a certain kind. But do away with the closedness, and the dynamical theory is quite a different affair. Take, as an example, the case of two interlinked systems which are separately unstable. This compound system can be made stable even in the presence of dissipative forces. A certain product of terms must be positive, so that the roots of a certain determinantal equation of the fourth degree may all be positive. The result shows that there must be angular acceleration, not retardation, of the gyrostat frame. This acceleration is a means of supplying energy from without to the system, the energy necessary to preserve in operation the functions of the system.

I have ventured to think this stabilising action by acceleration of the compound motion very important. It is lost sight of by those who consider and criticise gyrostatic appliances from the usual and erroneous point of view. Also, I believe that it is by analogy a guide to the explanation of more complicated systems in the presence of energy-dissipating influences, and that the breaking down of stability or *death* of the system is due to the fact that energy can no longer be supplied from without in the manner prescribed for the system by its constitution.

I had just concluded this somewhat fragmentary address when the issue of NATURE for July 24 came to hand, containing a report of Sir Ernest Rutherford's lecture at the Royal Institution on June 6. The general result of Sir Ernest's experiments on the collision of α-particles with atoms of small mass is, it seems to me, a discovery of great importance, whatever may be its final interpretation. The conclusion that "the long-range atoms arising from the collision of α-particles with nitrogen are not nitrogen atoms, but probably charged atoms of hydrogen or atoms of mass 2," is of the utmost possible interest. The α-particle (the helium atom, as Rutherford supposes it to be) is extraordinarily stable in its constitution, and probably consists of three helium nuclei each of mass 4, with two attached nuclei of hydrogen, or one attached nucleus of mass 2. The intensely violent convulsion of the nitrogen atom produced by the collision causes the attached nuclei, or nucleus, to part company with the helium nuclei, and the nitrogen is resolved into helium and hydrogen.

It seems that, in order that atoms may be broken down into some primordial constituents, it is only necessary to strike the more complex atom with the proper kind of hammer. Of course, we are already familiar with the fact that radio-active forces produce changes that are never produced by so-called *chemical* action; but we seem now to be beginning to get a clearer notion of the *rationale* of radio-action. It seems to me that it might be interesting to observe whether any, or what kind of, radiation is produced by the great tribulation of the disturbed atoms and continued during its dying away. If there is such radiation, determinations of wave-lengths would be of much importance in many respects.

I may perhaps mention here that long ago, when the cause of X-rays was a subject of speculation and the doctrine that mainly found acceptance was that they were not light-waves at all, I suggested to the late Prof. Viriamu Jones that radiation of extremely small wave-length would be produced if atomic or molecular vibration, as distinguished from what in comparison might be called molar vibration, could be excited. An illustration that suggested itself was this:—Take a vibrator composed of a series of small masses with spring connections. If these masses are of atomic or molecular dimensions any ordinary impulse or impact would leave them unaffected, while vibrations of groups of them, depending on the connections, would result. But the impact on one of the masses of a hammer of sufficiently small dimensions and mass would give vibrations depending on the structure of the mass struck, and independent of the connections, just as the bars of a xylophone ring, while the suspended series of bars, if it swings at all, does so without emitting any audible sound. This is, I believe, in accordance with the theory now held as to X-rays. We now have some information as to the mode of producing a local excitement so intense as to cause, not merely atomic disturbance, but actual disruption of the atomic structure. Further developments of Sir Ernest Rutherford's experiments and of his theory of their explanation will be eagerly awaited.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. P. PHILLIPS BEDSON, D.Sc., PRESIDENT OF THE SECTION.

IN again taking up the work of this section, after an interval of three years, a discontinuity without parallel in the annals of the association, it is natural that our thoughts should turn to the past, and in so doing we are reminded of the gaps in the ranks of those who were accustomed to contribute to the work of our section. In 1916 we met under a shadow caused by the death of Sir W. Ramsay, whose genius added in so many ways to our science. And to-day we have to record the loss of one who in his long life contributed in a variety of ways to the advancement of chemistry, and to whom we owe an addition to the number of elementary substances in the discovery of thallium, one of the early fruits of the use of the spectroscope. The chemistry of the rare earths has been especially illumined by the researches of Sir William Crookes. With physicists we would join in a tribute to the memory of Lord Rayleigh, amongst whose experimental researches is one of special interest to chemists, namely, the revelation of the existence of argon, of which discovery Sir J. J. Thomson has recently written that it was not made "by a happy accident, or by the application of new and more powerful methods than those at the disposal of his predecessors, but by that of the oldest of chemical methods: the use of the balance."

In this connection it is but right that, despite the feelings engendered by the war, I should refer to the passing of two great chemists—Baeyer and Fischer. The former died some two years ago, and the latter within the past two months. Each of them advanced by his experimental researches the progress of organic chemistry, and brought illumination into many of the obscure departments of this branch of science. The field of investigation latterly cultivated by Fischer has revived an interest in the "vital" side of organic chemistry as distinguished from the study of chemistry of the carbon compounds. Moreover, there are many British chemists, amongst them some of the most distinguished, who, as students, received guidance and inspiration from the teaching of Baeyer or of Fischer, and with them we gratefully acknowledge our indebtedness.

Fifty years ago Mendeléeff communicated to the Russian Chemical Society a memoir which has exercised a profound influence on chemical philosophy, and continues to serve as a guide in the interpretation of research and speculations on the nature of the elements. Without entering on the somewhat vexed question as to whom should be assigned the credit of the discovery of the periodic law, I trust I shall not be considered unmindful of the claims of Newlands by adopting the traditional history, and, as is usual, associate this discovery with the name of Mendeléeff, and consequently we may look on this year as the jubilee of the periodic law. Although there is already abundant special literature dealing with this subject, and the periodic system has been assimilated into the teaching of the science, and is dealt with in the text-books of chemistry, in some of which it forms the basis of the system employed in the exposition of the facts and theories of inorganic chemistry, still it appeared to me that I might utilise this as an opportunity of passing in brief review some of the features of the rise and development of the "periodic law."

The memoir, made known to the non-Russian reader by the abstract in German, shows the principle of periodicity, viz. the recurrence of similar properties at regular intervals with increase in the magnitude of atomic weights, the possibility of utilising the atomic weights as a basis of the classification of the elements, the necessity for the revision of the values thus assigned to the atomic weights of certain elements, and finally that the scheme demanded for its completeness the existence of many new elements.

The later writings of Mendeléeff contain the mode of tabulating the elements in the form usually adopted in chemical text-books, portraying the principle of periodicity and showing the grouping of the elements into natural families. But undoubtedly the clearest demonstration of the association between the atomic weights and the physical properties of the elements is that exhibited by the curve of atomic weights and atomic volumes, which is an outcome of the independent studies of these relationships by Lothar Meyer, and, as is well known, shows the members of the natural families of elements occupying corresponding positions on the curve. This curve, with its undulations, corresponding with the series of the elements, has contributed to impress on the mind of the student the relationship between the properties of the elements and their atomic weights, and may have exercised an influence in directing attention to these relationships which the attempts of the earlier workers in this field were not successful in doing.

Mendeléeff's table of the elements was just beginning to figure in the teaching of chemistry in my undergraduate days, and, together with the speculations underlying it, aroused considerable interest and proved an incentive and inspiration for experimental inquiry. Foremost in this country amongst those who by their writings have contributed to spread a knowledge of Mendeléeff's speculations was my fellow-student, Carnelley. His experimental investigations added materially to our knowledge and definition of the physical properties of elements and compounds, which further emphasised the periodicity in the relation of the atomic weights to the properties of the elements, and have provided data from which curves, resembling in contour the atomic volume curve, have been set up.

A valuable guide in fixing the atomic weights of the elements has been the specific heat which, as the discovery of Dulong and Petit showed a hundred years ago, varies in the case of solid elementary bodies inversely with their atomic weights; or, as it is more usually expressed, the solid elements have the same atomic heat. The investigation of the exceptions to this empirical rule brought out the fact that the specific heat is influenced by temperature, and the study of the influence of low temperatures led Sir James Dewar to the discovery that at about 50° Absolute the atomic heats of the elements are a periodic function of the atomic weights. Further, the graphic representation of this relation gives a curve very similar in its course to that of the atomic volume curve. So that the specific heat is another of the physical properties to fit into the periodic scheme.

The necessity for a revision of the atomic weights of certain elements, as pointed out by Mendeléeff, has induced several workers to direct their energies to the solution of the problems indicated, so that in our present-day tables many of the anomalies of position and sequence which existed in the earlier schemes have disappeared. Tellurium has still resisted all attempts to bring it into order, with an atomic weight less than that of iodine, which its association with sulphur and selenium demands. The interesting attempts to decompound tellurium have so far remained unfruitful.

But undoubtedly the most fascinating feature of the periodic system is that "it allows the discovery of many new elements to be foreseen." This and the manner in which Mendeléeff, in full conviction of the truth of the "periodic law," boldly assigned properties to those elements required to fill the blank spaces in the table of the elements, and the verification within twenty years in three instances of these prophetic specifications have contributed to the recognition and firm establishment of the "periodic law" as an article of belief in chemical philosophy, and to make it the mainspring and inspiration of the greater part of modern inorganic research.

The discovery of argon, the announcement of which formed a notable feature in the proceedings of the association at the Oxford meeting in 1894, and the recognition in it of an element with an atomic weight of 40, raised doubts in the minds of some as to the validity of the scheme of the elements based upon the periodic law. It was indeed a time of testing the faith. The suggestion that argon would prove to be a modified form of nitrogen was brushed aside by the incontrovertible establishment of it as an element, endowed only with specific physical properties and distinguished from all known elements by its lack of any of those activities which characterise the remaining elements. But argon was not destined to enjoy a splendid isolation for long. The researches of Sir W. Ramsay soon brought helium to earth, and he and his colleagues provided a number of companions for argon. So, in a very short period, was recognised the existence of a group of gaseous elements forming a natural family, the molecules of which are monatomic, the members of which are distinguishable by their spectra and atomic weights, but are all in agreement in their unreadiness to take part in any chemical change. This inertness or nonvalence provided a simple means of reconciliation with the periodic scheme of the elements, as all that was required was simply to add to the eight groups of the table of elements a zero group containing helium, neon, argon, krypton, and xenon, and with niton, the emanation from radium, as a recent addition. If we are to accept Mendeléeff's suggestion, the zero group should contain a member lighter than hydrogen in series i., and in a zero series a still lighter representative of the elements of the zero group, which he has postulated as the "æther" of the physicist.

Thus the discovery of argon has formed a starting-point in the development and a justification of the natural system of the elements, but it still remains, to make the tabulation complete, that provision should be made for the accommodation of the rare earths. The paper published by Werner in 1905, under the title "A Contribution to the Development of the Periodic System," shows how this can be satisfactorily accomplished.

The elements of the argon group form a valuable extension to the periodic system, and the knowledge acquired in the investigation of these substances has proved serviceable in the solution of problems in the realms of science and of industry. The knowledge of the properties and behaviour of helium was destined soon to play a part in the solution of the riddle of the radio-active elements, whilst it is specially noteworthy that argon, the "idle one," should have been pressed into industrial service.

This fact suggests the thought that idleness has its uses, and at the present time how satisfactory would it be were we able to find useful application for a quality which appears to be plentifully and widely distributed in this country.

The history of helium is still more astonishing, for not until thirty years after its existence had been surmised from spectroscopic observations of the sun was this element found to have a terrestrial existence, and now, as one of the achievements of science during the war, we may look on its production in bulk as a commercial proposition. Moreover, we are told "that the advances made in the production of helium warrant the opinion that, had the war continued after November 11, 1918, supplies of helium at the rate of 2,000,000 cub. ft. per month would have been produced within the Empire and the United States, and helium-filled aircraft would have been in service" (NATURE, July 17, 1919).

Some of the speculations to which the periodic system of the elements has given rise have been the subjects of communications to this section.

At the Aberdeen meeting Carnelley, whom I have already mentioned as an ardent worker in this field, gave an account of a scheme based on the conception that the elements are composite, having relations similar to those exhibited by the paraffin hydrocarbons and the isologous series of radicals derived from them. He regarded the elements, other than hydrogen, as made up of two simple elements, A and B. A he identified with carbon, with the atomic weight of 12, and B was assumed to have a negative atomic weight of 2.

In the following year, at Birmingham, Sir W. Crookes devoted his address to this section to an exposition of his ideas of the "genesis of the elements," a subject to which he on many subsequent occasions returned, and amplified in the light of recent discovery. The process of evolution of the elements from a primal "protyle" is depicted as taking place in cycle after cycle, in each cycle the "unknown formative cause" scattering along its journey clusters of particles corresponding with the atoms of the "elements," forming in this way a series such as that beginning with hydrogen and ending with chlorine; a repetition of the movement under somewhat altered conditions giving rise to a series of similarly related elements, and thus homology, which is shown by the members of the natural families, is provided for.

The investigations of Sir J. J. Thomson on the discharge of electricity through gases have established the divisibility of the atoms, and in his "Corpuscular

Theory of Matter" he has given us conceptions of how atoms may be constituted to provide a series so related that they reflect, if not reproduce, many of the chemical characters of the elements and their periodic relation to atomic weights.

With the discovery of radium and its remarkable properties we have been brought in contact with an element undreamt of in our philosophy. The interpretation of the results of the investigation of this element has called for drastic changes in our conception of an element. The pursuit of the researches of the radio-active elements, guided by the theory of the spontaneously disintegrating atom propounded by Rutherford and Soddy, has served to reveal facts which lend a special emphasis to many passages in the address of Sir W. Crookes to which I have already referred.

For instance, the passage in which he said: "Should it not sometimes strike us, chemists of the present day, that after all we are in a position unpleasantly akin to that of our forerunners, the alchemists of the Middle Ages? The necromancers of a time long past did not, indeed, draw so sharp a line as do we between bodies simple and compound; yet their life-task was devoted to the formation of new combinations, and to the attempt to transmute bodies which we commonly consider as simple and ultimate—that is, the metals. In the department of synthesis they achieved very considerable successes; in the transmutation of metals their failure is a matter of history."

Or again, when he propounded the question: "Is there, then, in the first place, any direct evidence of the transmutation of any supposed 'element' of our existing list into another, or of its resolution into anything simpler?"—a question to which he, Sir William Crookes, was at that time forced to reply in the negative, whereas to-day many instances might be cited in support of an affirmative answer to this question. Radio-activity has supplied a method of analysis—radio-active analysis—surpassing in delicacy any of the previously known methods for the examination of material substance; the application of these methods has not only added to the list of elements, but also new classes of elements. First, elements indistinguishable and inseparable by chemical means, yet differing slightly but definitely in their atomic weights. The existence of these "isotopes," as Soddy styles them (a name giving prominence to the fact that such elements occupy the same place in the table of the elements), demonstrates that absolute uniformity in the mass of every ultimate atom of the same chemical element is not an essential, but that "our atomic weights merely represent a mean value around which the actual atomic weights of the atoms vary within certain narrow limits" (Crookes, Address to Section B, 1886).

Whether the possibility of separating isotopes, recently suggested by Dr. Lindemann and Dr. Chapman, will be found capable of experimental realisation, must be left to the future to decide; in fact, in this matter we must adopt the attitude, prevalent in other than scientific circles, of "wait and see."

The investigations in the field of radio-activity have further brought to light that identity in atomic weight may be associated with difference in chemical properties, revealing the existence of a further class of elements for which Dr. Stewart suggests the name "isobares." Further, Dr. Stewart considers that isobaric elements are to be found, not alone amongst the radio-active, but some of the normal elements exhibit properties which may be explained on the assumption that they are isobarics. Thus the compounds formed from iron are regarded as indicating the existence of three irons, all having the same atomic weight. One of these, termed ferricum, is tervalent; one, ferrosum, is divalent; whilst the third, ferron, is inert and takes no part in chemical changes. The three are, under certain conditions, mutually interconvertible. This last condition does not apply in the case of the radio-active isobares.

The elements are to be regarded as divisible into three classes:—(1) Isotopic elements, each set of which have different atomic weights but identical chemical properties; (2) isobaric elements which have identical atomic weights but different chemical properties; and (3) normal elements which differ from each other both in atomic weights and chemical properties.

The discovery of X-rays may be acclaimed as having added a new sense to aid us in our investigation of material objects, and among their innumerable services may be reckoned the results which have followed from the investigations of the X-ray spectra of the elements by the late Lieut. Moseley, whose death in Gallipoli in 1915 is one of the many tragedies of the war specially deplored in the scientific world. From the analysis of the X-ray spectra Moseley has shown that for each element a value can be deduced, which is styled the atomic number and represents the space in the atomic table the element should occupy. The researches of Rutherford and Andrade on lead and radium B have proved that "isotopes" have the same atomic number. Whatever may be the ultimate explanation of the meaning of the atomic numbers, their experimental determination has already proved valuable in the solution of some of the anomalies of the periodic table. In addition to the case of isotopes, just referred to, the number of elements between hydrogen and uranium is fixed by finding 92 as the atomic number for uranium, and, further, Moseley's work has revealed that the atomic numbers are in agreement with the order of the chemical sequence, rather than the order of the atomic weights, which is of special interest and value in the cases of tellurium and iodine, and of potassium and argon, the decision in each case proving a welcome support to the position in the table assigned to these elements on chemical considerations.

Again, Moseley's atomic numbers remind us of the arrangement of the elements adopted by Newlands in his communication to the Chemical Society of 1866, in which he set forth the "law of octaves," the precursor of the periodic law.

In concluding this brief sketch, cognisance should be taken of the speculations of physicists as to the structure of the atom. Already several models of the atom are in the field which leave the uncuttable Daltonian atom far out of view; still, in a measure they help to an understanding of some of those regularities exhibited by the elements, and set forth in the natural system. Valency and its vagaries, which we are accustomed to describe by phrases such as "variable valency," "selective valency," and the like, still call for a full explanation.

I purpose now to direct attention to matters of another nature, which appear to me of interest to chemists, and to that extent have a bearing on the welfare of chemistry in this country.

Among the numerous revelations and surprises of the past five years has been the realisation on the part of the public and the Government of the importance of the chemical industries to the national well-being. The apathy and indifference of pre-war times were replaced by an apparently lively interest in things chemical, and there was what in the religious world would be styled a revival.

Politicians, the Press in all its varied forms, daily, weekly, monthly, and quarterly, took up the subject of our industrial insufficiencies and emphasised in various ways the importance of research in connection with our industries. Again, the coal-tar colour industry furnished, as it had done again and again, some thirty to forty years ago, the text from which research and its importance was preached. This time the reiteration had the effect that the "aniline phantasm," as I have seen it described, was recognised as a "key industry," important to the vitality of the manufacture of textiles; with the result that the Government, discarding its fiscal policy, was induced to subsidise the enterprise for the manufacture of dyes and other coal-tar products. The negotiations preceding the formation of British Dyes, Ltd., have been remarkable as revealing that, in the eyes of some at any rate, special knowledge is a "dangerous thing," and, in fact, was deemed sufficient to exclude its possessors from a seat on the directorate. This is all the more remarkable, as the history of similar enterprises in Germany shows the *personnel* of the directorates to be made up of university trained men and, in not a few instances, of professors. So that in Germany academic distinction and theoretic learning are not considered as excluding the possession of commercial acumen and those other qualities needed in a successful man of business.

In the early stages of the war the demand for explosives was met by the expansion of already existing factories, the increase in staff of which called for many additional men with chemical training, a call which become unprecedented and insistent when the national factories were founded, so that men and women with a chemical training found an opportunity of putting their knowledge at the service of their country. And in not a few instances those who, for financial reasons, had at the close of their college career taken up a less congenial employment were able to return to the practice of chemistry, for which in their student days they had specially fitted themselves.

In the foreword of the publication "Reports on Costs and Efficiencies for H.M. Factories," issued by the Ministry of Munitions, we are told that only "when it was decided to commence the erection of new and national factories, and an attempt was made to collect from existing factories the necessary technical data and assistance, did it become evident that, due to the extraordinary demands of the war, there was —practically throughout the entire country—a regrettable lack of available accurate technical data, and an even greater lack of trained technical men, more particularly chemical engineers,"

To anyone acquainted with the conditions existing in this country in pre-war days, the lack of "trained technical men" is no matter of surprise. In fact, one cannot fail to be astonished at the remarkable development of chemical manufacture which has taken place under the directing influence of Lord Moulton in response to the call from Army and Navy. That men were found capable of taking a part in these varied undertakings cannot, at any rate, be credited to the encouragement which the teaching of chemistry or the students of the science had received from those directing industries which employ or should employ the services of chemists. It is no uncommon experience to find the chemist employed simply in the analytical testing of raw materials and manufactured products, and even in the working of processes under their control the potentiality of the chemist is not utilised to the full, as is evident from the following, which is a quotation from the preface to the brochure issued by the Ministry of Munitions to which I have already referred: "Since the beginning the policy of the Department with regard to our national factories has been to aim at maximum efficiency in respect of cost and usage of materials.

"For this purpose the greatest efforts have been made to place before all those who are in any way responsible for control full details concerning the working and costs of the factories. This was rather an innovation in the field of chemical manufacture, as until comparatively recently, either intentionally or through negligence, it was customary at many chemical plants to keep the chemists in complete ignorance, not only of the cost at their plants, but also even of the efficiencies.

"It is amazing that manufacturers can expect improvements in chemical processes when their chemists are kept in ignorance of such vital facts.

"It has happened very often that as soon as detailed figures were seen by chemists at a plant, important alterations and improvements have at once been suggested, the need for which would otherwise never have been noticed."

The condition of service indicated in the passage quoted, together with the low scale of remuneration which obtained hitherto in chemical industries, help to explain the scarcity of the kind of scientific labour referred to in the quotation I have made from the "Foreword."

But are we not told and invited to believe that all this is changed, that the records of the magnificent achievements of British chemists in the war have so educated the people, and may we say, the Government also, that the practitioners in chemistry will no longer find it essential that in describing their vocation they should be required to add, unless for special reasons, such prefixes as "analytical," "research," "scientific," or "engineering" to the word chemist, secure in the feeling that by describing themselves as "chemists" their standing, training, and profession will be correctly understood?

Still, a feeling akin to despondency, if nothing worse, is pardonable when, realising the fundamental importance of chemistry to our industries, and the thousand and one ways chemical research has ministered to the amenities of our everyday life, there should exist, not alone in the mind of the general public, but of the educated also, such a lack of information as has been revealed during the past few years—to wit, the myth woven into the history of the production of glycerine, the confusion in the minds of legislators between phosphates and phosgene. More serious, however, is the fact that the method of investigation employed by the chemist is so little appreciated or understood as to lead one to imagine that the discoveries and achievements are the results of a species of legerdemain. The production of new colours, a succession of happy thoughts, and that "by an accident the secret of synthetic indigo was unlocked." This last is a quotation from a review entitled "The Value of Scientific Research," published some three years ago, and is typical of much that passes muster in appraising the value of chemical research. That the unravelling of the constitution of indigo which occupied Baeyer and his pupils some thirteen years—the account of these investigations covers some 180 pages of Baeyer's collected works—should be summarised in this way appeared to me to call for a protest. My protest was made, and I attempted to put the matter in the correct light, showing the synthesis of indigo to be, indeed, a brilliant example of the value of theory and of a practical illustration of the importance of the chemist's conception of the architecture of molecules, as exemplified by Kekulé's theory of the constitution of benzene. The protestation evoked a reply from a correspondent signing himself D.Sc., Ph.D., who sought to justify the description of the revelation of the secret of synthetic indigo by reference to an accident which occurred in the investigation of the processes for the manufacture of phthalic acid and certainly greatly facilitated the production of this substance—an intermediate in the manufacture of artificial indigo. So, if the initiated emphasise the unessential, why should we blame the layman and be surprised that well-ordered and planned design should appear to be but the workings of chance, for every such achievement is a witness to the conquest of well-founded theoretical speculation?

But I do not wish to conclude on a despondent note, nor is it right that I should do so in view of the many activities operating for the promotion of scientific research, and of such evidence as that supplied by the magnificent endowment of the chemical department of the University of Cambridge, all of which are evidences of what we may reasonably hope to be a happy augury for the future of chemistry and chemists in this country.

NOTES.

The James Watt centenary celebrations in Birmingham were opened with lectures by Prof. F. W. Burstall and Prof. Hele-Shaw on Tuesday morning (September 16). In the afternoon there was a memorial service at Handsworth Parish Church, in which Watt, Boulton, and Murdoch were buried, an address being delivered by Canon E. W. Barnes, Master of the Temple. This was followed by a garden-party at Heathfield Hall, and a reception by the Lord Mayor at the Council House. On Wednesday morning, as we go to press, lectures are to be given by Sir Oliver Lodge, Prof. Alex. Barr, and Prof. J. D. Cormack, and in the afternoon visits will be made to some of Watt's engines. In the evening will be held the centenary dinner. On Thursday the University will hold a special Degree Congregation to confer honorary degrees on the American Ambassador (the Hon. J. W. Davies), Sir Charles Parsons, Vice-Admiral Goodwin, M. Rateau (of Paris), Sir George Beilby, Col. Blackett, Prof. Barr, and Mr. F. W. Lanchester. The response to the appeal for the memorial fund has up to the present been very meagre, and unless large additions are made to the subscription list the realisation of even one of the objects of the fund will not be possible. It is to be hoped that a marked improvement may be made during the week.

Summer time is to end this year at 2 a.m. on September 29. Each year the terminal dates of summer time have varied, and, though the dates will, of course, be known to our future compilers of natural phenomena, the use of summer time can scarcely fail to result in some errors. Even so simple a change as that of the Gregorian calendar has been attended by mistakes. Some years ago, for instance, the late Sir Edward Fry referred to some entries on British earthquakes in the diary of John Wesley (Nature, vol. lxxix., 1898, p. 98). He remarked that the London earthquakes of February 8 and March 8, 1750, which Wesley describes, are not mentioned in Mallet's Catalogue. Wesley's dates are correctly given, for the Gregorian calendar came into force after September 2, 1752. Mallet, however, gives the days in new style as February 19 and March 19. The error in this case is easy to detect; but, unless the letters "G.M.T." or the words "summer time" are added, it may be difficult to decide whether records of an earthquake at, say, 2.12 and 3.8 relate to the same shock at about 2.10 G.M.T. or to different shocks.

We regret to learn from Dr. G. C. Simpson, Director-General of Observatories, Simla, that Mr. W. L. Dallas, who was Scientific Assistant to the Meteorological Reporter to the Government of India from 1882 to 1906, passed away at Simla on August 5. Mr. Dallas's original meteorological work was devoted almost entirely to a study of the weather conditions over the Indian seas, although he published a few papers on more general subjects. He discussed for the Government of India the marine observations of the Indian seas collected by the London Meteorological Office during twenty years—1856–75. He also investigated the nature and causes of storms in the Arabian Sea, using all records available for the period 1648–1889, on which inquiry all later work undertaken by the India Meteorological Department for warning ships approaching India from the west was based. Mr. Dallas fittingly closed his long official connection with the India Meteorological Department by the compilation of a meteorological atlas of the Indian seas, which will be found in use on most ships visiting the East.

Mr. Edwin O. Sachs, whose death we announced last week, will be remembered mainly by his keen interest and untiring activity in relation to all questions regarding fire protection and fire prevention. The terrible holocaust of the Paris Charity Bazaar fire in 1887 led Mr. Sachs to form the British Fire Prevention Committee, of which he was the chairman and guiding spirit up to the time of his death. In his work with the committee Mr. Sachs was supported by a number of public men and professional friends. Thanks to his energy and devotion and his able leadership, the committee's work, from very small beginnings, soon covered a vast field of activity, which widened from time to time until the foundations of a comprehensive organisation were firmly laid. The large number of tests undertaken by the committee were made in a specially constructed testing station which Mr. Sachs designed, and to which he not only gave unstinted and devoted labour, but also largely financed. This testing station, which has been enlarged and improved from time to time, was the first of its kind, and has served as a model for similar centres of investigation throughout the world. The numerous activities of the committee—which during the war were greatly increased, and included arrangements for a voluntary fire survey force for more than two thousand war hospitals, camps, and factories, also research work of the highest importance to the nation—were initiated and guided by Mr. Sachs's unceasing energies, even during his latter years. All this work on the committee, as well as his other public activities, were rendered entirely voluntarily, and in all he did he was inspired by the highest ideals.

During the evening of September 11 an earthquake shock, causing considerable damage, was felt in the region of Monte Amiata, near Siena. At San Casciano several houses were wrecked. A slighter earthquake was also felt on September 12 at Ebingen (Würtemberg).

The *Times* correspondent at New York reports that on September 13 Mr. Roland Rohlfs, a testing pilot with the Curtiss Aeroplane Corporation, rose from Roosevelt Field, Long Island, to a height of 34,200 ft. This "record" is not officially confirmed, but Mr. Rohlfs will try on the first favourable day to make an authenticated attempt to exceed the altitude believed to have been reached by him.

On May 20 the volcano Kloet, in Java, discharged suddenly a great quantity of hot mud, which, spreading out in three streams, destroyed the town of Blitar and about thirty villages, and caused the death of several thousand persons. The place was visited by an exploring party two days later, and an interesting two-page reproduction of one of the photographs of the mud-stream is given in the *Illustrated London News* for September 13 (pp. 396–97).

AT a joint meeting of the Royal Asiatic Society, Société Asiatique, American Oriental Society, and Scuola Orientale of the University of Rome, recently held in London, Prof. A. T. Clay, of Yale University, described the efforts of American scholars to free themselves from dependence on Germany for research work in Asia. Several young Assyriologists in America are now devoting themselves to research work. Yale University has taken over the work of Sir W. Ramsay at Antioch, and the American School of Oriental Research in Palestine, which was closed on account of the war, is now to be re-opened on a more extensive scale. At least one professor and several students will be sent annually from Yale to direct operations, which will be carried out in co-operation with the British School, which will be founded on a more important basis.

STUDENTS of the mygalomorph spiders will do well to consult a critical systematic paper on South African species by John Hewitt in the *Annals of the Transvaal Museum* (vol. vi., pt. 3).

SOME results of a collecting expedition to Korinchi Peak, Sumatra, are published in the Journal of the Federated Malay States Museums (vol. vii., pt. 3, 1919). Descriptions, with excellent figures, of a number of Diptera, by F. W. Edwards, of the British Museum, are especially noteworthy.

WE have received the seventeenth Report of the State Entomologist of Minnesota. In addition to articles of economic interest, it contains several papers of systematic value, such as O. W. Oestlund's contribution to the classification of aphids and F. L. Washburn's summary of the Hymenoptera of the State. The illustrations in this Report are exceptionally praiseworthy.

DRS. S. HADWEN and A. E. CAMERON, working for the Canadian Department of Agriculture, have made a definite contribution to our knowledge of horse bot-flies (Bull. Entom. Research, vol. ix., pt. 2) by their observations on the eggs and early larvæ of *Gastrophilus haemorrhoidalis* and *G. nasalis* as compared with *G. intestinalis (equinus)*. The first-named species has stalked eggs which are laid on the hairs of horse's lips, while the second lays on the hairs of the intermaxillary space. It is possible that the newly-hatched larvæ may penetrate the horse's skin in these regions, as they were found to bore into the mucous lining of the mouth and also into the tongue of a recently killed calf.

THE possibilities of the manufacture of paper-pulp in Australia is the subject of a Bulletin (No. 11) issued by the Advisory Council of Science and Industry of the Commonwealth of Australia. The bulletin describes the results of some preliminary investigations of the native sources of wood-pulp and pulp from fibre-plants. The most satisfactory results have been obtained with karri and other species of eucalypts, and it is suggested that a thorough survey of the resources might indicate the possibility of building up a wood-pulp industry in Australia. As regards the fibre-plants, a number were found on testing to be unsuitable for paper-making. It is unlikely that either of the grasses Lalang or Marram, which have been used for pulping purposes, could be employed profitably in Australia, and negative results have also been obtained with prickly pear. A blend of 20 per cent. of a sedge (*Gahnia decomposita*) and 80 per cent. karri-pulp is reported as very satisfactory. The conclusion is that if Australia's demands for paper are to be supplied from native sources, the principal material to be used for some years to come must be straw, of which large quantities are produced within a hundred miles' radius of Adelaide.

VARIOUS memoranda and letters on "The Reconstruction of Elementary Botanical Teaching," which appeared in the *New Phytologist* during 1917–18–19, have been brought together in pamphlet form. As indicated by the letters, the teaching refers almost exclusively to the elementary university course, and the participants in the discussion are, with few exceptions, engaged in teaching of a university standard. The discussion originated from a memorandum by five botanists who pleaded for a more important place for plant physiology as compared with morphology in the elementary course. This was regarded by some eminent morphologists as a challenge, to which they replied with some vigour. The discussion brings out the fact that botany is a wide subject, attracting students of widely differing temperaments, and there is real difficulty in planning an elementary course which shall form an adequate introduction to the different branches in one or more of which the student may subsequently specialise. As regards the *motif* of the elementary course, it is important that the plant should be studied as a living organism and as part of a larger organisation which is closely associated with its environment. But present-day plant-life is not merely the expression of present-day environment, but largely the outcome of past history; and the neglect of the study of history may be disastrous. There is a considerable amount of elementary botanical teaching outside the universities, and the point of view and methods suitable for the university student are not necessarily those suited to boys and girls at school.

ALTHOUGH the statement is made quite definitely in many text-books that formic acid occurs in the stinging hairs of the common nettle (*Urtica dioica*), the proof has not hitherto been very satisfactory. In early experiments the nettles were cut up, distilled with water, and reactions of formic acid obtained on testing the distillate. Later observers, however, have found that various parts of plants yield formic acid when tested in a similar manner. Hence it was not certain that the acid in the earlier experiments had come from the stinging hairs; it might have been derived from the general plant tissues. Moreover, one of the chief chemical reactions of formic acid, namely, its power of reducing salts of silver and mercury, is not necessarily a conclusive proof of the presence of the acid under the particular conditions of these earlier experiments, since other "reducing" substances might also have been present. The question, however, appears to have now been definitely settled through some ingenious experiments devised by Dr. Leonard Dobbin (Proceedings of the Royal Society of Edinburgh, vol. xxxix., ii., No. 11). By pressing the leaves of growing nettles between dry filter-paper impregnated with barium carbonate, the contents of many thousands of hairs were absorbed without contamination by juices from any other part of the plant. After appropriate treatment the product yielded barium and lead salts, which were crystallised on glass slides, and the two formates identified under the microscope. Whether or not formic acid is the main cause of the intense irritation produced by nettlestings is a further question; the active irritant has been regarded by one investigator as being probably not formic acid, but an enzyme.

THE cause of the colours of "Blue John" and other varieties of fluorite has long been a matter of doubt and controversy. During the last two years Messrs. B. Blount and J. H. Sequeira have carried out an interesting investigation of the problem, and their results are now briefly described in the Transactions of the Chemical Society (vol. cxv., p. 705, 1919). They have carefully analysed blue and white varieties of the mineral, tested the powdered material by extraction with organic solvents, examined the gases occluded by "Blue John," and subjected several types of fluorite to "raying" by exposure to radium and X-rays. They conclude from their experiments that there is no substantial difference between white fluorite and the blue, green, and amethystine varieties, except in the presence of a small amount of organic matter to which the colours are ascribed. The state of dispersion of the organic matter is not discussed. It is already ascertained that the blue colour of certain varieties of rock-salt is due to a colloidal dispersion of sodium in sodium chloride, and the blue colours of sodalite and ultramarine are almost certainly due to a similar cause. To correlate the colours of fluorite with the presence of different amounts of organic matter therefore still leaves the core of the problem unsettled; and it is to be hoped that the authors will continue their work by applying methods of X-ray analysis and ultra-microscopy in the hope of demonstrating the degree of dispersion of the organic matter, molecular or colloidal, in each of the varieties of fluorite on which their present work has been conducted.

THE Union of Technical Men (*Bund technischer Berufsstände*), which has recently changed its name to the Imperial League for German Technology (*Reichsbund deutscher Technik*) is now publishing a regular weekly periodical, which reflects the opinions of the leaders of technical thought in the country. Questions affecting, in particular, the work of reconstruction find an important place in the journal. It is interesting to note that already more than one great conference or Technical Parliament has been held, and energetic measures are being taken with a view to ensure the adequate representation of scientific and technical thought on all public bodies. An announcement in the publications of the League states that a daily paper (*Die Arbeit*) will make its appearance as soon as the difficulties connected with the release of paper supplies are overcome.

WE have received recently a copy of *The Chemical Technology*, a monthly journal devoted to chemistry and chemical technology, published in Tokyo. It is printed chiefly in the Japanese language, but contains a section of about eight pages in English. This consists mainly of commercial notes upon chemical products, such as dyestuffs, alkaloids, wax, menthol, and peppermint oil. The Japanese columns contain a number of articles upon branches of technological chemistry, and some of a more general nature, including one on "Science and its Future," by Mr. S. Oguri. Judging by their titles, the articles cover a wide range of subjects, and indicate that chemists in Japan are quite awake to the importance of their science to the nation's industries. It may be noted, in passing, that the journal contains several American advertisements, but not a solitary British one.

FROM the director of the Wellcome chemical research laboratories we have received copies of sixteen scientific papers published during the last few years by the institution in question. They are chiefly accounts of investigations upon materials likely to be of value in medicine. On one hand, plants used as official or domestic remedies have been examined more thoroughly than hitherto; and, on the other, active constituents of drugs, such as alkaloids, have been investigated with the view of determining their constitution and facilitating the possible synthesis of similar therapeutic agents. The distribution of these memoirs to scientific institutions, formerly made periodically, was suspended during the period of the war, and is now being resumed. The results of the investigations, however, have already appeared in the Transactions of the Chemical Society and the *Pharmaceutical Journal*, so that they need not be mentioned here in detail. It will suffice to say that they form an important contribution to our knowledge of the medicinal plants examined, and are a testimony to the excellence of the work done at the laboratories.

THE importance of having a thoroughly trustworthy instrument for detecting and measuring the amount of any combustible gas present in the air at any time has led the Bureau of Standards at Washington to investigate the working of existing instruments and to design a further instrument depending on a new principle, which appears to have a great future before it. It depends on the combustion which takes place about a platinum wire in the mixture when an electric current is sent through the wire so as to heat it sufficiently. Three methods of measurement are adopted. The wire may form one arm of a resistance bridge and indicate the amount of gas by the rise of temperature, and therefore of resistance of the wire. Or the current in the wire may be increased until the wire just glows, the increase required being less as the amount of combustible gas increases. Or the heat generated by the combustion may be used to heat a bimetallic strip, the bending of which increases as the heat generated, and therefore as the amount of gas present. Full details of the instruments, with drawings, are contained in Scientific Paper No. 334, by Messrs. E. R. Weaver and E. E. Weibel, of the Bureau.

VOL. iii. of the Memoirs of the College of Science, Kyoto Imperial University, contains an account of a series of researches on the electrical resolution of spectral lines (Stark effect). The method employed was that originated by Lo Surdo, in which the intense electric field in the cathode dark space of a vacuum tube is utilised. The elements studied include H, He, Li, Ca, Mg, A, N, and O, and a number of new and interesting results have been obtained. The observations on the helium spectrum are particularly complete, and are summarised diagrammatically in a manner which brings out clearly most of the characteristic features of the effect. Special attention is given to the phenomenon of "isolated components," which only exist in sufficiently strong fields, and seem to be exclusively associated with a diffuse type of series. This latter property, together with other features of their observed behaviour, would suggest that it may be legitimate to regard them as a special class of satellite. Another observation of much interest refers to certain combination series lines which make their appearance only in intense electric fields. The examination of the secondary spectrum of hydrogen yielded fifty-four affected lines; these results, in conjunction with the Zeeman effects already on record, should be of material assistance in elucidating the structure of this spectrum. Among other conclusions of general interest may be mentioned the confirmation of the view, which previously rested on somewhat fragmentary evidence, that arc lines are affected by electric fields to a much greater extent than enhanced lines of the same element.

ALTHOUGH there is a general belief that underfed individuals are more susceptible to infection than well-fed persons, and that when the former contract a disease they show less resistance and are more prone to succumb to it, there is no definite scientific evidence even of a general character to support the theory. The study of the interesting question whether the immunity of an animal to disease is affected by a rigorous and prolonged dietetic deficiency is a natural outcome of the work on accessory food factors which has recently been carried out at the Lister Institute, and the current issue of the *Biochemical Journal* contains a suggestive paper on the subject by Dr. S. S. Zilva. Immunity is a complicated biological phenomenon which does not lend itself to quantitative estimation, but certain phenomena which accompany it, such as phagocytosis, complement fixation, and agglutination, can be estimated quantitatively for comparative purposes. Dr. Zilva has studied the effect on amboceptor and agglutinin formation and the complement content of the blood of rats, of diets deficient in (*a*) the elements calcium, iron, potassium, chlorine, phosphorus, and sodium; (*b*) certain amino-acids; and (*c*) the antiscorbutic, antineuritic, and fat soluble A accessory factors, the rat being the animal employed. The diets investigated were (1) those low in the elements mentioned; (2) those containing 12 per cent. and 8 per cent. of caseinogen as a source of protein; (3) those containing 18 per cent. of gliadin as the sole source of protein; and (4) those deficient in each of the three accessory food factors. As a result of several of the deficiencies the animals exhibited restricted growth and poor condition, but, except when the diet was deficient in phosphorus, no differentiation in the titres of the agglutinins and amboceptor could be recorded. Guinea-pigs, whether fed on an unrestricted mixed diet, quantitatively restricted mixed diet, or a scorbutic diet, showed no difference in the amboceptor and agglutinin titres or in the complement activity of their blood.

THE useful select list of scientific and technical books published in the Descriptive Catalogue of the British Scientific Products Exhibition, 1919, has, with the permission of the British Science Guild, been issued separately in pamphlet form by Messrs. A. and F. Denny, 147 Strand, London, W.C.2. The list gives in sixty pages the bibliographic particulars of standard books in the English language in sixteen branches of applied science, from aeronautics to wireless telegraphy. The date and price of the existing edition are shown in each case, and every volume in the list is on sale, so that any of the books ordered can be obtained without difficulty. Messrs. Denny will be glad to send a copy of the list to anyone who will apply to them for it.

THE following volumes are in active preparation for publication by the Hakluyt Society:—"The Chronicles of Muntaner," translated and edited by Lady Goodenough; "Jons Olafssonar Indiafara," translated by Miss B. Phillpotts, edited by Sir R. C. Temple, Bart., 2 vols.; "William Lockerby's Journal in Fiji, 1808," edited by Sir E. F. im Thurn and L. C. Wharton; "A Description of the Coasts of East Africa and Malabar in the Beginning of the Sixteenth Century," by D. Barbosa, translated by L. Dames, vol. ii.; and "Anales del Peru," by L. F. Montesinos, translated and edited by P. A. Means.

A LENGTHY and interesting catalogue (No. 181) has just been circulated by Messrs. W. Heffer and Sons, Ltd., Cambridge. The books (more than 1600 in number) are of a miscellaneous character, but there are sections devoted to archæology, folk-lore, anthropology, and kindred subjects; Irish literature, folk-lore, and archæology; and science and mathematics. In addition, Messrs. Heffer direct attention to collections of flint and bronze implements and of pottery which they have for disposal.

Messrs. George Bell and Sons, Ltd., have completed arrangements with Prof. Moureu for the publication of a translation of "Notions fondamentales de chimie organique." The translation is being made of the fifth French edition, in which additional space is devoted to a more extensive treatment of stereochemistry, and of the relations between chemical constitution and physical properties. There will also be an additional chapter on dyestuffs.

OUR ASTRONOMICAL COLUMN.

COMETS.—Miss Vinter Hansen and Mr. Fischer Petersen have deduced elliptical elements for the comet 1919*b* (Brorsen-Metcalf), and give the following ephemeris:—

For Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log *r*	Log Δ
Sept. 19 ...	12 7 43	42 46	9·8967	9·5175
21 ...	12 1 24	38 54		
23 ...	11 56 36	35 30	9·8577	9·5935
25 ...	11 52 52	32 28		
27 ...	11 50 0	29 43	9·8168	9·6647
29 ...	11 47 50	27 11		

Prof. Wolf noted that at the end of August the comet was easily visible to the naked eye as a large, round nebula, with central condensation, and a tail. The theoretical brightness is now diminishing, but there is likely to be an increase in physical brightness as perihelion is approached (about October 17). The comet is in conjunction with the sun on September 22; after that date it may be observed to most advantage in the morning sky.

M. Ebell gives the following continuation of the ephemeris of Kopff's periodic comet 1919*a*:—

For Greenwich Midnight.

	R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Sept. 18	19 52 18	7 50	Sept. 26	20 2 12	7 45
20	19 54 40	7 49	28	20 4 51	7 43
22	19 57 6	7 48	30	20 7 34	7 41
24	19 59 37	7 46	Oct. 2	20 10 21	7 38

On September 24, $\log r = 0{\cdot}2755$, $\log \Delta = 0{\cdot}0740$, magnitude 11·7.

Continuation of the ephemeris of comet 1919*c*:—

For Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Sept. 18	14 49 5	16 0	Sept. 30	15 12 47	10 44
22	14 56 46	14 16	Oct. 4	15 21 8	8 57
26	15 4 40	12 30	8	15 29 42	7 10

The comet is brightening slowly, its magnitude on October 8 being 8·5.

THE BLINK MICROSCOPE.—Mr. R. T. A. Innes has an article on this subject in *Scientia* for September. He is one of the chief workers with this instrument, so he speaks with authority. It is unrivalled as the readiest means of picking out all the large proper motions on a pair of plates. Taking the smallest proper motion that can be detected in the case of plates taken twenty-five years apart as $1\frac{1}{4}''$ in this interval, or 5″ per century, Mr. Innes states that there are about three such stars in each square degree, or 120,000 in the whole sky. He estimates that the number of stars with sensible proper motion would increase as the square of the time-interval, so that with a century interval there would be 2,000,000 proper motions.

It is explained in the article that the proper motions found by photography are not absolute, since they take no account of the systematic drift of the region of the sky, due to the solar motion. At present photography does not appear to be capable of giving absolute proper motions without the aid of the transit circle. It is necessary to determine absolute places and proper motions of a sufficient number of reference stars on each plate to enable them to be deduced for the remaining stars.

IRRIGATION IN EGYPT AND THE SUDAN.

THE admirable record of agricultural progress achieved under British control in Egypt offers every incentive to further exertions, with a view to increase the productivity of a country so rich in latent possibilities. It is interesting, therefore, to note the resumption of irrigation undertakings, which have been temporarily suspended during the war. During the last generation the Nile has undergone drastic engineering treatment, and now, no longer free to give vent to irregular and wasteful discharges, its valuable waters, conserved and controlled by artificial works, are increasingly administered on systematic lines and directed to those localities where their beneficial influence can be most effectively exercised.

The pioneer dam of Mougel Bey, just below Cairo, restored and raised to a higher degree of utility by the late Sir Colin Scott-Moncrieff, the barrages at Asyût, Esna, and Zifta, and the bolder and more imposing structure at Aswân, are now being followed by other works which will, no doubt, produce results as noteworthy and important.

The schemes at present in hand include three separate projects relating to different sections of the river. There is a scheme for the development of the Gezirah plain of the Sudan on the Blue Nile, just south of Khartoum; another for the benefit of Egypt proper by utilising the flood-waters of the White Nile; and a third scheme of drainage improvement for the deltaic region included in the provinces of Gharbieh and Beheira, lying below Cairo.

The Blue Nile scheme consists of a dam at Makwar, about five miles south of Sennar and 175 miles south of Khartoum, with a canal, some forty miles in length, leading from just above the dam to the district to be irrigated, which is a remarkably level and treeless plain some 300,000 feddâns in extent (a feddân is 1·04 acre). The cotton, which it is capable of producing, will be raised as a winter crop, absorbing the river winter supply without interfering with the summer discharge. The dam will be a work of some magnitude, withstanding, when completed, a head of 40 ft. of water, and capable of coping with a discharge of some 1,250,000 gallons per second in a river subject to sudden and extreme fluctuations.

The White Nile scheme is, fundamentally, a development of the Aswân undertaking, which has now reached the limit of its effective utility. In 1916 the demands of the area under cultivation exceeded the available supply. It is, accordingly, proposed to construct an auxiliary reservoir dam at Gebel-el-Auli, or Gebel Aoli, on the White Nile, capable of impounding an adequate summer supply of water for Egypt, and at the same time reducing the excessive flood-waters of the main Nile. This scheme has been the subject of certain criticisms by Sir William Willcocks, whose own proposal was briefly referred to in the Notes column of NATURE for May 22 last. A subsidiary work is the formation of a channel from the Blue Nile above Sennar, so that the superfluous water from that reservoir may be conveyed to the Gebel-el-Auli reservoir. The Gebel-el-Auli dam will have a pressure-head of 23 ft.

The increased water supply to Lower Egypt, due to the Aswân reservoir, has severely taxed the drainage channels of the provinces of Gharbieh and Beheira, forming the alluvial plain between Cairo and the sea. It is necessary to find some measure of relief, and a solution of the problem is sought in the construction of large pumping installations on the borders of Lake Mareotis and Lake Borollos.

Interesting details of the engineering features of the various projects are given in a series of articles recently published in the *Engineer*, from which most of the foregoing particulars are taken.

BRYSSON CUNNINGHAM.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

STOCK of the value of 300,000*l.* has been presented to the University of California by Mr. E. F. Searles, of San Francisco.

IT is announced that Yale University will receive from the estate of the late Mr. J. W. Sterling approximately 3,600,000*l.*, or about 600,000*l.* more than had been anticipated.

ANNOUNCEMENT is made in the *Times* that Mr. Balfour is to be nominated for election as Chancellor of Cambridge University, in succession to his brother-in-law, the late Lord Rayleigh.

DR. T. STUART, formerly professor of mathematics in Hongkong University, has been appointed lecturer in mathematics, and Mr. G. Mavor, formerly of the Gillingham Technical Institute, lecturer in mechanical engineering at the Loughborough Technical College.

THE sum of 1000*l.* has been given to the applied science department of Sheffield University by Mr. J. D. Brunton, of Musselburgh, for the annual award of a medal and premium for the best metallurgical research work done at the University during the year.

DR. J. F. GEMMILL, lecturer in embryology, University of Glasgow, and in zoology at Glasgow Provincial Training College, has been appointed to the chair of natural history at University College, Dundee, in succession to Prof. D'Arcy W. Thompson.

THE Edith Barnard memorial fellowship in chemistry in the University of Chicago has been endowed through the gift of 600*l.* by the mother, brother, colleagues, and friends of Edith E. Barnard, a former instructor in chemistry in the University. The fellowship has been temporarily maintained since 1916, but it has now been placed upon a permanent basis.

THE Commission for the Relief of Belgium is placing at the disposal of the country the sum of 6,000,000*l.*, which is to be devoted to university education, and will facilitate access to the universities for children of the poorer classes. The Universities of Brussels, Louvain, Ghent, and Liège are each to receive 13 per cent. of the money, the School of Mines at Mons 3 per cent., and the Colonial School 6 per cent.

A COURSE of training in industrial chemistry will begin at the Northern Polytechnic Institute, Holloway, N.7, on September 22. The course is open to the general public, and is adapted to the requirements of demobilised men who desire to qualify for positions as analytical and works chemists. In addition to the usual training in chemistry and allied subjects, glass-working, instrument-making, and plumbing are also to receive attention. Detailed information may be obtained from the Principal.

UNDER the Government scheme of financial assistance for the higher education of ex-Service officers and men, the total number of grants awarded by the Board of Education now amounts to 9500, including 4000 officers and 5500 men. The courses in respect of which grants have been awarded include more than 2500 for engineering and technological subjects, between 800 and 900 for classics, philosophy, and literature, and about 1200 for pure science and mathematics. Applications are still being received in large numbers, and are being dealt with at the rate of more than 100 a day.

THE new session of the Sir John Cass Technical Institute will commence on Thursday, September 25. The courses of instruction provided are specially directed to the technical training of those engaged in chemical, metallurgical, and electrical industries and in trades associated therewith. Full facilities are provided for those wishing to carry out work associated with the industries in which they are engaged or to undertake special investigations and research. Special courses of higher technological instruction form a distinctive feature of the work of the institute. The curriculum in connection with the fermentation industries includes courses of instruction on brewing and malting, bottling and cellar management, and on the microbiology of the fermentation industries. A connected series of lectures in fuel and power, comprising liquid, solid, and gaseous fuels and their application, electrical supply and control, the transmission of power in works, fuel analysis and technical gas analysis is also included in the syllabus of the chemistry department for the forthcoming session. Full details of the courses are given in the syllabus of the institute, which can be had on application at the office or by letter to the Principal.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 1.—M. Léon Guignard in the chair.—A. **Lacroix**: The mineralogical and chemical constitution of the volcanic lavas of Tibesti. Fourteen complete rock analyses are given, together with a general account of the minerals present.—G. **Humbert**: The measurement of the *ensemble* of the positive classes of Hermite, of given discriminant, in an imaginary quadratic body.—E. **Cosserat**: Some stars possessing a total annual proper motion of more than 0·5″. The movements of stars mentioned by A. van Maanen in 1915 and 1917, and one pointed out by Wolf in 1916, have been studied by means of the photographic catalogue of the Toulouse Observatory. The positions of seven stars are provisionally given possessing a proper motion of more than 0·5″.—M. **Tilho**: The raw materials and railways of tropical Africa north of the equator. A discussion of the best railway scheme, taken in conjunction with existing railways, for opening up northern Africa.—E. **Kogbetliantz**: New observations on ultra-spherical series.—G. **Guillaumin**: Contact forces in heterogeneous solids, with special reference to reinforced concrete.—B. **Jekhowsky**: Orbit of Metcalf's comet 1919*b*. The calculations are based on observations made on August 21, 22, and 23.—C. L. **Charlier**: The spiral nebulæ. As a working hypothesis it is supposed that spiral nebulæ are formed by the collision of an extra-galactic body with the solar system. This hypothesis explains simply two well-established facts.—A. **Soret** and R. **Couespel**: A multiple-valve microphone.—A. **Boutaric**: The calculation between the ratio of the vapour-pressure of a solid and that of the surfused liquid at varying temperatures.—J. **Guyot** and L. J. **Simon**: The action of dimethylsulphate and the alkaline dimethylsulphates on dry alkaline bromides and chlorides.—J. **Delpech**: The pure "B" powders. These specimens were prepared by complete solution of the nitrocellulose, followed by a filtration through cotton-wool under pressure. The powder thus produced is transparent, and doubtful portions can be detected by inspection.—MM. **Vermorel** and **Dantony**: The comparative usefulness of ordinary Bordeaux mixtures and mixtures prepared with the addition of casein for the preservation of grapes. The addition of casein is very advantageous.—MM. G. **Bertrand**, **Brocq-Rousseau**, and **Dassonville**: The destruction of bed-lice by chloropicrin. Quite moderate amounts of chloropicrin suffice for the practical disinfection of beds.

BOOKS RECEIVED.

The Exact Diagnosis of Latent Cancer: An Enquiry into the True Significance of the Morphological Changes in the Blood. By Dr. O. C. Gruner. Pp. vii+79. (London: H. K. Lewis and Co., Ltd., 1919.) 7*s*. 6*d*. net.

The Planting, Cultivation, and Expression of Coconuts, Kernels, Cacao, and Edible Vegetable Oils and Seeds of Commerce. A Practical Handbook for Planters, Financiers, Scientists, and others. By H. Osman Newland. (Griffin's Technological Handbooks.) Pp. vi+111+xi plates. (London: Charles Griffin and Co., Ltd., 1919.) 6*s*. net.

CONTENTS. PAGE

Science and Sociality. By Sir Arch. Geikie, O.M., K.C.B., F.R.S. 45
Botany of Cultivated Plants. By F. K. 46
Our Bookshelf 47
Letters to the Editor:—
Sea-fishery Investigations and the Balance of Life.—Prof. Walter Garstang; Prof. W. C. McIntosh, F.R.S. 48
Dr. A. G. Vernon Harcourt, F.R.S. By H. B. D. . 49
Dr. Charles A. Mercier 50
The British Association at Bournemouth 51
Section A—Mathematical and Physical Science—Opening Address by Prof. A. Gray, M.A., LL.D., F.R.S., President of the Section 52
Section B—Chemistry—Opening Address by Prof. P. Phillips Bedson, D.Sc., President of the Section 59
Notes 63
Our Astronomical Column:—
Comets 66
The Blink Microscope 66
Irrigation in Egypt and the Sudan. By Dr. Brysson Cunningham 67
University and Educational Intelligence 67
Societies and Academies 68
Books Received 68

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THURSDAY, SEPTEMBER 25, 1919.

THE MISSING THEME.

Wild Life of the World: A Descriptive Survey of the Geographical Distribution of Animals. In three volumes. By R. Lydekker. Vol. i., pp. xiv+472; vol. ii., pp. xii+440; vol. iii., pp. xi+457. (London: F. Warne and Co., 1916.) Price 4*l.* 4*s.* three vols.

IT is doubtful whether any modern naturalist other than the late Mr. Richard Lydekker could have written such a book as this. Endowed with a remarkable memory, boundless energy, and a facile pen, he spent his days in acquiring a perfectly unrivalled knowledge of natural history and in writing about it. No matter what aspect presented itself for discussion, it found Lydekker and his pen both ready and willing. A friend in common, writing for a newspaper, once confessed to Lydekker that he had great difficulty in finding themes for his weekly articles. "Pooh! I find no difficulty," said Lydekker. "I do not require a *theme*—I think of a *word.*" Using every possible moment and opportunity, and writing at incredible speed, Lydekker's literary output was enormous; it covered, moreover, the whole wide field between comparative anatomy, palæontology, and systematic work on one hand, and field natural history and sport on the other. While writing, at least, he was never filled with doubts or tormented by vain cares; whatever came into his head first he wrote, and what he wrote he printed light-heartedly as soon as possible. One scarcely likes to apply that harsh epithet "careless" to writing with so much good, solid work as its foundation, but the dangers of Lydekker's methods are obvious, and as a result one cannot place the normal degree of trust in any book that he wrote. Nevertheless, the fact that his books contain a huge store of real and valuable information is beyond all dispute and a testimony to the industry and genius of the author.

The three stately volumes now before us represent Lydekker's last effort. Well printed and beautifully illustrated, they appear unusually attractive. Opening them and reading at random, one is usually pleased and sometimes delighted with the text, and no doubt to many persons the book will be not only useful, but also a precious mine of information. Casual reading, however, is not the purpose of the book; it aims at being a descriptive survey of the geographical distribution of animals; but an attempt to read it as a whole proves to be a formidable and wearisome task, which one leaves sooner or later with a feeling of disappointment. From the title one expects a connected narrative in which there will be an attempt to expound, albeit in a popular manner, some of the principles underlying geographical distribution, to show how the present depends upon the past, and to bring home to the reader, however ignorant of zoology, the fundamental importance of such things as isolation—in its numerous forms—in the great scheme of evolution.

It would not matter at all what sort of view or theory the author developed in his narrative; he might have proceeded, with equal advantage, along the lines of his own "Geographical History of Mammals," or pursued the attractive, though totally divergent, courses of Scharff on one hand, or of Matthew on the other. Books with an endoskeleton are generally far better than those with a mere exo-skeleton. In one case the reader has something definite and more or less fascinating to follow; even when the writer's style is harsh and his phrasing none too happy, there is a plot which holds one fast while it gradually reveals itself in a well-connected stream of facts. In the other, the facts are disjointed and scattered—interesting and important in themselves, perhaps, but with little or no apparent bearing upon one another; in such a case the author may be endowed with superlative gifts of language and expression, enabling him to charm us on every page, perhaps, when taken in small doses, but he can never succeed in holding the attention of the reader from cover to cover. "Wild Life of the World" is in all essential respects a distinguished example of the books without endoskeletons. In this case, too, alas! Lydekker did not trouble to think of a theme—though he thought of a great many words.

The work calls for little more in the way of general criticism, but it may be worth while to direct attention to one or two specific matters. As an instance of the hasty selection of the facts dealt with, we may mention that, while more than two pages (vol. i., pp. 212–14) are devoted to a discussion of European field-mice (Microtus), no mention is made of the Orkney vole (*M. orcadensis*), which from the point of view of geographical distribution is one of the most interesting and important species; nevertheless, room is found for a whole paragraph dealing with the characters and habits of a phantom species, *M. campestris,* described from Brunswick long ago by Blasius, but generally admitted now for many years to be nothing more than a misidentification of the common Continental vole, *M. arvalis.*

In reading the book we have noticed few misprints. There is, however, an unfortunate transposition in the account of the cuckoo (vol. i., pp. 90–96) which may bewilder the reader. The matter from the word "moreover" in line 2 of p. 93 down to the end of the paragraph seems to be a misplaced continuation of paragraph 2 of p. 91, dealing with the colour and markings of the eggs. The name of the inventor of the harpoon-gun, Svend Foyn, has been converted into "Sven Foyle" (vol. iii., p. 310). It is with considerable satisfaction that we notice that Lydekker endorsed the view that whales and seals in southern latitudes are now in need of a measure of protection, and that our own Government has to bear the weight of direct responsibility in this matter. The quite indiscriminate and unscientific, though lucrative, slaughter which is at present happening in the southern hemisphere and elsewhere is rapidly leading both the larger Cetacea and a valuable industry to extinction.

Lydekker's remark that the Addo Bush elephants "are specially protected" causes a pang when we recollect that the statement is no longer true. No naturalist could hear of the recent decision to exterminate this most interesting herd without grief. One may be pardoned for wondering whether much more would be heard either of the damage done by these elephants or of the project to exterminate them if the authorities, in granting the licence to kill, were to stipulate that the whole of the profits of the chase should be expended upon obtaining such a series of specimens, photographs, and casts as would form an adequate memorial of the threatened race for the use of zoologists and comparative anatomists, and that the balance, if any, should be applied for the purposes of zoological research in Africa.

To conclude, we would reiterate that this book contains a vast amount of most interesting and valuable information brought together by a man of unrivalled experience and ability; this information is most lucidly conveyed throughout, and many passages in the work are quite charming. The illustrations, on the whole, are very good, and some of the coloured plates may fairly be called magnificent. Our sole regret is that Mr. Lydekker did not require a theme.

M. A. C. H.

WATER IN ACTION—CONTROLLED AND FREE.

(1) *Irrigation Engineering.* By Dr. A. P. Davis and H. M. Wilson. Seventh edition, revised and enlarged. Pp. xxiii+640. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 21*s.* net.

(2) *Shore Processes and Shoreline Development.* By Prof. D. W. Johnson. Pp. xvii+584. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 23*s.* net.

(1) AFTER passing through six editions, this work, originally composed by Mr. Wilson in 1896, has been recast and largely rewritten with extensive additions by Dr. A. P. Davis, whose own book on "Irrigation Works in the United States" was reviewed in NATURE for June 20, 1918. It speaks much for the merits of a technical work that it should reach a seventh edition, and the present issue will undoubtedly maintain the reputation gained by its predecessors.

The scope of the treatise is wide—admittedly too wide for complete treatment—and the object kept in view, and that very successfully, has been to present a general outline of the whole field of irrigation work, including its history, the chemistry of soils and soil treatment, sources of water supply, methods of application and measurement, construction of canals and dams, drainage and sewage disposal, water rights, surveys and preliminary investigations, and systems of operation and maintenance. It is obvious that, even in a volume of 600 odd pages, matters so many and so varied could not be treated exhaustively, and that some must receive less attention than, perhaps, is their due. The chapter on masonry dams, for instance, would, in our opinion, have admitted with advantage of some amplification in respect of the fundamental law of the middle third, and some account of the theory of vertical shearing stresses, especially as the book is intended primarily as a manual for engineers.

On the other hand, there are to be found on nearly every page practical notes of considerable utility. Moreover, at the end of the volume is the complete specification, running to fifty-six pages of small print, of the contract for the construction of the Arrowrock dam in Idaho. This, in itself, will prove of inestimable value to the practising engineer for reference purposes. There are also a number of tables with useful data, and computed results of various formulæ.

Another restriction, which must be noted and, perhaps, is inevitable, is that, with one or two rare exceptions, all the examples illustrated are chosen from American practice. It is true that the Assuan dam is mentioned, and that Indian irrigation is not without notice, but the book is written almost entirely from the American point of view. Possibly it gains in interest and value in this way, since the authors thus confine themselves to cases in which they speak with experience and authority.

The illustrations, both photographs and diagrams, are excellent throughout. It is a most valuable and informative book, in a comprehensive way, on a subject which materially affects farmers, geologists, meteorologists, engineers, chemists, and business men, as well as the highest interests of the State.

(2) A work of some 550 pages, in which a list is given of 416 authorities cited, and the references in one chapter alone amount to 187, cannot fail to impress the reader with the erudition of its author and the immense labour he must have taken to collect his data. We pay a tribute, in passing, to the unremitting zeal and perseverance which have produced so concise a compendium of opinion on a subject which, on account of its complexity, is little understood and yet is of the greatest scientific interest.

The book is compiled on methodical lines. Each chapter opens with an "Advance Summary" and closes with a "Résumé." The first and second chapters deal with waves and their work, the third with currents, and the fourth with shore classification. The ensuing six chapters contain an exposition of theories of shoreline development.

The earlier part of the volume is largely historical and retrospective; it reviews the data obtained by experimentalists in the past, with the conclusions based upon them. That there is a radical divergence of testimony is evident from the fact that by one school of thought coastal drift is attributed entirely to wave action, and by another to current flow. By the author no doubt is entertained that, as a whole, waves are the more important agency, and in this view of joint action we are disposed to concur.

In dealing with shorelines, the author rejects the German system of numerical notation, and classifies them broadly as submergent, emergent, neutral, and compound, with a cycle of development passing from young to mature and old. Each of the four classes is dealt with at length, and there are apposite examples, illustrated by photographs, charts, maps, and diagrams, which will repay study. Fjords are not recognised as an indication of land subsidence, but are attributed to glacial action, and it is interesting to note the author's opinion that "any careful analysis of the process of marine erosion must lead to the conclusion that marine planation is possible without coastal subsidence."

The book covers a fairly wide area, and is written with the intention of assisting the engineer, the geologist, and the geographer. As affecting the first-named profession, the difficulty of reconciling the conflicting views of so many eminent authorities seems to us almost insuperable. There is scarcely any problem which causes the harbour engineer more perplexity and anxiety than that of forecasting the effect on the shoreline of a structure projecting into the sea, and in the present state of our knowledge—or ignorance—the evidence available is often capable of quite contradictory interpretations. No doubt further investigation will throw more light on this baffling question, but, for the present, it is beset with obscurity.

The volume is an excellent addition to the literature of physiography, and it fulfils a special function in classifying much fragmentary and detached information not readily accessible.

BRYSSON CUNNINGHAM.

MAMMALIAN PHYSIOLOGY.

Mammalian Physiology: A Course of Practical Exercises. By Prof. C. S. Sherrington. Pp. xi+156+ix plates. (Oxford: At the Clarendon Press, 1919.) Price *12s. 6d.* net.

THE publication of Prof. Sherrington's practical course of mammalian physiology will surely be recognised as an event of first-rate importance for the teaching of physiology and for medical education.

Many teachers must long have felt the limitation imposed by the use of the frog for practically all class-work on living animal organs. The experiments possible to students were restricted to certain aspects of the subject; some were liable to be retained in the course which had mainly historical interest, and others were apt, in unpractised hands, to degenerate into exercises in fine dissection. Nor had the technical facility thus acquired much relation to the later requirements of the medical equipment.

The introduction into class teaching of the surviving carcass of the decerebrated or decapitated cat effects a great liberation. The student can observe for himself the main phenomena of mammalian function. The technique is in most cases relatively so simple that attention is concentrated on the observation of the result; at the same time, it has real value as an introduction to surgical manipulations.

The course opens with exercises on isolated mammalian plain muscle—intestine, spleen, and artery—and on the perfused heart of the rabbit. They involve no very new departure, but the methods given require simple apparatus only, and are admirably adapted to give successful results in the hands of students. Here, too, as throughout the book, each exercise is given the maximum educational value by the explanatory and historical comments.

From Exercise IV. onwards the decerebrated or decapitated carcass is used. Starting with relatively simple experiments on the arterial blood-pressure, the course leads to more elaborate demonstrations of the effect of nerve-stimulation on the vascular mechanism and the activity of the respiratory centre, of vascular and somatic reflexes, and ultimately, when the requisite dexterity has been acquired, to such relatively exacting experiments as that on the stimulation of pancreatic secretion by secretin. In each exercise the opportunities are fully used for incidental observation of important phenomena, not directly connected with the main object of the experiment.

The student who conscientiously follows this course must emerge with a wealth of experience in the methods of physiological observation, and a vivid apprehension of vital phenomena, which no amount of reading or even of witnessing prepared demonstrations could give. Prof. Sherrington himself points out that the method leaves to the individual teacher a wide choice of valuable exercises, beyond the representative series which he has been able to accommodate within the limits of his course. He opens, indeed, a new vista of possibilities to student and teacher alike.

The value of the book is greatly enhanced by the admirably clear drawings of dissections and apparatus. The records reproduced, nearly all taken from experiments made in the class, give convincing evidence that the exercises are well within the compass of the keen student. The last exercise of all, that on the determination of the opsonic index, seems to lie curiously outside the general scope of the course, and to have no clear connection with the opportunities offered by the brainless mammal. Doubtless experience has shown that its inclusion has some special advantage.

Not only students and teachers, but also those engaged in original investigation, have abundant cause for gratitude to Prof. Sherrington for the care and labour which he has expended on putting his methods and experience at their disposal.

H. H. D.

OUR BOOKSHELF.

Birds Beneficial to Agriculture: Economic Series No. 9, British Museum (Natural History). By F. W. Frohawk. Pp. vi+47. (London: British Museum (Natural History), 1919.) Price 2s.

It is important that attention should be focussed now and again on the benefits that accrue to farmer and gardener from the activities of birds, for too frequent reiteration of misdemeanours tends to produce an antagonism which the facts do not warrant; and there is greater danger in indiscriminate destruction than in indiscriminate protection. Recognising these facts, the Trustees of the British Museum have done good service, at once to the farmer and to the naturalist, in publishing this pamphlet, and in preparing the special exhibit to which it makes an efficient and attractive guide.

Of the birds the presence of which in Britain is of any importance in this connection, "120 species may be regarded as decidedly beneficial to agriculture generally," and of these Mr. Frohawk describes in detail a very fair sample of forty-four species, and adds besides two short general notices, necessarily somewhat perfunctory in treatment, on birds in their relation to injurious insects and to agriculture. Careful illustrations by the author make easy the task of identifying a large proportion of the species described. It is to be regretted, however, in a work dealing primarily with economic values that more space could not have been given to feeding habits and food statistics, even at the expense of specific characters and of habits of less immediate importance. Nevertheless, this latest addition to the "Economic Series" of British Museum Publications should help to awaken and broaden interest in the valuable heritage which Britain possesses in its birds.

Rudiments of Handicraft. By W. A. S. Benson. Pp. 40. (London: John Murray, 1919.) Price 1s. net.

This is a forty-page pamphlet, illustrated by fourteen pages of sketches, which attempts to set forth the principles and practice of manual training for children between the ages of eight and twelve, taking wood in the form of sawn laths 1⅛ in. wide and ¼ in. thick as the material to be used.

The idea of the use of strip wood manipulated by quite simple tools is by no means new, having been adopted in certain important educational centres more than twenty years ago. It is difficult to realise how some of the exercises figured in the book can be made into the substantial structures for which they are designed on the methods described, and many of the drawings leave much to be desired from both the technical and artistic points of view. It is just as important for the pupil to be taught to make an accurate drawing in plan elevation and section of the object he purposes to produce as it is for him to execute it.

The well-trained manual instructor who ought to find an honoured place in every school will search in vain for much that is really helpful to him in the pamphlet. The principle of hand and eye training and of its high and necessary educational value is now fully admitted by educationists and is well established, and a large body of capable men fully trained in teaching methods are now available who have formed themselves into an association and assemble in annual conference with the view of promoting the efficiency of their work.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

National Representation upon International Councils.

In the account of the meeting of the International Research Council (NATURE, August 14, p. 464) it is stated that "the United Kingdom" was "represented" on the council by "delegates." The explanation in the first paragraph of your Notes of September 4 of how the "delegates" were appointed shows that the words are the expression of an intention rather than of a fact. The council apparently wished that its decisions should have some authority other than that derived from the personal distinction of its members, but their wishes remained unfulfilled because there is in existence no machinery for selecting a delegation representative of the scientific workers of this country. It seems worth while, therefore, to inquire what characteristics such machinery must have in order that it should fulfil this purpose, and how such machinery could be set in action.

I suggest that the machinery necessary and sufficient would be such as secures that every professional scientific worker is informed of any action that it is proposed to take which may affect his work and that he has a constitutional means of expressing his opinion upon the proposal. It does not appear to be necessary that any attempt should be made to obtain the equality of voting power which is important in a representative body concerned with political and economic questions—so long, of course, as such questions are excluded from the domain of the body and its attention is confined to purely scientific matters.

The chief difficulty in establishing such machinery is that of defining the class of professional scientific workers. It ought to be overcome by the method used in defining the members of other professions. Lawyers, architects, actuaries, and medical practitioners are defined by membership of certain professional societies, of which the distinctive feature is that they admit to membership all who have undergone certain training and acquired certain experience. Societies having this feature already exist in the profession of science; the various scientific and engineering institutions and institutes are examples. They do not at present cover the whole field, but it will probably be agreed that it is desirable that they should. The best way of securing the representation of science would be to set up institutes for those branches of science which do not already possess them; to organise a small permanent secretariat supported by them all; and to charge this secretariat with the duty of bringing before the institutes any scientific matters likely to interest them. It should be made clear that this secretariat should be the means of communication between the scientific profession of this country and all outside bodies (foreign scientific bodies, Governments, commercial organisations, and so on); to discuss the questions submitted to it, the institutes would appoint delegates appropriate to the nature of each question.

But it is always desirable, if possible, to use existing machinery for such a purpose. It is possible that such an organisation as is required might be developed out of the Conjoint Board of Scientific Societies. The societies represented on it do not all conform to the type of institutes; some are barely scientific; some have no professional test for membership; some of them overlap and represent practically identical interests. But it is probably better to have some machinery at once rather than a perfect machine which will take long to get into action; probably also the machine will improve as it works; its defects will be apparent, and there will be a demand for their cure. I venture, therefore, to suggest respectfully that, unless anybody has a better plan to propose, the Conjoint Board should consider early and earnestly whether they cannot take upon themselves, permanently and consistently, the functions of a body representative of scientific workers in all purely scientific matters.

Hitherto these functions, in so far as they have been exercised at all, have been exercised by the Royal Society. While it was held that the proper spokesmen for science were its most eminent students, no body could have been more suitable for selecting them than that which annually selects for the coveted distinction of its membership the fifteen most eminent men of science still outside its ranks. (For it is obvious that no woman could be included in that number.) But if the spokesmen are to be representative delegates, no body could be less suitable. If the character of the society is to be maintained, exclusiveness must be as essential a part of its constitution as inclusiveness must be of any representative body. By its very nature the Royal Society can never represent any but a small fraction of scientific workers; it cannot represent the fraction which, because its work lies in the future rather than in the past, is most likely to be affected by any proposals for change. We all thank the society for what it has done; we can express our gratitude best by liberating its energies for those more important tasks for which its constitution is adapted.

Norman R. Campbell.

Kettlewell, September 20.

Intravenous Injections of Gum Solutions in Cholera.

In Nature for June 5 Prof. Bayliss advocates, with good reason, in view of his valuable work on gum solutions in shock, that a trial should be made of their intravenous injection in cholera with a view to obtain a more prolonged maintenance of the blood-pressure than sometimes follows the use of hypertonic salines. Last year Prof. Bayliss kindly sent me a copy of his paper on gum solutions in shock, and in acknowledging it I informed him that I had previously read it, and been so struck with the possibilities of the method being of great value in the very severe cases of cholera which repeatedly collapse, and are sometimes lost in spite of hypertonic salines, that I had lost no time in trying it, but, unfortunately, with very disappointing results. This letter apparently did not reach Prof. Bayliss, probably on account of "enemy action."

With one exception, the cases in which I tried the gum solution were rather below the average severity, as is commonly the case in the rainy season, when the trial took place; yet several were lost which I should have expected to have recovered under hypertonic salines Still more striking was the fact that, instead of the great relief, often resulting in sleep before the hypertonic saline injection is finished, the gum solutions were followed by increasing distress, difficulty of breathing, and cyanosis, which soon compelled me to abandon their use. In view of the shortness of my trial, I decided not to publish my results at once, in the hope that others might be more successful, but I have now learned that my friend, Lt.-Col. A. Leventon, I.M.S., has extensively tried gum solutions in accordance with Prof. Bayliss's method at the Campbell Medical School Hospital, Calcutta, where well over one thousand cases have been treated in the first half of this year, and Lt.-Col. Leventon has authorised me to state that, with various strengths of the purest gum arabic up to 7 per cent., his results have been in entire agreement with mine, and he has also had to abandon the method. He, too, noted the same distress and cyanosis which I saw, and the unexpected loss of not very serious cases under the treatment—clearly indicating that gum solutions do not meet the physiological needs of cholera cases.

I confess that this failure has been a great disappointment to me, but I believe the explanation to be that the gum solutions lead to the retention in the circulation of the deadly cholera toxins, which are absorbed from the bowel in increasing quantities with the restoration of the circulation by intravenous injections of large quantities of salt solution, with or without gum, but which are usually sufficiently rapidly re-excreted through the kidneys and bowels after hypertonic saline to avoid dangerous accumulation in the blood. The fact that I found salines made up with freshly distilled water produced febrile reactions, indicating that the fever was due to toxin absorption, lends support to this view. There is still room for considerable improvement in the treatment of the most severe toxic cases of cholera, but the hopes which Prof. Bayliss's researches in shock led me to expect from gum solutions in cholera have been disappointed. I have for long thought that the most promising line of advance is the use of anticholeraic serums, such as those formerly made by Salimbeni in Paris and Schurupow in Russia, but which I have not yet been able to obtain facilities for making in Calcutta owing to the war. Perhaps one of the hill laboratories of India could take up this important line of work, and send the serum to be tested in Calcutta, in addition to my system of treating cholera.

Leonard Rogers.

I beg to thank you for your courtesy in permitting me to see the above communication from Sir Leonard Rogers. It is unfortunate that the letter to which he refers did not reach me, because it is evident that the effect of gum saline in states similar to that of cholera requires investigation. If the cases to which reference is made had been very severe, one might have supposed that an excessive viscosity was conferred on the blood by the addition of gum. I have made some experiments on this point, but have been unable to detect any serious result when gum saline has been injected after the blood has been concentrated by various means.

It is possible that the retention of toxins may be the explanation, and, of course, the object of any simple intravenous injection is merely to keep up a normal circulation until the remedial agents, such as the specific sera to which Sir Leonard Rogers refers, may be able to produce their effect. The symptoms mentioned, however, suggest to my mind rather some mechanical action of the gum, and it might perhaps be worth making a trial of a preliminary saline injection, followed later by one of gum saline, to avoid too rapid a loss of the fluid injected. In any case, I hope that the experiments now in hand may throw further light on the problem and lead to a means of avoiding the serious disadvantage. I may mention that in my experiments gum saline was found very effective in restoring the renal secretion, and I am convinced that if it should be found possible to use such solutions they would be more permanent in their results and lead to the more rapid elimination of the toxins, if this takes place through the kidney.

W. M. BAYLISS.

A Photoelectric Theory of Colour Vision.

READING in the *Irish Times* of to-day (September 11) a very brief reference to a paper communicated by Sir Oliver Lodge to the British Association, in which Sir Oliver suggests that light absorbed in the black pigment may stimulate certain atoms into radioactivity and so cause the sensation of light, I am reminded of a theory of colour vision which I endeavoured to investigate some years ago. The theory is that the emission of electrons, probably by the pigment layer under light stimulus, is responsible for light-sensation, and that where these electrons act upon the cones they excite colour vision. It is known that, in the photoelectric expulsion of electrons by light, the range of the electron increases with the frequency. Hence for violet light the cone would experience a different distribution of the stimulus from that for red light, and so on.

I endeavoured to detect a photoelectric effect by experiments of the usual sort, using a bullock's eye in which the pigment layer had been exposed. Although a fairly sensitive arrangement was ultimately arrived at, I failed to detect the sought-for effect. I put the matter aside, although urged by some physiologists to continue it.

That the photographic image is initiated in a somewhat similar manner seems very probable. On this view much has already been written.

J. JOLY.

Trinity College, September 11.

Mathematics at the University of Strasbourg.

I HAVE received the programme of the courses in mathematics at Strasbourg, which will undoubtedly stand second only to Paris among the French universities. The Institut de Mathématiques, which forms part of the Faculté des Sciences, is to have five titular professors and three "maîtres de conférences," and offers complete graduate and post-graduate courses. The professor of *analyse supérieure* and director of the Institut is M. Maurice Fréchet. MM. Valiron, Villat, and Esclangon occupy respectively the chairs of calculus, rational mechanics, and astronomy; the chair of geometry has not yet been filled.

While English mathematicians are fully appreciative of the work of their French *confrères*, the French universities, where students of the other nations of the world have flocked, have in the past been a little neglected by English mathematical students. An English student could not do better than spend one of his post-graduate years in France, where he will find every facility and encouragement, and a very warm welcome.

H. BRYON HEYWOOD.

The Magnetic Storm of August 11–12, 1919.

I OBSERVE in the issue of NATURE for August 21 an account of the magnetic storm of August 11–12, 1919, by Father Cortie, of Stonyhurst College Observatory, and note that he looked out for a possible display of aurora on the night of August 11. "But," he says, "the brightness of the moon effectually veiled any such appearance, even if it were present."

In these circumstances it may be well to record that a fine display of the Aurora Borealis was observed here, Cape Breton Island, Nova Scotia, on the night of August 11. The affected area extended far into the southern sky. Pulsations of light swept upwards to the zenith, resembling clouds driven before a heavy wind.

ALEXANDER GRAHAM BELL.

Beinn Bhreagh, near Baddeck, N.S.

September 5.

THE WATT CENTENARY CELEBRATIONS.

THE Watt Centenary Celebrations in Birmingham last week were full of interest, and the presence of representatives from the United States of America, Australia, France, Japan, and Sweden, as well as a cordial message from Norway, bore testimony to the honour in which the memory of James Watt is held throughout the world. At the inaugural meeting on Tuesday, September 16, the Lord Mayor (Sir David Brooks), in welcoming the visitors (among whom were Mrs. Gibson Watt and Miss Boulton, direct descendants of James Watt and Matthew Boulton), said that it was fitting that Birmingham should wish to establish a permanent memorial to the man whose discoveries and inventions had done so much for the city of his adoption. He thought that the proposals as to the form which the memorial should take would commend themselves not only to Birmingham citizens, but to all who really appreciated the work which James Watt and his associates had accomplished. It was proposed to endow a "James Watt Chair of Engineering" at the University of Birmingham, for the prosecution of research in the fundamental principles underlying the production of power. He hoped that the success of this part of the scheme would early be placed beyond doubt. In addition to this it was very desirable to have in the city a suitable building to house examples of the work of Watt, Boulton, and Murdock, and the relics which these men had left behind—a building which might also be a suitable meeting place for scientific and technical societies.

An address on "The Rise of Engineering Manufacture" was then delivered by Prof. F. W. Burstall (professor of mechanical engineering in the University of Birmingham). Before the middle of the eighteenth century a high degree of skill in metal work had been attained, but lack of power restricted the scale on which work could be done. Prof. Burstall directed attention to the fact that Boulton and Watt were looked upon as the first builders of steam engines, but their work in starting a system of co-ordinated manufacture had generally been overlooked. He believed that both the conditions of work and the quality of the workmen to-day were considerably in advance of those of one hundred years ago. There was no likelihood that the highly-skilled worker would ever be replaced by a machine, but for the vast number of unskilled workers machinery meant monotonous work. For the latter the provision of means of healthy recreation was of vital importance.

Then followed a lecture by Prof. Hele-Shaw on "James Watt and Invention." The lecturer emphasised the importance of inventions, and remarked that in the late war the country was many times saved by our own inventions, which were brought into being under the stimulus of patriotism and the encouragement given by timely organisation. He made the suggestion that, as Watt was so pre-eminent as an inventor, the proposed James Watt chair should be a chair of invention instead of one of engineering. Such a chair would be unique and worthy of James Watt as a new and original departure.

In the afternoon an impressive memorial service was held at Handsworth Parish Church, where Watt and his associates worshipped and were buried. Adjoining the church is the memorial chapel in which stands the famous Chantrey statue of James Watt, and there, after the singing of the anthem "Let us now praise famous men," the Lord Mayor of Birmingham laid a laurel wreath at the foot of this statue. The address was delivered by the Rev. Dr. E. W. Barnes, Canon of Westminster, who claimed that "it was especially fitting that Birmingham should honour James Watt, for it was there that he perfected his steam-engine; there he found workmen of sufficient skill to carry out his designs; there he found in Boulton the friendly capitalist of whom he was in need; there his fortune was made; and there he died in honourable old age. Throughout his life Watt was a religious man. He had not the temper or interests of a theological partisan. His attitude was that of a philosopher, conscious of the complexities of social organisation and of the inherent difficulties of government—a man of science, fully understanding how immense were the distances that shut us in, and not unconscious of the danger of unduly dogmatic speculation as to the unknown." Dr. Barnes compared the good and evil resulting from Watt's genius: "We were, owing to Watt's inventions, using up coal at a dangerously rapid rate, and when it was gone the industry and the workers which the coal sustained must pass to other lands. The desire for more motion and for barren luxuries had crowded life and wasted toil, taking largely from man's mental freedom and physical rest. And of all barren luxuries by which man wasted Watt's legacy the worst was war. We could thank God sincerely for Watt's discoveries and the mechanical revolution to which they led, if we remembered that it was the political sagacity and moral wisdom of men that had been at fault. In the last century mechanical progress so outstripped spiritual growth that disaster resulted. In default of security gained by religious idealism, the better men and the best races would be eliminated by war, and we should be left with moral degenerates, clever, indeed, in the invention and control of machines, but destitute, and even contemptuous, of spiritual energy."

After the service the visitors were entertained at a garden party at Heathfield Hall by Mr. George Tangye, and much interest was shown in Watt's famous garret-workshop, which has been preserved in the condition in which he left it a century ago.

On Wednesday morning, September 17, the proceedings were presided over by the United States Ambassador (the Hon. J. W. Davies), and an address was given by Sir Oliver Lodge on "Sources of Energy." The lecturer, in his most attractive and vigorous style, dealt mainly with the possibilities of intra-atomic energy. The stock of energy of this kind is prodigious, but it is at present almost entirely inaccessible, and the lecturer speculated on the possibilities of its use in the future.

This was followed by Prof. J. D. Cormack, Regius Professor of Engineering in the University of Glasgow, with a paper (written in collaboration with Prof. Barr) on "The Model of the Newcomen Engine repaired by James Watt."

In the afternoon, visits were paid to some James Watt engines, one at Ocker Hill being shown in action. Here Watt's original indicator was seen at work, and indicator-diagrams taken on it were distributed among the visitors. The occasion was one of unique interest, vividly impressing the mind with the genius of the great engineer, and at the same time bringing home the vast developments which a century has seen in the applications of steam-power.

In the evening about 300 guests assembled for the centenary dinner at the Grand Hotel, the Lord Mayor presiding, and the American Ambassador and the Chancellor of the Exchequer being prominent in a gathering of distinguished men. In proposing the toast of the "Houses of Parliament," Sir Oliver Lodge insisted on the vital need of the encouragement of scientific research, not by an *ad hoc* bureau in London, but through the universities throughout the country. He coupled with the toast the name of the Chancellor of the Exchequer. "They in Birmingham had an affection for Mr. Austen Chamberlain, and they in the University of Birmingham regarded him with affection because when he last held his present office he increased to them a Government grant which subsequent occupants of the office had followed up. It would be wisdom for this country to lavish money upon the universities. Economy was necessary, but it did not pay to cut off the best part of the money granted to the universities."

Mr. Austen Chamberlain, in replying, spoke of the difficulties of a Chancellor of the Exchequer, especially at the present crisis; but he was sympathetic. University education was one of the things that seemed to him to require generous treatment, and he had endeavoured to ensure that university grants should be increased—not merely by a temporary increase which was given to repair the injury done by the war, but by a permanent increase. That expenditure would grow as they could afford it, but they must not expect the Government to move too far. People might be enthusiastic men of science and devoted sons of universities on Monday, but on Tuesday, when he presented the budget, they were taxpayers. ". . . The Government would do its share on one condition only—that the towns did their share also."

The toast of "The Navy, Army, and Air Force," proposed by Mr. Gilbert C. Vyle, was replied to by Admiral Sir G. G. Goodwin, who acknowledged the debt of the Navy to Watt, and by Colonel Barraclough (professor of engineering in Sydney University), the latter expressing the opinion that "if the agitator, the profiteer, the man who was inclined to relax his labours, could all come to Soho and live, as the visitors to that commemoration had done, with the memories of Watt and his co-workers, they would go away with a higher sense of their responsibilities to themselves and to the community of which they formed a part."

The American Ambassador proposed the toast of "The City of Birmingham" in an admirable speech, in the course of which he said that one date in the summary of the important events in the life of James Watt was that of the American Revolution. "The ideas that the revolution embodied had not lost their force. But, great as that revolution was, and important as Americans believed the date to be, he was reminded that it was the year of an even greater revolution—the year when James Watt made his invention a practical success."

The toast of "The Memory of James Watt" was proposed by Prof. Burstall, who emphasised the value to James Watt of the strength and co-operation of Boulton.

Prof. Rateau brought "a tribute of honour and appreciation from science and labour in France to the memory of the great man in whose honour they were met that day."

On Thursday, at a special degree congregation, honorary degrees were conferred by the University on the American Ambassador, M. Auguste Rateau, Prof. Archibald Barr, Sir George Beilby, Colonel Blackett, Engineer Vice-Admiral Sir George Goodwin, and Mr. F. W. Lanchester. It was much regretted that Sir Charles Parsons was unable to be present.

On Saturday representatives of the Chamber of Commerce, the University, and engineering workers in Birmingham formed an impressive procession headed by a model of a James Watt engine. The interest taken by the workers themselves in the memory of Watt is perhaps the most encouraging feature of the commemoration, for the future depends very largely on the attitude of organised labour, and there is no doubt that many of the leaders of labour take an enlightened view of the educational needs of the country.

PROF. J. W. H. TRAIL, F.R.S.

WE regret to record the death on September 18 of Prof. Trail, who for forty-two years held the Regius chair of botany in the University of Aberdeen. Carrying his sixty-eight years with uncommon vigour, he lectured twice daily to the overcrowded classes of the past summer, and he seemed in July to be in the enjoyment of his usual health, so that it was with a shock that his friends heard of a serious operation. At first he rallied, but then rapidly sank. Those who knew him could hardly imagine for him any other end than that he should thus die in harness.

Prof. Trail was a marked figure in Aberdeen. Orcadian by birth, he was the son of Dr. S. Trail, professor of systematic theology in Aberdeen, and moderator of the General Assembly in 1874. He graduated with highest honours in natural science in 1876, and took his M.D. in 1879. In 1873–75 he travelled in Northern Brazil as naturalist to an exploring expedition, and used this opportunity for making a special study of Palms, of which family he had an expert knowledge. His results were published in a series of papers "On the Palms of the Amazon Valley," contributed to the *Journal of Botany*. On his return at the age of twenty-six he was appointed to the chair of botany in succession to Dr. Dickie. He held that post till his death.

Prof. Trail's work was marked by extreme accuracy, and guided by a keen sense of duty. Once a specimen was collected, he felt the obligation to make the most of it. The result of such work, extending over so long a period, has been the amassing of an enormous record of facts relating especially to the native flora. The *Scottish Naturalist* was one of the chief channels of his publication. There he produced a series of papers on Scottish galls and on leaf-diseases, which will provide rich material for those who follow. His mind was attracted by fact rather than by theoretical construction. His knowledge of those details which he studied was singularly wide and exact. For instance, having noted the inconstancy of floral construction in *Polygonum aviculare*, he monographed a single plant, and found as many as 120 distinct variations in number and relation of the floral parts borne upon it. He was rather reluctant in publication, but he was most generous in imparting his knowledge by correspondence, thus suggesting the stores that lay behind. These were most readily revealed to the botanical visitor to his house.

Prof. Trail was thoroughly typical of Aberdeen, vigorous, self-reliant, with a strong sense of duty, and a touch of austerity in its performance. Brought up in the granite city, he took a large hand in the guidance of education there. Not only was he a leader in the University itself, but he also took part locally in directing that secondary education which forms the natural foundation for the higher learning. Himself son of a professor and moderator, he married a daughter of the late

Prof. Milligan, who was also moderator of the General Assembly, and clerk of senate in Aberdeen, and he leaves a son and three daughters. Thus truly the spirit of Aberdeen University was bred in his bones, and inspired him throughout his life. F. O. B.

NOTES.

SIR RICHARD GLAZEBROOK's appointment as Director of the National Physical Laboratory expired on September 17 on his attaining the age of sixty-five. Sir Richard had held the post with distinction for twenty years, having been appointed on the foundation of the laboratory by the Royal Society in 1899. For the first two years the work of the laboratory was carried out at Kew Observatory by the staff of the observatory with the addition of three scientific assistants. The income was approximately 5000*l*. per annum. Soon afterwards Bushy House became the home of the laboratory, and as its work extended additional buildings were erected in the grounds. At the present time these buildings probably provide a space twenty times that of Bushy House, and the staff now numbers about five hundred, nearly two hundred of whom are women. The ordinary expenditure of the laboratory just before the war was about 40,000*l*. per annum. During the war it rose to 110,000*l*. per annum. The rapid growth of the institution is the best proof that it met a real need, and that it met it efficiently. It owes its success to the administrative powers of the director and to the skill he exercised in his choice of the men to fill the earlier appointments. Without exception, these men have distinguished themselves by their scientific work and have contributed largely to the reputation the laboratory now enjoys. Eighteen months ago the laboratory was taken over by the Department of Scientific and Industrial Research, and, according to the report of that Department for 1918–19 just issued, 154,000*l*. is allocated to it for the current financial year Although the laboratory does not attain its majority under Sir Richard's directorship, he has had the satisfaction of rearing it to a vigorous manhood, and he will from his Cambridge home watch its growth under Government auspices with interest. He is succeeded by Dr. J. E. Petavel, professor of engineering in the Victoria University of Manchester.

CIRCULAR No. 39, dated September 1, issued by the Meteorological Office, mentions the retirement of Rear-Admiral Sir John F. Parry and the appointment of Rear-Admiral F. C. Learmonth, C.B., who succeeds as Hydrographer of the Navy, and consequently as an *ex-officio* member of the Meteorological Committee. A conference of meteorologists will be held in Paris on September 30 and subsequent days, following the conference in London of the meteorologists of the British Dominions from September 23 to 27. A note is given relative to the time of occurrence of minimum air-temperature on the grass. The observations at Cahirciveen have been handled to test a suggestion made that the grass minimum for the night is frequently reached between sunset and 21h. Since April 1, 1917, the grass minimum at Valencia has been set at 18h., and read daily without disturbance at 21h. Out of 850 observations made to June, 1919, the number of occasions on which the phenomenon was observed was 101, which seems to be accounted for by a cloudy to overcast sky setting in during the evening, followed by rain, mist, or drizzle, with a wind of moderate force having a southerly component, the sky previously, between 18h. and 21h., being comparatively clear. The effect of terrestrial radiation is clearly to be traced in the foregoing explanation.

FROM the September issue the *Technical Supplement to the Review of the Foreign Press*, formerly issued by the General Staff of the War Office, is to be known as the *Technical Review*. With the same organisation and staff it will continue to provide a digest of the technical Press of the whole world for the benefit of engineers and manufacturers. At present the articles in it consist either of abstracts or of titles, with occasional short accounts arranged under the heads:—Engineering construction and transportation, mechanical engineering, mining and metals, shipbuilding and marine engineering, electrical engineering, aeronautics, chemical engineering and industry, miscellaneous, recent publications, and engineering index. The review provides for engineering in general the information as to recent progress which has been available for electrical engineering for some years in *Science Abstracts*, and for chemical engineering in *Chemical Abstracts*, as well as in the abstracts published by the Chemical Society and the Society of Chemical Industry.

AN important collection of Lycænidæ and Hesperidæ has recently come into the possession of Mr. J. J. Joicey, and is now at the Hill Museum, Witley. This collection was made by Mr. Hamilton H. Druce, who is well known as one of our greatest authorities on the Lycænidæ and Hesperidæ. A great many types of species described by Mr. Druce, as well as many of the types of Semper, are contained in the collection. Entomologists desirous of comparing any specimens in this collection are invited to write to the Curator, the Hill Museum, Witley, Surrey.

THROUGH the courtesy of the Corporation of London, a series of fortnightly lectures on industrial problems will be delivered at the Guildhall at 4.30 p.m., commencing on October 7. The speakers will include Mr. E. J. P. Benn, Prof. Ripper, Dr. Russell Wells, the Right Hon. Sir Auckland Geddes, Sir George Paish, and the Right Hon. Lord Emmott. Tickets for this series can be had on application to the Secretary, Industrial League and Council, 66 Victoria Street, S.W.1.

THE New York correspondent of the *Daily Mail* announces that, on September 18, Mr. Roland Rohlfs reached an altitude of 34,610 ft. in seventy-eight minutes in a 400-h.p. Curtiss triplane. The flight was observed by officials of the Aero Club, who sealed Mr. Rohlfs's instruments, and, when he landed, sent them to Washington for verification. The previous record for altitude was that of 30,500 ft. attained by Capt. Lang and Lieut. Blowes in January last. (See NATURE, January 9, p. 369.)

IT was announced by Sir Robert Hadfield at the autumn meeting of the Iron and Steel Institute, which opened on September 18, that the Prince of Wales had consented to become an honorary member of the institute. Dr. Federico Giolitti, formerly professor of metallurgical chemistry and metallography at Turin, was presented with the Bessemer medal for 1919 in recognition of his services to the science of metallurgy.

A LARGE neolithic graveyard, of the La Tène period, has been found by Dr. B. Schnittger at Gestilren, in Vestrogothia. Two quadrangular and ten circular stone enclosures were set on a gravel esker and covered by smooth slabs. The bones were burned, and in hollows or urns. Similar graves are known at Halleby and other places in Ostrogothia, but these are the first discovered in Vestrogothia.

THE Scandinavian Association for a Tropical Biological Station has decided to send an expedition this autumn to select a site for a research station to study marine biology. Dr. Th. Mortensen, who is chairman and founder of the association, will lead a small party including probably Dr. Nils Holmgren and a botanist. They will visit Celebes, North Borneo, Amboina, and New Guinea.

PROF. G. T. MORGAN will deliver the Streatfeild memorial lecture at the Finsbury Technical College at four o'clock on Thursday, October 2, taking as his subject "Applied Chemistry in Relation to University Training." Admission will be free.

IN the *Canadian Field-Naturalist* (vol. xxxiii., No. 2, May, 1919), Mr. F. W. Waugh, of the Geological Survey, Ottawa, gives a careful account of Canadian aboriginal canoes. The types of these are found in separate regions—the Eskimo kayak and umiak in the north, and to the south that of the birch-bark canoe. The latter apparently reached its perfection in the Algonquian area, a region extending from round the Great Lakes and some distance westward, to the maritime provinces and the New England States. This distribution was largely determined by the range of the canoe birch (*Vetura papyrifera*), which extends practically from the Atlantic coast to the Rockies. The disappearance of the birch southward is indicated by the inferior canoes of elm, buttonwood, and basswood bark built by the Iroquois of Central New York State. This latter type was heavy, inconvenient for portaging, and usually short-lived. Practically everywhere within the region of Algonquian influence proper the birch-bark canoe was essentially the same, such differences as occur concerning mostly the shape of bow and stern, which has evidently been derived almost exclusively from a single pattern, with local variations in the amount of curvature or recurvature, and the method of decking over at the ends, where such a device was employed.

PROF. CHILTON has published some notes of interest on destructive boring crustacea in New Zealand (*N.Z. Journ. Sci. and Techn.*, vol. ii., no. 1). The well-known European *Chelura terebrans* (an amphipod) and *Limnoria lignorum* (the "gribble," an isopod) are active destroyers of pier-timber in the southern seas, and the latter devours also the insulating material of submarine telegraph cables. In addition, an Australian isopod, *Sphaeroma quoyana*, burrows into sandstone rock as well as into timber.

IN the Annals of the Natal Museum (vol. iv., pt. 1), among several interesting zoological papers, one on the wing venation and respiratory system of certain South African termites by Claude Fuller is worthy of special notice. Details are given of the relation between wing nervures and primitive air tubes in several genera of termites, and the student of insect transformations may obtain much instruction from Mr. Fuller's demonstration of the development and unfolding of the wings from the larval and nymphal rudiments.

DR. VICTOR E. SHELFORD writes in the *Scientific Monthly* of August last on the general question of the waste involved in the discharge of domestic and industrial sewage into the sea and rivers. Experimental methods for testing the effect on fishes of various substances in solution have been devised. The reaction employed was the turning away of various kinds of fish from the part of a large tank where the contents of the water in the toxic substance was above or below the normal amount. The sensibility of fish to such compounds as occur in waste material is thus shown to be greater than has hitherto been supposed, thus an increase in carbon dioxide of 2 c.c. in one litre above the normal caused the turning-away reaction. A low oxygen content was also detrimental, and this was usually found to accompany a high carbon dioxide content. The waste substances resulting from gas-production works and from munitions processes were also studied, and it was shown that these substances, though almost insoluble, had very marked effects on fish-life. References to papers published by the author and his colleagues are given.

VOL. xxv. of the "Rapports et Procès-Verbaux" issued by the International Council for the Exploration of the Sea deals with the administration for the years 1916–18. The usual financial contributions were made by the neutral countries, Denmark, Holland, Norway, and Sweden, and by Great Britain for the years 1916–17 and for 1918–19. Some fishery investigations were carried on in Scandinavian waters, and a hydrographical bulletin summarising the results so far obtained is being prepared. The influence of the war on the fish population of the North Sea is discussed, and the opinion expressed that the stock of certain kinds of fish is undergoing considerable changes. "It is even within the bounds of possibility that the previous indications of 'over-fishing' may be replaced by indications of 'over-population' of fish." The testing of such opinions is regarded as a matter of much importance. "New points of view even as to restrictive laws may be expected as a result of such investigations." There is, however, no indication that such work is being seriously undertaken, and the "accumulated stock," if it exists, must soon be seriously diminished by the intensive trawling which may be expected very soon.

A DETAILED report on fruit culture in Malaya by J. N. Milsum (Bull. Dept. Agr., Fed. Malay States, No. 29, Kuala Lumpur, 1919) has recently appeared. The story that is told here or written between the lines might be told of most countries of the eastern tropics, or, indeed, of most countries where the population that is likely to consume such fruit is small and migratory. The native of the country is content with the fruit that is easily produced there and already well known (in this case the durian, mango, sapodilla, mangosteen, jak, etc.), and has no desire for others. The migratory European planter does not think it worth his while to grow fruit that he may not remain to consume. And, lastly, and most important of all, the profits of the established industries (here largely rubber) are greater and more certain than those of fruit culture, so that no one is tempted to grow fruit commercially. The result is that the resident in the country is reduced in general to bananas, pineapples, mangoes, and a few more, and these usually not of the best quality. What is really required, and shows real possibilities, is the improvement of those fruits that are already cultivated rather than the introduction of new ones. The resident, too, must be prepared to pay a good price for a good article. A detailed account is given of many different fruits and how to cultivate them, but little attempt is made to discriminate between really first-class fruits, such as banana, mango, or pineapple, and inferior fruits such as rambutan or rose-apple—interesting fruit to taste once in a while, but not fruit that anyone is likely to wish to cultivate.

THE Memoirs of the Indian Museum (vol. vii., No. 2, July, 1919) contains an interesting paper entitled "Observations on the Shells of the Family Doliidæ," by E. W. Vredenburg. The memoir is illustrated by seven excellent plates reproduced from photographs, in which the features of four of the principal species of Dolium are well shown. The material dealt with is largely contained in the Indian Museum, and includes several species of Dolium and of Pirula. A very welcome and important feature is a review of the fossil occurrences of species belonging to these two genera, from which it appears that the genus Dolium is not known in formations older than the Oligocene, the greater number of fossil representatives being Upper Miocene and Pliocene; it seems to have reached the climax of its development at the present day. The genus Pirula, on the other hand, is known from Cretaceous times, and the fossil species are more numerous than the recent ones. In discussing the synonymy of certain of the species of Dolium, the author brings forward some excellent arguments in favour of the selection of specific names of long-established usage and tradition instead of the adoption of names which, though earlier, are not always to be trusted; for, as the author points out, there is always the risk of an industrious bibliographer discovering some forgotten monograph of earlier date than the one relied upon as final. This is only one of many cases, both of generic and specific names, which can be cited to show that a rigid application of the law of priority is not always to the benefit of science. As has been pointed out by others, it is for the International Zoological Congress to consider the adoption of a list of *nomina conservanda*.

CANADA and the Colonies of Bermuda and Newfoundland issue regularly a "Monthly record of meteorological observations" under the directorship of Sir Frederic Stupart. The record for March has just reached us, and it contains a mass of means for barometer, temperature, relative humidity, precipitation, wind direction and velocity, and cloudiness. For chosen stations the hourly readings are given which allow of minute examination of the climate. The detailed observations are "boiled down" to give a general synopsis of temperature and precipitation for the several districts and provinces. It is stated that under ideal conditions the means should be derived from stations uniformly distributed, but such ideal conditions are not only wanting in Canada, and it is a common failing elsewhere, if not everywhere. Maps are given showing difference of temperature from average, and total precipitation in inches. The temperature-map shows a deficiency of 14° F. around Alberta and an excess of 6° to the south of Hudson Bay. The precipitation is indicated by degrees of shading, the heavier falls being well shown over the parts bordering the Pacific and the Atlantic Oceans.

A MORE than usually interesting discussion of a typhoon in the Eastern seas by the Rev. José Coronas, S.J., the chief of the Meteorological Division of the Weather Bureau of the Philippine Islands, has been recently issued. The storm is called the "Quantico" typhoon, as it caused the total wreck of a large steamer of that name on the northern shore of Tablas Island. The storm is also known as "the Christmas typhoon of 1918," as it occurred on Christmas Day. The typhoon is carefully tracked throughout its course and maps are given at frequent intervals. Detailed observations are also given of the movement of the barometer and the direction and force of the wind. Several plates are given showing the damage caused by the typhoon. The track of the typhoon is said to be altogether abnormal, and this is probably the most interesting feature, as it contains a warning for both the seaman and the forecaster. The typhoon is shown to have first moved towards the west by north, then to have inclined northwards whilst to the east of the central part of the Philippines, and finally recurving backward not only to west by north, but to west by south, and even to west-south-west. The slow movement of the typhoon on December 23–24 is said, in 99 per cent. of the cases, to be a sign that the typhoon was recurving north-eastward, especially at the end of December, and to the east of the Philippines. Observations, however, prove most conclusively that the movement was in the opposite direction. The rate of progress of the typhoon was at first about 11 miles an hour, the rate afterwards decreasing to 4 miles an hour or less, whilst after recurving to the west-south-west the typhoon attained its former rate of progress. The vortical calm was probably 15–25 miles in diameter. The area of destruction whilst it was raging in or near Luzon was about 80–100 miles in diameter.

THE "Algebraic Cube" is a model illustrating the formula $(a+b)^3=a^3+3a^2b+3ab^2+b^3$. Imagine a cube of edge equal to $a+b$ cut by three mutually perpendicular planes each distant a from one of the sides. The eight pieces into which the cube is divided will consist of a cube of edge equal to a, a cube of edge equal to b, three blocks of base a^2 and height b, and three blocks of base b^2 and height a. Thus each piece represents a single algebraic term, which is engraved on the face of the block. The block a^3 is coloured blue, the three blocks a^2b are yellow, the three blocks ab^2 red, and the cube b^3 black. The model is the three-dimensional analogue of the well-known Euclidean construction showing the relation $(a+b)^2=a^2+2ab+b^2$, and should prove a very useful aid in teaching young pupils the foundation of the rule for the extraction of cube roots. The blocks are supplied in a neat cubical box, 10 cm. to the edge, by Messrs. Barnes and Morris, Ltd., scientific instrument makers, Audrey House, Ely Place, London, E.C.1.

WE learn from the *British Journal of Photography* of September 12 that Mr. Herbert A. Lubs, of the colour laboratory of the United States Bureau of Chemistry, has investigated the preparation of *p*-aminocarvacrol and its use as a developing agent in photography. It is conveniently prepared from carvacrol by the production of nitrosocarvacrol, and the reduction of this by ammonium sulphide. Five grams of the pure derivative were obtained from 10 grams of carvacrol. As a developer for prints *p*-aminocarvacrol was found to be as good as metol, *p*-aminophenol, or *p*-aminocresol, and the lasting quality of the mixed developer was superior to that of *p*-aminophenol, but not quite so good as that of the others. This work has been done particularly with the view of utilising the abundant source of carvacrol that may be prepared from cymene. Thymoquinol and *p*-aminothymol were also prepared, but they proved to be less satisfactory both with regard to yield and their behaviour as developing agents.

IN *Engineering* for September 12 Dr. W. C. Unwin gives an account of an investigation he has made on the results of notched-bar tests. Dr. Unwin has applied Prof. Martens's method of calculating the "mean error," which differs little from the probable error and is easier to calculate, and has taken the test results given in the paper on shock tests by MM. Charpy and Thenard (Iron and Steel Institute, 1917), and also those in the British Association report for 1918. Dr. Unwin finds that an empirical formula of the form: Work of rupture/area of fracture raised to a power n, gives closer agreement with the experimental results than other formulæ which have been employed. n ranges from 1·17 to 1·41 for the Charpy and Thenard results. Dr. Unwin considers, however, that the results are too few for a safe generalisation, and that further progress cannot be made until a greater number of careful tests have been made with bars of different sizes, the results of which are as consistent with each other as those of Charpy and Thenard, the value of whose 1917 paper it would be difficult to overrate.

AN interesting description, with working drawings, of a Michell thrust bearing appears in the *Engineer* for August 29. This bearing has been made by Messrs. Cammell Laird for H.M. destroyer *Mackay*, and was fitted to the port turbine, whilst the starboard turbine had a thrust bearing of the ordinary type. The pressures on these bearings were 549 lb. and 120 lb. per sq. in. respectively, and it is interesting to note that the oil discharged from the Michell bearing was about 18° cooler than that from the ordinary type. Another valuable point about the Cammell Laird design is in the form of a thrust-indicating device fitted to the bearing. This consists of a number of small hydraulic cylinders having rams which bear against the abutment ring which carries the thrust pads. By pumping oil into these cylinders the rams force the abutment ring off its seat, and the whole of the propeller thrust is then carried by the rams. Thus the pressure in the cylinders is a measure of the thrust. On the trials of the *Mackay* the thrusts registered were 59 tons and 56 tons respectively for the port and starboard engines, and varied to 61 tons and 47 tons when turning. Variations in speed were also recorded by the thrust indicator, and give fair curves on a graph. This device is likely to be extremely valuable in solving problems of propeller efficiency and resistance of ships by enabling experiments to be carried out on the ship itself as well as on tank models.

Messrs. George Bell and Sons, Ltd., announce for early publication a new "Card Test for Colour-Blindness," consisting of twenty-four cards devised by Dr. F. W. Edridge-Green. Mr. J. Reid Moir is publishing through *Mr. W. E. Harrison, the Ancient House Press, Ipswich*, a volume entitled "Pre-Palæolithic Man," in which will be given an account of the flint-implements discovered in certain Pliocene deposits in East Anglia. The book will also contain chapters dealing respectively with flint fracture, the ancestry of the Mousterian palæolithic artefacts, and the Piltdown remains. *Messrs. Hodder and Stoughton* announce for appearance in their New Teaching Series of Practical Text-Books "Chemistry from the Industrial Standpoint," P. C. L. Thorne; "The Natural Wealth of Britain: Its Origin and Exploitation," S. J. Duly; "Foundations of Engineering," W. H. Spikes; "Chemistry and Bacteriology of Agriculture," E. J. Holmyard; "Applied Botany," G. S. M. Ellis; "Everyday Mathematics," F. Sandon; "The Mathematics of Engineering," S. B. Gates; "Mathematics of Business and Commerce," O. H. Cocks and E. P. Glover; and "Geography of Commerce and Industry," R. S. Bridge. The list of announcements of the *Oxford University Press (Mr. Humphrey Milford)* has just been issued, and contains, among others, the following works:—"Medical Science: Abstracts and Reviews"; "Pathology of War Gases," Dr. M. C. Winternitz; "United States Forest Policy," J. Ise; "Fungal Diseases of the Common Larch," W. E. Hiley; "Effects of the Great War upon Agriculture in the United States and Great Britain," Prof. B. H. Hibbard; "Aristotelis Meteorologicorum Libri Quattuor," Recensuit Indicem Verborum Addidit, F. H. Fobes; "James Tod's Annals and Antiquities of Rajasthan," edited, with an introduction and notes, by Dr. W. Crooke; and "The Heart and the Aorta," Drs. Vaquez and Bordet, translated by Dr. Honeij. A new series of books is to be brought out by the *University of London Press, Ltd.*, entitled "The Education of the Future." It will be edited by Mr. Benchara Branford, who is writing an introductory volume on "The Modern Philosophical Basis of Education." Other volumes of the series will be "Psychology of the Class," F. Watts, and "The Teaching of Geography," Miss A. Booker.

READERS of NATURE interested in geology should see the latest catalogue (No. 88, new series) of Messrs. John Wheldon and Co., 38 Great Queen Street, W.C.2, which contains the titles of upwards of two thousand publications relating to geology and mineralogy, conveniently classified under the main headings of Geographical, General Geology, and Economic (Mineralogy, Metallurgy, and Mining). The catalogue is particularly strong in French and German works.

OUR ASTRONOMICAL COLUMN.

COMETS.—Mr. H. Vanderlinden has computed the following orbit of comet 1919*c* (Metcalf-Borrelly) from observations on August 24 and 30 and September 5. It differs considerably from that already published, but is evidently more accurate:—

$$T = 1919 \text{ Dec. } 7{\cdot}2721 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 185^\circ\ 49'\ 37''\\ \Omega &= 120^\circ\ 59'\ 14''\\ i &= 46^\circ\ 23'\ 30''\end{aligned}\right\}1919{\cdot}0$$
$$\log q = 0{\cdot}046698$$

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Sept. 28 ...	15 12 8	10 50	0·1943	0·3221
Oct. 2 ...	15 21 18	8 50	0·1827	0·3173
6 ...	15 30 49	6 48	0·1711	0·3127
10 ...	15 40 41	4 43	0·1594	0·3083
14 ...	15 50 55	2 37	0·1478	0·3041

The magnitude is 8·8 on October 2; brightening slowly.

Many naked-eye observations of comet 1919*b* (Metcalf-Brorsen) are reported, so the brightness evidently exceeds the tabular value. No revised elliptical elements have yet been published. The errors of the Copenhagen ephemeris are now quite appreciable, so a little sweeping may be necessary to find the object.

THE FUTURE OF THE TRANSIT CIRCLE.—Mr. J. E. de Vos Van Steenwijk has a paper on this subject in the September *Observatory*. Some ardent supporters of photography think that our transit circles might be scrapped altogether. The paper reminds us that fundamental places of the sun and principal fixed stars are still needed, but they may safely be left in the hands of a few observatories. Reference stars for photographic plates must also be observed, but the number required may be greatly diminished if portrait lenses with a large field are used for the photographs. The paper suggests two other useful fields: (1) A meridian parallax Durchmusterung; while the individual results might not be very accurate, probably a good many stars would be found that would repay further research. (2) It is desirable to obtain accurate positions and proper motions of as many stars as possible of types M and N. Owing to their non-actinic colour, these stars are more suitable for visual than for photographic research.

HEREDITY AND EVOLUTION.

IN recent investigations on the subject of heredity much interest has centred around the question of the determination of sex. In this connection attention may be directed to a short but important paper by Prof. Jacques Loeb (Proc. Nat. Acad. Sci., Washington, vol. iv., 1918, pp. 60–2), in which he describes observations on the sex of frogs developed from parthenogenetic eggs incited to segmentation by the mechanical stimulus of puncture. Twenty of these creatures reached ages of from ten to eighteen months, several attaining the size of the full-grown, normal adult male, to which sex belonged seven of the nine the gonads of which were examined, the other two being females. Hence it appears that frogs of either sex may arise as the result of "artificial parthenogenesis." Cytological study demonstrated the presence of the full (diploid) number of chromosomes in these males, and Prof. Loeb infers that the female is probably heterozygous for the sex-character. But there seems to be good evidence for an "indifferent" condition as to sex in some immature frogs at least, as shown by the well-known researches of Prof. R. Hertwig and suggested by observations of Prof. Loeb in a former paper of his that the testes of a male just after transformation may contain a few eggs. It is doubtful, therefore, whether sex in frogs is absolutely determined by the nature of the germ-chromosomes.

Individual animals in which the secondary characters of the two sexes are combined afford a curious puzzle to students of this question. In the *Journal of Genetics* (vol. vii., No. 3) the Rev. J. E. Hull gives details of a few cases of such "gynandry" among spiders. In one case (*Œdothorax fuscus*) the specimen externally was "completely male on the left side and female on the right"; in another (*Maso sundevallii*) it was "male on the left side, but not quite female on the right," the apex of the right palp being somewhat swollen. A third spider (*Lophomma herbigradum*) was perfectly male on the right of the cephalothorax, with modified falx and palp, and female on the left, but the abdomen showed the characteristic female epigyne half-developed on the right, the left half of the abdomen being male. Such abnormalities, though highly interesting, are so rare that it will probably be long before they will yield much enlightenment on fundamental problems of sex. In the same issue of the *Journal of Genetics* Mr. D. W. Cutler describes the spermatogenesis of infertile hybrids between pheasant and Gold Campine fowl, and finds that the process is abnormal: "The failure of the synaptic threads to form bivalent chromosomes is evidently the cause of sterility in the hybrids." This result is compared with those derived from the study of the germ-cells of other sterile hybrids, in some of which the sex is apparently determined by the sex of one of the parent species.

A short but noteworthy contribution to this subject is Drs. L. J. Cole and W. A. Lippincott's paper on the relation of plumage to ovarian condition in a Barred Plymouth Rock pullet (*Biol. Bull.*, vol. xxxvi., No. 3). This bird assumed partially the male plumage, and the change was found to be due to a large ovarian tumour; though the abnormal feathers were like those of a male in shape and structure, they resembled hen feathers as regards "barring." This, the authors believe, differentiates "secondary sexual dimorphism from dimorphism caused through sex-linkage as illustrated by the barring." After an implantation of normal ovarian tissue, new feathers which were definitely female grew in a few weeks.

New subjects for hybridising experiments are afforded by the northern and southern forms of African ostrich, the results of crossing which are described by Prof. J. E. Duerden (*Journal of Genetics*, vol. viii., No. 3). These two species (or sub-species) interbreed freely, and the offspring are fertile among themselves and with the parent forms. "Everything points to the distinctive characteristics of the two species as having separate factorial representation in the germ plasm." The bald patch on the head of the northern race is dominant to the feathered condition of the southern, but in most features "blended" inheritance is apparent. None of the specific characters appear to have any adaptive value.

The application of Mendelian analysis to economic plant-breeding is well exemplified by A. St. Clair Caporn's studies (*Journal of Genetics*, vol. vii., No. 4) on early and late ripening in an oat-cross and on variation in glume-lengths of extracted parental types and the inheritance of purple colour in a wheat-cross (*Triticum polonicum × eloboni*). "Earliness" and "lateness" in oats are not sharply defined characters; they are spread over a period, though "the ripening times of the parents used did not overlap." The hybrids were more or less intermediate, while in the F_2 generation there was "evidence of early, late, and many intermediate forms." Some remarkable results were obtained from the wheat-crossing experiments. In the F_2 generation a marked change in the average length of the glumes in homozygous long-glumed plants "as compared with the average of the parent *T. polonicum*, under equal conditions, persists right through into the F_3 generation." The inheritance of purple pericarp colour "is distinguished by one cardinal and unaccounted for anomaly; segregations analogous to the F_2 segregation have not been found in the F_3 generation."

Most students of "Mendelism" would probably hold the opinion that little remains to be added to our knowledge of the classical case of the blue Andalusian fowl But Dr. W. A. Lippincott (*Amer. Nat.*, vol. lii., No. 614) gives reasons for believing that "the 1 : 2 : 1 ratio is in reality a combination of two 3 : 1 ratios," and that the condition in the blues is due to the combined action of two factors, one of which restricts the distribution of the black pigment within the feathers in such a way that it gives the characteristic blue-grey appearance, while the other extends the black pigment to every feather of the bird. Somewhat similar suggestions had previously been made by R. Goldschmidt and by A. L. and A. C. Hagedoorn. According to Dr. Lippincott, the birds usually defined as "white splashed with black" would be more correctly described as "blue-splashed." His theory seems largely dependent on the possibility of "crossing-over" of determinants in the chromosomes, for which no evidence is yet forthcoming, and he admits that "if these cross-overs should not be found, it might at first appear that the interpretation of the case of the blue Andalusian is in all probability exactly what has been suggested from the first, namely, that blue is a heterozygote intermediate between the parental types."

A noteworthy critical discussion on the factors of organic evolution has been contributed by Prof. L. B. Walton to the *American Naturalist* (vol. lii. Nos. 622–23). He believes that heritable characters in general arise from preformed unit factors that may have been in existence during long geological periods; the modern study of genetics gives no means of distinguishing a new factor from one long in existence. He suggests that the mutations studied by De Vries in plants, and the modifications obtained by Castle in mammals, are due to the combination of pre-existing factors, while the famous mutations in flies elucidated by Morgan "are in the nature of modal fluctuations having no definite cumulative value." Prof. Walton's own definite contribution in this paper is found in his summary of the direction of axial rotation in Euglena and other Protozoa which "is best explainable on the basis of the apparent east-west motion of the sun having influenced the movement of the organs of locomotion." This seems an insecure foundation for such a generalisation as the author's statement that "the primary factors in evolution are environmental, and thus dynamic."

G. H. CARPENTER.

CHEMISTRY OF "BURGUNDY MIXTURE."

THE chemistry of "Burgundy mixture" is practically important, because to give it the greatest efficiency it should possess a maximum fungicidal power and a minimum potentiality for injuring foliage. The reaction of sodium carbonate and copper sulphate solutions has been studied by Pickering and by Ravaz, but, according to a paper contributed to the August Journal of the Chemical Society by Messrs. Robert L. Mond and C. Heberlein, the problem is more complex than they considered. The latter authors have studied the reactions of copper sulphate with varying proportions of sodium carbonate and of sodium hydrogen carbonate; have determined the amount of absorbed sodium carbonate and the ratio of copper oxide to carbon dioxide in the various precipitates and the amount of basic copper sulphate in the mixtures; and have studied the solvent action of carbon dioxide and the change of the colloidal precipitate to a crystalline form. As a result of their experiments Messrs. Mond and Heberlein conclude that three distinct copper compounds are formed when sodium carbonate and copper sulphate solutions are mixed:—(1) Insoluble hydrated basic copper carbonate (the bulk of the precipitate); (2) insoluble hydrated basic copper sulphate; and (3) soluble basic copper sulphate in the form of a hydrosol; the proportions of which vary with the conditions of precipitation. One molecule of copper sulphate is completely transformed by 0·93 molecule of sodium carbonate instead of the one molecule theoretically necessary. In a 1 per cent. mixture of copper sulphate and sodium carbonate (in the proportion 1 : 0·93 mol.) made at 15°, 9·6 per cent. of the copper is present as soluble basic sulphate, the basic carbonate contains copper oxide and carbon dioxide in the ratio 2·2 : 1, the insoluble basic sulphate contains copper oxide and sulphur trioxide in the ratio 15 : 1, the precipitate contains absorbed sodium carbonate in the proportion of 1 part to 74 of copper oxide, and 52·4 per cent. of the carbon dioxide is evolved. At higher temperatures more carbon dioxide is evolved, all being expelled on boiling. The amount of basic sulphate formed decreases as the proportion of sodium carbonate increases, the proportion in solution (but not that of the basic carbonate) increasing with the amount of free carbon dioxide. At first the precipitate is wholly colloidal, but eventually it becomes crystalline, the colloidal condition apparently being conditional on the absorbed sodium carbonate. The transformation is accelerated by free copper sulphate, carbon dioxide, or sodium hydrogen carbonate, but retarded by sodium carbonate or 0·02 per cent. of glue.

ÆTHER AND MATTER: BEING REMARKS ON INERTIA, AND ON RADIATION, AND ON THE POSSIBLE STRUCTURE OF ATOMS.[1]

PART II.—THE POSSIBLE STRUCTURE OF ATOMS AND THEIR RADIATION.

HOW, then, are we to explain the different kinds of matter? Here we enter upon territory so recently annexed as to be still very debatable; but progress has been and is still being made, and it is only through the work of recent explorers that we can attempt to answer the question at all. It is invidious to select names, but I must mention Rutherford, Soddy, Barkla, Bragg, Moseley, Nicholson, and Bohr, among many others. Moseley—as brilliant as any of them, and patriotically self-sacrificing like all our splendid youth—was killed, alas! by a Turkish bullet at Gallipoli; though not before he had made an immortal discovery. How much more might he not have accomplished had it not seemed good to evil Powers to impose by force their dominance on the world!

To give a certain and definite answer to questions about the structure of the atom is premature. I can only state the answer which at present tentatively appeals to me and, I think, to others. Your professor of natural philosophy (Sir J. J. Thomson) is lecturing, I see, on Saturday afternoons concerning spectroscopic evidence on this great subject, and he will, no doubt, carry the matter further.

Meanwhile, and very briefly, the idea about the atom which at present seems most likely to be on the path towards truth is a central positive nucleus surrounded by a system of negative electrons—so much is pretty certain—while according to one theory the system is composed of revolving electrons moving under an inverse-square law in regular orbits, very like the sun and planets. The orbital movement is governed by electric force instead of by gravitation, but the laws of motion, and the perturbations which may be caused by outside forces, are very like those familiar to astronomers.

According to Moseley's experimental counting and Bohr's theory, hydrogen seems to be like a sun with one planet, just a positive and a negative electron, the two being equal electrically, but differing in inertia, the positive being the more massive, though probably for that reason the smaller or more concentrated of the two. Helium seems to have two central unbalanced positive charges and two revolving negative; lithium, three of each; beryllium, four; boron, five; carbon, six; nitrogen, seven; oxygen, eight, and so on, according to the number of the element in Mendeléeff's series—a number something like half the number expressing its atomic weight.

The number of positive atoms in the nucleus was counted for several elements by Rutherford, and the number of negative corpuscles in the orbit was counted by Moseley; the two numbers agree. Normal atoms are therefore electrically neutral, so that their external electric attraction at any reasonable distance is nil; but it is supposed that at atomic or molecular distances the outer or orbital electrons which can interlock with those of others determine the atom's chemical affinity and all the chemical behaviour of the substance. An atom with one or two outlying planets—let us surmise—would be an active chemical element, a monad or dyad perhaps. An atom with a close-grouped, self-contained system would be an inert element of the argon-neon-helium series. These

[1] Amplified from a discourse delivered at the Royal Institution on Friday, February 28, 1919, by Sir Oliver J. Lodge, F.R.S. Continued from p. 19 (September 4).

might exhibit chemical properties, perhaps, under enormous pressure. The heavier atoms contain the most particles, and must have the most complicated structure. There is every grade, from the simplest, hydrogen, with one electron, to the most complex, uranium, with ninety-two. There is room for ninety-two elements in the series, and no more. All these are actually known except five or six. There are only these few unfilled gaps in the chemical series of elements as thus planned.

Radio-activity.

A complicated atom has a certain amount of instability, and may fall down occasionally into the next simple grouping, flinging away one or more of its units. When this happens there is a sort of atomic cataclysm or explosion; a projectile and some quanta of energy are emitted. This is the phenomenon of radio-activity. Uranium after three (or possibly four) such eruptions becomes the element three (or four) steps down the series, viz. radium. Radium after five more explosions becomes apparently the well-known and stable element lead, or at least something chemically indistinguishable from it, though perhaps of slightly different atomic weight,—what has recently been called an "isotope" of lead. That is the kind of statement that without too much rashness can be cautiously and tentatively made.

At every serious cataclysm an α-particle or atom of helium is emitted from the nucleus, accompanied by a β-particle or negative corpuscle from somewhere, usually from the planetary system. A sympathetic æthereal gush of γ-rays accompanies the eruption. A definite unit of energy—a quantum or a simple multiple of it—is emitted at each explosion; and the remaining electrons then settle down into their new orbits, the element changing in character and chemical properties accordingly.

A catastrophe of this kind can be produced by a sufficiently rapid projectile, an α- or β-particle shot off, say, by radium; and a minor catastrophe or emission of a β-particle can also be produced by the accumulated energy of properly attuned X-rays. When an X-ray or ray of ultra-violet light agrees in frequency with the orbital frequency of an electron, we can suppose (not without a little difficulty) that its energy is absorbed until a quantum has been accumulated, and then a β-ray or excessively rapid electron is emitted.

Remarks on the Quantum.

In my view, it should not be thought that energy exists in numerical bundles or quanta; the discontinuity is not really in energy, but in the atom. Atomic properties are essentially numerical and discontinuous, and we ought not to be surprised at an equilibrium which needs a specific amount of energy to upset it. The energy must be supplied by the disturbing impulse; but in the case of ultra-violet or X-ray radiation the energy can only be attributed to the disturbing impulse on the principle of resonant or syntonic accumulation; for its intensity does not matter. Nor ought it to matter so long as the tuned impulse is repeated often enough—a repetition for which an extremely minute fraction of a second is ample. What matters is not the brightness or energy of the incident radiation therefore, but its frequency. On the other hand, a β-projectile cannot effect a real disturbance unless it possesses a minimum quantum of energy; for in that case there is no accumulation.

The quantum, considered merely as a finite store of energy, is susceptible of exceedingly elementary illustration. Here is a case of stable equilibrium (a simple pendulum or a round-bottomed flask loaded so as to oscillate stably) which responds to the slightest touch and returns to equilibrium. There is no quantum about that. But here is another case of stable equilibrium (a brick or block or pillar standing on end) which takes no notice of any but a finite force, and requires a finite amount of energy to upset it, viz. its weight multiplied by the elevation of its centre of gravity as it revolves round its lower edge; this being also the amount of energy emitted when it falls. Or there may be a union of the two kinds of equilibrium. This rounded rocking flask, for instance, or a rocking-horse, may accumulate oscillations until the energy reaches a sort of quantum, when it upsets and breaks or causes an accident. This last is the kind of stable equilibrium which we meet with in an atom.

A flying particle below a certain limit of energy can alter the eccentricity of an orbit, and may thus excite some simple radiations which continue until the orbit becomes circular again; but a synchronous X-ray disturbance, however intrinsically feeble, may precipitate a catastrophe; and simple facts of this kind seem to be, in the main, responsible for the general notion of quanta of energy. The really remarkable thing about a quantum, the thing which makes it so essentially worthy of attention, is the fact that it is a universal constant; the same amount of energy is found associated with every kind of matter—the same, or differing only by simple multiplication. Hence the notion at one time put forward that energy itself might be atomic and exist in indivisible packets, like cartridges.

Hypothetical Structure of Atoms.

The real facts concerning the quantum, which are the result of observation, suggest, when interpreted properly, that there are stable electronic orbits in an atom, and that these follow a regular law of succession, analogous perhaps to Bode's law of planetary distances in the solar system. Spectroscopic evidence —the so-called Balmer's series of lines—strongly bears out this idea. For there is what is called K radiation, of highest frequency, apparently due to perturbations of the innermost, the most rapid, ring; L radiation of lower frequency from the next outer ring; M radiation from a ring outside this; and recently there is talk of a J radiation of extra high frequency from a ring still closer to the nucleus—perhaps quite close to it, part of it perhaps—and, anyway, well within the K ring.

The frequencies adapted to bring about an atomic catastrophe, or which are emitted during perturbations, are usually high up in the series of X-ray series of vibrations, far above visible light. I assume that these frequencies correspond with the frequency of orbital revolution, and that the inverse-square law holds good. The more massive the nucleus, the greater must be the frequency of orbital revolution at a given distance, in accordance with Kepler's third law. The square of the frequency multiplied by the cube of the radius of the orbit will be constant for all the orbits of all the atoms of any given substance, and will give the attracting force of the nuclear centre for that substance.

In other words, this product (or, what comes to the same thing, the radius multiplied by the square of the speed) will correspond with the number of unneutralised positive charges which go to make up the nucleus. It will give, in fact, the number of the element in the Mendeléeff series. The K radiation frequency from uranium, therefore, must be exceptionally rapid, because the nucleus is so strong. For hydrogen, the nucleus of which is only 1/92nd of that of uranium, the orbital frequency might be comparatively slow, not higher than the ultra-violet; while the L radiation from hydrogen, it is now thought, may be within the limits of the visible spectrum, an M series being, perhaps, in the infra-red.

But how comes it that hydrogen, with only one electron, can have a K series and an L series and an M series at all? Bohr's theory suggests that even a single electron may have alternative orbits—not necessarily occupied; and the spectroscope strongly suggests that the radii of these alternative orbits run as the squares of the natural numbers

$$1 \quad 4 \quad 9 \quad 16 \quad 25, \text{ etc.}$$

The frequencies, or reciprocals of periodic times, would then be as the inverse cube of the natural numbers

$$1 \quad \tfrac{1}{8} \quad \tfrac{1}{27} \quad \tfrac{1}{64}, \text{ etc.}$$

and this is, approximately and roughly, what the K, L, M series of spectrum lines correspond with—with some exceptions.

When a cataclysm occurs and an electron is expelled, it is expelled, as I think, with the velocity which it possessed in the atom just before it burst its bonds and flew off. For the energy required to fling a planet to infinity, under an inverse-square law, is just double the energy with which it was already moving in its circular orbit. Its own orbital energy is, therefore, the quantum of energy that has to be supplied in order to get a satisfactory ejection. Some of it might be supplied by the falling in of other particles from their original orbits; for their kinetic energy therein would be inversely as the distance from the nucleus. Hence if K, L, M orbits have the radii 1, 4, 9, three units of L energy would represent the fall from L to K, and this added to the original L energy would give the quadruple L energy which is equal to the K energy, and able to eject a K particle. Similarly, a ninefold multiple of the M energy, eight units of which would be acquired by falling to K, would supply that particle with the ejection energy equally well.

Would an M particle falling to L be able to eject an L particle? $\frac{1}{4}-\frac{1}{9}=\frac{5}{36}$ of a K unit of energy would be acquired in the fall from M to L—that is, $\frac{5}{4}$ M units,—so altogether $\frac{9}{4}$ of M energy would be transmitted, and that, being equal to a unit of L energy, ought to be sufficient.

Hence, in general, particles may be ejected from any ring, either by direct impact from outside, or by accumulated disturbance of X-rays, or by a collapse of particles from one orbit to the next; and from an immense group of atoms, as in a visible speck of substance, all kinds of radiation can be emitted simultaneously.

Are we to suppose that there is only one electron in each orbit, or may several of them distribute themselves over a ring in accordance with some law of stability? Both alternatives are possible, and both are likely to be found in Nature. It seems scarcely likely that a uranium atom should possess ninety-two different orbits, although it does contain ninety-two electrons. Yet even this number of orbits is possible within the dimensions of an atom. We need not exclude the possibility as taking up too much room. For, given the size of the ultra-innermost or J orbit as 1, the outer orbit would, on Bohr's law pressed to extremes, be $(92)^2$ times that radius—say, 8464 times the size of the innermost orbit; but if this innermost orbit is near the uranium nucleus, which may be $\sqrt[3]{92}$, or, say, 5 times the radius of the hydrogen nucleus, the boundary or confine of the atom is some 10,000 times as far away; leaving, therefore, just room enough for the ninety-two Bohr orbits, though not much more than is required.

Hence, if there were any reason to desire them separate, they could be made room for, without endowing the atom with outlying or ever-ready electrons likely to confer upon it very active chemical properties. But, so far as I see, so many separate orbits are not likely; for there is every probability that periodically, as you ascend the series, the outer ring is not occupied by a single electron, but by a closed, compact sort of structure of many electrons, with very little outside affinity; so that we reach periodically an atom which is chemically inactive—helium, neon, argon, krypton, etc.—up to emanation, or what Ramsay called niton. So little cohesion holds between such atoms that they are able to exist as permanent gases, in spite of the high density of some of them. This, at least, appears to be the view of Rutherford and Soddy. Helium only condenses to a liquid when cooled down to near the absolute zero of temperature. Its cohesion or intermolecular attraction is nearly nil.

A Fanciful Analogy.

If I attempt to compare the supposed alternative orbits in an atom with the known orbits of the solar system, it is mainly to emphasise, provisionally and tentatively, and perhaps semi-humorously, the astronomical view of the atom, and to bring out still more strongly the resemblances whatever thorough differences there may be as well.

I write down the squares of the natural numbers, therefore, and underneath put the initial letters of the names of planets, with its real distance written under each in the same units.

Radii of Bohr's atomic orbits	1	4		9	16	25	36	49	64	81	100	121	144	169	196
		m	V	E	M	Asteroids		J			S				U
Planetary distances		3·9	7·2	10	15·2	20–35		52			95·4				192

The obvious suggestion is that asteroids should be looked for between Jupiter and Saturn, and between Saturn and Uranus; but I would not venture to predict the existence of any such bodies on the strength of this analogy, because you will doubtless have noticed that no analogue of the planet Venus appears in the list of atomic orbits; the scheme provides no place for her—a lamentable omission which must discredit and, I expect, condemn even the analogy. Nevertheless, I make no apology for introducing it in order to emphasise astronomical similarities in the possible structure of an atom.

QUANTITATIVE INTERPOLATION.

On Atomic Radiation.

Permitting ourselves this view of the atom as a working hypothesis, we have to picture each atom as an attracting centre or nucleus, with a number of alternative orbits in regular succession round it, but not all necessarily occupied by revolving electrons. The atoms of different elements differ in the number of positive units in the nucleus, and in the corresponding number of revolving negative units; in fact, the diverse chemical elements in their atomic constitution form a definite arithmetical series with common difference 1. There is a discontinuity or finite step in passing from one element to the next in the series; there is no continuous passage from one to another; hence if the physical transition or mutation ever occurs, it must be by some sort of sudden convulsion.

To extract laws for this hypothetical structure, suggested by the labours of many workers, we may attend to the different rings of one kind of atom, or we may attend to the corresponding rings in different kinds of atom. Each, for instance, has an innermost ring, which it is convenient at present to call the K ring because of the shortest wave-lengths, or so-called K spectrum, which its perturbations emit. And in ascending the series of elements, as the nucleus gets stronger by addition of units, the electron in this innermost or K ring must revolve faster and faster to counterbalance the greater attracting force. Its orbit will accordingly get smaller and smaller, in the proportion proper to the law of inverse square. And the frequency will increase for both reasons, *i.e.* for both the greater speed and the shorter journey. The spectrum accordingly, while preserving the same type, ascends the ladder of frequency.

Suppose the atomic number, or strength of the nucleus in atoms of successive elements, increases in arithmetical progression $N-1$, N, $N+1$, etc., then the radius of the given type of orbit may shrink in the same proportion, so that rN is constant; and the velocity v may increase in the same proportion, so that rv is constant; or, in other words, so that the moment of momentum in corresponding rings of different atoms is the same. There is good evidence that such is the case. The law, so far as it is a law, is styled by Prof. Millikan the atomicity of angular momentum. If the value of mvr or $mr^2\omega$ differs in different rings, it differs by finite steps.

The frequency of orbital revolution will depend on v directly and on r inversely, so the frequency $(v/2\pi r)$ will increase in the proportion of N^2; and this, in some form of other, is known as Moseley's law.

The energy, $\frac{1}{2}mv^2$ in a given type of ring, will also depend upon N^2 in different atoms, and is therefore simply proportional to the frequency. The orbital energy is half the energy with which a particle breaks loose (or is driven to infinity) whenever a convulsion occurs. The convulsion can be stimulated by X-rays or ultra-violet light of the right frequency; their energy appears to be stored by resonance until the critical breaking-up point is reached. The ratio of emission energy to frequency is a remarkable universal constant, and is called h, the quantum. It is not energy, but the accumulation or integral of energy for a certain time; and it is permissible to write $mv^2=2mu^2=hn$; because the emission velocity u (the velocity from infinity) is $\sqrt{2}$ times the orbital velocity v. But h, or rather $h/2\pi$, may also be taken as representing the orbital angular momentum mvr (more strictly, if the orbit is at all elliptical, mvp) for the ring whence the particle came. It would be rather convenient if the designation h were transferred to $h/2\pi$ before it is too late; but I must leave this minor change to the approval of leaders in this subject.

I may point out that this constancy of angular momentum in different orbits bears a curious analogy to Kepler's second law about rate of description of areas in the same orbit. And, if a coincidence, it is odd that the symbol h should have been used both for Kepler's $r^2d\theta/dt$ and for an atomic quantity which is also $r^2d\theta/dt$ multiplied by $2\pi m$.

Within each atom Kepler's laws must presumably hold; so r^3/t^2, or rv^2, is constant for the different circular orbits in each atom; whence the energy in successive rings of one atom is inversely as their radii; hence the ring most likely to eject a particle is the innermost or K ring.

This characteristic constant rv^2 of an element is proportional to the central attracting force, and therefore proportional to N. Hence it goes up step by step in the series of atoms, as N does.

Summary.

N is Moseley's atomic number, and equals the number of orbital electrons, or the number of unbalanced positive charges in the nucleus. The constant rv^2 is characteristic of all the rings in one atom (N being constant). The product rv is a constant characteristic of a given type of ring in the whole series of atoms (N going up step by step); but in any one atom this product rv ascends from ring to ring in regular arithmetical stages, the same stages as $\sqrt{r}$.

The product rv^2 is constant inside each atom, and proceeds by steps from atom to atom; while the product rv is the same for different atoms, but changes inside each atom and proceeds by steps from ring to ring. In fact, we may write:—

For all the Rings in One Atom.

Central force	rv^2 is constant.
Angular momentum for the rings in one atom ...	$rv \propto \sqrt{r}$
Energy for the same ...	$v^2 \propto 1/r$

For any Ring in any Atom.

Central force for any ring in any atom	$rv^2 \propto N$

For the same Type of Ring in Different Atoms.

Radius of given type of ring in any atom ...	$r \propto 1/N$
Orbital velocity in ring of that type	$v \propto N$
Moment of momentum in given type of ring ...	rv is const. as regards N.
Frequency in that type of ring	$v/r \propto N^2$
Energy in same	$v^2 \propto N^2$

So for a given type of ring in different atoms the orbital energy is proportional to the frequency; which is a curious result thoroughly consistent with Moseley's law, ascertained by experiments on emission, and true, at any rate, for emission energy. The ratio

$$\frac{\text{emission energy}}{\text{frequency}}=\frac{mv^2}{v/2\pi r}=2\pi mvr=2\pi.mr^2.2\pi r=2\pi I\omega$$

So if we call this h, or a multiple of h, then on our hypothesis $h/2\pi$ is the indivisible unit of angular momentum for an orbital electron.

The speed with which an electron is ejected is very high, something like 0·9 of light, so the increase of mass at high speeds must be taken into account in propounding a reason for the emission of corpuscles.

Radiation Heterodoxy.

In considering the radiation from an atom, I have virtually made the hypothesis that so long as orbits are circular they do not radiate, but that if perturbed into ellipses, with corresponding fluctuation of speed —as they would be by the influence of a flying charge passing through or near them—then they would radiate, with the proper orbital frequency, until the eccentricity disappears again and they resume their stable circular orbit once more, though, of course, they might be so much perturbed as to eject a particle. Any one of the rings, if perturbed at all, may radiate and give appropriate spectral lines. An external synchronous alternating field will also cause them to absorb energy, even though they were not radiating any until the extra energy arrived.

This hypothesis, if at all regarded, is equivalent to a request to mathematicians to reconsider their theory of electronic radiation. Radiation intensity is known to be proportional to the square of acceleration (Sir Joseph Larmor, and to some extent FitzGerald and Hertz, established this), and I must admit that the reasoning seems to make this law applicable to every kind of acceleration; but my rash suggestion is that it may be only speed-acceleration that is really effective, and not transverse or curvature-acceleration at constant speed. For this will not perturb the lines of force holding the electron to the nucleus, but will leave them in a constant condition so long as the orbit is circular and the speed therefore constant. There is a recognised difference of the same sort in connection with varying inertia; its value is not affected by transverse acceleration, with the speed left constant, but it is affected by longitudinal acceleration, which alters the speed.

So I am in hopes that it may be found that this latter or speed-acceleration is what is responsible for radiation, and that mere curvature at constant speed in a circular orbit need not radiate at all, provided always that the superposition of an external alternating field of the right frequency may cause absorption. Many of the difficulties connected with the stability of the astronomical atom would be evaded if the theory of radiation could be modified in this way, and the excitation of characteristic radiation by almost any kind of perturbation of the orbit would be intelligible.

Speculations on Radiation and Atomic Structure.

Bohr's remarkable theory of atomic structure does not pretend to be strictly dynamical; it is partly empirical, being based on the discontinuity signalised by Planck's constant, but it is very brilliant, and extensively justifies itself by agreement with facts.

His expression for the frequency of radiation emitted by any element is virtually, to a fair approximation,

$$n=\frac{2\pi^2 me^4}{K^2h^3}\cdot\left(\frac{E}{e}\right)^2\left(\frac{1}{p^2}-\frac{1}{q^2}\right)$$

where $\frac{E}{e}$ is Moseley's atomic number N, the number of unbalanced charges in the nucleus or the number of electrons in the atom, and where p and q are integers, of which p changes from series to series, while the lines in each series are given by the mutations of q. For heavy atoms the E in the above formula should be E *minus* a geometrical function of all the other electrons inside the radiating orbit, because they will affect the central attracting force. In this way outstanding discrepancies may plausibly be explained. But the remarkable thing is that the formula gives the frequencies, not merely relatively, but absolutely. For if the experimental values otherwise obtained for e, m, and h are inserted, the constant outside the brackets, called Rydberg's constant, which is spectroscopically determined and known to be the same for all elements, comes out right. A very notable fact!

The above expression for spectral lines not only agrees with the Rydberg-Balmer known spectroscopic series, and with the kind of formula given by many pioneer workers, but has been able to predict other series which have been afterwards observed. It also accounts for many extra-low-frequency lines which, though not obtainable in the laboratory, are observable astronomically by suggesting that they come from very large masses of highly rarefied gas. For under such conditions the atoms would have more room and could possess far outlying or ultra-Neptunian electrons, and yet have total substance enough to display their spectra.

To contemplate the emission of radiation, both waves and particles, we may picture one of the satellite electrons in a many-orbited atom struck or so thoroughly perturbed by the sudden arrival of a foreign charge as to precipitate it into the next inner ring, ejecting the constituent of that ring into the one below, and so on, after the manner of the "jack for mustard" game with a series of wooden bricks set up on end.

Wave-emission should accompany each transition. The effect of precipitating the innermost electron on the body of the nucleus is not clear; but a compound nucleus must be a strangely interlocked conglomerate, and an explosion seems not unlikely, especially if one of the supposed binding negative electrons were ejected. The potential gradient close to a nucleus is prodigious.

The effect of the arrival or departure of a charged particle at the nucleus would be suddenly to change its intrinsic attracting force; and this of itself would render all the orbits elliptical for a time, with eccentricity $\frac{1}{N\pm1}$,[2] thus exciting radiation of several frequencies. If the radiation ceased when the eccentricity was got rid of, a new circular orbit would be taken up; and thus perhaps discontinuities might be accounted for in a dynamical manner.

The effect of properly attuned X-rays or ultra-violet light, if it is to be accomplished through resonance—and it is difficult to account for its independence of intensity otherwise—seems to require a fair range of frequency in those rays; for their effect on a revolving electron would naturally be to increase its angular speed and so throw it out of tune with the particular disturbance to which it initially responded. The sectorial area swept out would increase, the radius vector would increase, the linear speed would therefore diminish in spite of the resonant effort to increase it—unless, indeed, under the peculiar conditions in an atom, there may be some compromise. The alternative would be for the electron to be constrained, under conditions of stability, to maintain its frequency unaltered, either proceeding in an outward spiral towards a position of Planckian instability, or trying still to obey the law of inverse squares by increasing the eccentricity of its orbit with given axis major until it becomes practically parabolic.

This could represent an inversion of the process by which the electron may have been originally bound, according to Bohr's theory of what happened before the atom became neutral. For it is to be presumed that a positively charged α-particle, after ejectment, neutralises itself by accretion and settles down.

CONCLUSION.

I have led you over a great deal of territory in a hurried manner, and occasionally have entered on regions where the ground is not yet solid and secure. Let it be granted that the chemist may naturally object to an astronomical atom and may prefer a more static or geometrical structure, although such a structure would have less clear and explicable properties. The static or Boscovich atom, with purely hypothetical interior fluctuations of force, leaves every-

2 This can be proved as follows:—

For a circular orbit

$$rv^2=\mu$$

and

$$r^2v^2=h^2=\mu r.$$

When μ suddenly changes to $k\mu$ (where k may be $\frac{N\pm1}{N}$) the velocity does not instantly change, but the orbit acquires an a and an e, such that

$$a(1-e^2)=\frac{h^2}{k\mu} \text{ or } e^2=1-\frac{r}{ka};$$

also

$$\frac{\mu}{r}=v^2=k\mu\left(\frac{2}{r}-\frac{1}{a}\right).$$

This last gives

$$\frac{r}{a}=2-\frac{1}{k},$$

so

$$e^2=1-\frac{1}{k}\left(2-\frac{1}{k}\right)$$
$$=\left(1-\frac{1}{k}\right)^2.$$

And the place where the sudden impulse occurred, becomes an apse of the new orbit, because $r=a(1\pm e)$. (See also Appendix I. in *Proc. R.I.*)

thing in the dark, and is therefore less tempting to a physicist, until some physical explanation of those fluctuations can be given. At present they seem to be postulated merely in order to secure positions of equilibrium in which an electron can settle down. Orbital revolution achieves the same end, in apparently a more complicated but really a more tractable manner. Moreover, it confers upon an atom the sort of energy and structural velocities which are conspicuous in the various types of radio-activity. True, it is a working hypothesis at present, and nothing more, but it seems likely to be a fruitful one; and that is its present justification.

The subject is in the nascent or rapidly growing stage; and, provided we refrain from dogmatism, it is legitimate thus tentatively to survey and explore the boundary between knowledge and ignorance, and to speculate as to what may be the next stages in the exhilarating pursuit.

The apparent resemblance between an atom and the solar system opens up extraordinary vistas for further inquiry. Optics and gravitation still have many secrets. The interactions between æther and matter are as yet barely understood. We know that the energy of an electric current is really in the æther, *i.e.* in the magnetic field surrounding the current; but we must admit that the electromagnetic explanation of inertia is no ultimate explanation; it is but relegating the property to some fundamental property of the æther, of which substance presumably matter itself may in some way be composed.

Evidence suggests that the æther is an excessively dense substance, and that it circulates slowly along lines of magnetic force.[3] But though so dense we have no means of apprehending it directly. Matter, though so comparatively filmy and fragmentary, yet looms large in our estimation because of our material sense-organs; its properties force themselves on our attention, because, in fact, our bodies are composed of matter. But underneath and behind all the known properties of matter lie the unknown properties of the æther of space; and if we are to create a true philosophy we must attend continually to æther as well as to matter in the physical universe. The æther makes no appeal to our senses, but it is none the less real for that. Sensation is no test of reality—many of the most important things are in the insensible universe; and he is the wisest man who shuts the door on no opportunity for investigation, but keeps his mind open and is ready to explore every avenue towards truth.

[3] This view of the energy of a magnetic field, that it is direct kinetic energy of the æther moving longitudinally, suggests a possible (or nearly impossible) experimental means of determining the real density of the æther of space—a subject on which I have much more to say. See *Phil. Mag.* for May, 1919.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

EDINBURGH.—Considerable developments have recently taken place in the departments of pure and applied mathematics of the University. Since 1914, the department of pure mathematics has occupied a separate building, the Mathematical Institute, in ground adjacent to the Arts Quadrangle. This building contains lecture-rooms large and small, mathematical laboratory, reading-room with students' library, research-room with a library of mathematical periodicals and advanced works, and rooms for the staff. The laboratory course comprises interpolation, construction of mathematical tables, numerical solution of algebraic and transcendental equations, numerical integration, least squares, graduation or adjustment, fitting of normal and skew frequency curves, correlation, practical Fourier analysis, spherical harmonic analysis, periodogram analysis, with drawing-board work in nomography, descriptive geometry, and cartography.

The most recent development is the institution of a diploma in actuarial mathematics. This is intended for students who are employed in the numerous life insurance offices in the city of Edinburgh, and are, therefore, only part-time students of the University, attending, however, day, not night, classes. The course, which covers two years, is conducted on the mathematical side by Prof. E. T. Whittaker, F.R.S., and on the actuarial side by Dr. A. E. Sprague, president of the faculty of actuaries. Students who obtain the diploma will be exempted from Part I. and Part II. of the faculty's examinations for fellowship.

The Mathematical Institute is the meeting-place of the Edinburgh Mathematical Society, and houses the library of the society.

In the department of applied mathematics, which is under the charge of Dr. C. G. Knott, arrangements have been made for the inclusion of special honours courses on wave-motion in matter and æther, kinetic theory of gases, and radiation. The former courses on dynamics, hydrodynamics, and elasticity have also been extended, one of the full-year courses being specially adapted to the needs of the student of engineering. There is also a post-graduate course on quaternion vector analysis.

MR. J. S. W. BOYLE has been appointed lecturer and assistant in chemistry in University College, Dundee, in succession to Dr. J. K. Wood.

THE Right. Hon. Christopher Addison, Minister of Health, will deliver the introductory address at the opening of the winter session of the London (Royal Free Hospital) School of Medicine for Women, University of London, on Wednesday, October 1, at 3 p.m.

THE ninety-seventh session at Birkbeck College, Breams Buildings, London, E.C.4, will commence on Monday next, September 29. Courses, day and evening, in the faculties of arts, science, laws, and economics for the examinations of the University of London begin on the following Tuesday. Full details of the courses are given in the syllabus of the college, which can be obtained on application to the secretary.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 8.—M. Léon Guignard in the chair.—L. **Mangin**: Notice on the work of the late William Gilson Farlow.—G. **Humbert**: The measurement of the classes of Hermite of given discriminant in an imaginary quadratic body, and on certain non-Euclidean volumes.—G. **Bigourdan**: The work of La Caille (conclusion) and his successors at the Mazarin College.—M. **Stuyvaert**: The elimination of one unknown between three algebraic equations.—N. E. **Nörlund**: The principal solution of a certain equation of finite differences.—G. **Guillaumin**: The transversal effects of contraction in reinforced concrete structures.—P. **Chofardet**: Observations of Borrelly's comet (1919*c*) made with the *coudé* equatorial at the Observatory of Besançon. Observations, with positions of comparison stars, are given for August 25, 27, and 28. The comet is of the 10th magnitude, is round, about 2′ diameter, with a central condensation. There is no tail.—J. **Guillaume**: Observations of Borrelly's, Kopff's, and

Metcalf's comets made with the *coudé* equatorial at the Observatory of Lyons. Observations of each comet were made on August 28.—G. **Sagnac**: The æther and the absolute mechanics of waves.—J. **Rey**: A lighthouse of great power, arranged with metallic mirrors. A description of the optical arrangements adopted at a lighthouse erected off the coast of Tunis. Metal reflectors only were used, without glass. Details of the photometric measurements and range are given.—Ch. **Mauguin** and L. J. **Simon**: Cyanogen chloride. A review of the methods suggested for the preparation of cyanogen chloride, including three new electrolytic methods, based on the electrolysis of a mixture of hydrochloric and hydrocyanic acids. The pure liquid chloride solidified at −6·5° C., and boiled at 12·5° C. The only other cyanogen chloride is the solid polymer melting at 145° C.—Ch. **Pussenot**: New observations concerning a recent submersion of the coasts of Morbihan.—M. **Leriche**: The fossil fishes of the coast region of the Congo, and on the presence of the Eocene in this region.—L. **Blaringhem**: Vigour of growth, compensating sterility, in the hybrids of species of Digitalis (*Digitalis purpurea*: *D. lutea*). The hybrids between species of Digitalis are absolutely sterile, but there is an excessive development of the plant-tissues with all the characters of young, super-nourished organs.—E. **Roubaud**: The antagonism of cattle and man in the blood nutrition of *Anopheles maculipennis*. The anti-paludic *rôle* of domestic cattle. When the mosquito has choice of man or domestic animals, it attacks the latter for preference. In order of preference, mosquitoes go first to pigs, then cattle and horses, then sheep, rabbits, and dogs. Fowls are not touched. When there are plenty of cattle adjacent to a house, the mosquito is not found in the house.—G. **Bertrand** and M. **Dassonville**: The treatment of scab in horses by the vapours of chloropicrin. Chloropicrin has been successfully applied to the cure of scab in horses; it possesses advantages over the sulphur dioxide treatment.

BOOKS RECEIVED.

Mind and its Disorders: A Text-book for Students and Practitioners of Medicine. By Dr. W. H. B. Stoddart. Third edition. (Lewis's Practical Series.) Pp. xx+580. (London: H. K. Lewis and Co., Ltd., 1919.) 18*s*. net.

An Elementary Course of Infinitesimal Calculus. By Prof. Horace Lamb. Third edition, revised. Pp. xiv+530. (Cambridge: At the University Press, 1919.) 20*s*. net.

The Study of the Weather. By E. H. Chapman. (The Cambridge Nature Study Series.) Pp. xii+131. (Cambridge: At the University Press, 1919.) 3*s*. 6*d*. net.

An Enquiry Concerning the Principles of Natural Knowledge. By Prof. A. N. Whitehead. Pp. xii+200. (Cambridge: At the University Press, 1919.) 12*s*. 6*d*. net.

Aeroplane Structures. By A. J. Sutton Pippard and Capt. J. Laurence Pritchard. With an introduction by L. Bairstow. Pp. xii+359+xxi plates. (London: Longmans, Green, and Co., 1919.) 21*s*. net.

The Natural History of South Africa. By F. W. Fitzsimons. Mammals. Vol. i., pp. xix+178. Vol. ii., pp. xi+195. (London: Longmans, Green, and Co., 1919.) 9*s*. each vol.

Principles of Electric Spark Ignition in Internal Combustion Engines. By J. D. Morgan. Pp. vii+88. (London: Crosby Lockwood and Son, 1920.) 8*s*. 6*d*. net.

Ireland: The Outpost. By Prof. G. A. J. Cole. Pp. 78. (London: Oxford University Press, Humphrey Milford, 1919.) 3*s*. 6*d*. net.

The Stanton Drew Stones. By E. Sibree. Pp. 20. (Bristol: J. W. Arrowsmith, Ltd., 1919.) 1*s*.

Geology of India for Students. By D. N. Wadia. Pp. xx+398+xx plates. (London: Macmillan and Co., Ltd., 1919.) 18*s*. net.

Mendelism. By Prof. R. C. Punnett. Fifth edition. Pp. xv+219+vii plates. (London: Macmillan and Co., Ltd., 1919.) 7*s*. 6*d*. net.

Proceedings of the Aristotelian Society. New series. Vol. xix. Containing the Papers read before the Society during the Fortieth Session, 1918–19. Pp. iii+311. (London: Williams and Norgate, 1919.) 20*s*. net.

Aristotelian Society. Supplementary vol. ii. Problems of Science and Philosophy. The Papers read at the Joint Session of the Aristotelian Society, the British Psychological Society, and the Mind Association, held at Bedford College, London, July 11–14, 1919. Pp. iii+220. (London: Williams and Norgate, 1919.) 12*s*. 6*d*. net.

Guide to the Study of the Ionic Valve: Showing its Development and Application to Wireless Telegraphy and Telephony. By W. D. Owen. Pp. vii+59. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 2*s*. 6*d*. net.

The Essentials of Chemical Physiology for the Use of Students. By Prof. W. D. Halliburton. Tenth edition. Pp. xi+324. (London: Longmans, Green, and Co., 1919.) 7*s*. 6*d*. net.

CONTENTS.

PAGE
The Missing Theme. By M. A. C. H. 69
Water in Action—Controlled and Free. By Dr. Brysson Cunningham 70
Mammalian Physiology. By H. H. D. 71
Our Bookshelf 72
Letters to the Editor:—
National Representation upon International Councils.—**Dr. Norman R. Campbell** 72
Intravenous Injections of Gum Solutions in Cholera.—**Sir Leonard Rogers, C.I.E., F.R.S.; Prof. W. M. Bayliss, F.R.S.** 73
A Photoelectric Theory of Colour Vision.—**Prof. J. Joly, F.R.S.** 74
Mathematics at the University of Strasbourg.—**H. Bryon Heywood** 74
The Magnetic Storm of August 11–12, 1919.—**Alexander Graham Bell** 74
The Watt Centenary Celebrations 74
Prof. J. W. H. Trail, F.R.S. By F. O. B. 76
Notes 77
Our Astronomical Column:—
Comets 80
The Future of the Transit Circle 80
Heredity and Evolution. By Prof. G. H. Carpenter. 81
Chemistry of "Burgundy Mixture" 82
Æther and Matter: Being Remarks on Inertia, and on Radiation, and on the Possible Structure of Atoms. Part II. By Sir Oliver J. Lodge, F.R.S. . . 82
University and Educational Intelligence 87
Societies and Academies 87
Books Received 88

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THURSDAY, OCTOBER 2, 1919.

THE WASTE OF YOUTH.

Problems of National Education. By Twelve Scottish Educationists. With Prefatory Note by the Right Hon. Robert Munro. Edited by John Clarke. Pp. xxvi+368. (London: Macmillan and Co., Ltd., 1919.) Price 12*s*. net.

THE extension of the school age from fourteen to fifteen, with compulsory education in continuation classes to eighteen years of age, which is the main provision of recent educational legislation, adds four additional years of schooling at the most critical and formative period of life. It is to be hoped rather than expected that better use may be made in the future than has been made in this country of the school period in the past. One opens this book on "Problems of National Education," a collection of twelve essays by Scottish educationists, expecting some assurance at least that the stale old stock-in-trade of the schoolmaster derived from the Middle Ages had, in public education at least, been finally discredited. Then Latin was the universal written language, and it has been handed on as a ready-made means of disciplining youth to distasteful tasks, after all intelligible reason has ceased and the manifold activities of a rapidly expanding and luxuriant scientific civilisation have made it unsuitable. But, alas! in education the vicious circle besets one at every turn. It is idle to expect the child to be put *au fait* with the modern world, of which already he probably knows far more in certain ways than his teachers, until the latter have caught up with it and the subjects of their training in the ancient universities and the training institutions been fundamentally recast. But in this book every and any aspect of education is discussed exhaustively rather than this central problem.

The work of building up more and more elaborate superstructures on such false foundations meanwhile goes merrily on. Physical training, ethical, moral, religious, æsthetic, and civic education, anything rather than the intellectual foundations, are all explored in these centrifugal essays by experts in the vain hope of disguising the rottenness of the core. For, excellent and informative as are many of these discussions on the outriders and secondary consequences of national education, on the main theme, which is engaging the attention of the taught, if not the teachers, this volume is singularly vacuous.

Thus we read: "The new movement regards the purpose of education as primarily social efficiency and social progress rather than individual development and personal success," followed by the inevitable reference to Plato and Aristotle, which with unconscious and monotonous irony reiterates the fatal retrospective habit of mind. The future, if it learns from the past, will see to it that this type is put in charge of museums and cemeteries rather than of the growing child.

The main primary, as it was the original, purpose of the school is still to provide the child with a suitable intellectual equipment with which to face the world of the twentieth century. That is the weak spot, and it does not solve the problem to pretend that intellectual efficiency is Prussian and therefore to be shunned, or that preparation for the world of to-day is vocational and therefore no proper part of school work.

Principal Laurie contributes the most valuable and satisfying exposition of the position in his essay on "Technical Education." His statement—"To deal with the promotion of scientific research, I draw no distinction between pure and applied science, as no distinction can be drawn in practice. The first essential is the pursuit of science for its own sake as a pure branch of knowledge" (p. 249)—may be generalised. With regard to intellectual training, no distinction can be drawn between cultural and vocational training. The first essential is that the intellect must be trained for its own sake. The culture of a workman is the vocation of a scholar, and *vice versa*, though the scholar might not be sufficiently cultured to admit it. The educationist surely should use every means most calculated to develop the growing intelligence of a child and not scorn the new because they are, or may be, vocational.

Another remark from this essayist needs no comment:—"The love of knowledge for the sake of knowledge, which inspired the Greek civilisation, is not understood by the very men who have received a classical education. They do not see that the man of science is carrying on the tradition of Greek culture to-day."

As an example of how completely cut of touch a teacher may be with the psychology of modern youth, a passage from the essay on "Moral and Religious Elements in the School" may be quoted (p. 148):—"There seems to be no good reason why the narratives of the miracles in the Old Testament should be excluded. The wonderful and the miraculous are a source of great delight to young children and may be turned to good moral purpose. Provided that at some stage in the pupils' school career they are exhibited in their proper light, there is no reason to debar children from reading and enjoying these narratives." Possibly this may throw some light on the complaint (p. 110): "Little or no respect or consideration for older people is exacted from the young. It is not easy to detect in them the spirit of reverence either for institutions or individuals."

Classical education, according to Prof. Burnet, is about to achieve fresh laurels in the new era. "Humanity" its exponents call it—"that is to say, the literature, institutions, and thought of antiquity," thereby subtly suggesting that modern man is not humane, or humane by descent rather than by ascent, in conformity with the ancient, exploded Biblical myth, so harking ever backwards to the past rather than reaching out towards and apprehending the more glorious future.

"Now the first thing," he says (pp. 183–85), "we have to realise is that we are witnessing the dawn of a renaissance of humanism in Europe comparable only to that of the fifteenth century or to the magnificent expansion of science in the nineteenth. . . . Excavation, especially in Crete, and the recovery of papyri from the sands of Egypt have not only transformed our outlook upon the Mediterranean civilisation, of which our own is the lineal descendant, but has given us the inspiring feeling that some new truth of first-rate importance may come to light any day. . . . It is becoming plain that what we call science may be best described as *thinking about the world in the Greek way*." (Dr. Laurie's way of putting this has already been quoted.) "But there is another, and perhaps a deeper, reason for believing that a humanist renaissance is at hand . . . In the hard times ahead of us the greater number will turn rather to the poets, historians, and philosophers for solace and edification than to the austerer discipline of the exact sciences. That is for the few; the mass of men can hardly penetrate beyond its outer courts."

So, the classics are still for the many and science for the few! Nothing is incredible, not even that this and much more like it should actually be written as a contribution to "Problems of National Education" at the close of the great war. If these are the people to whom their children's educational destinies are to be committed for four further years, the Labour Party will do well to expedite its attainment of a minimum State subsistence. For, be they turned out from school with their physique, morals, and manners, religious and æsthetic perceptions, civic ideals, and use of the subjunctive mood in subordinate clauses in the ancient languages never so perfect, it is difficult to see what else can save them from starvation in the hard times ahead. Until something more in keeping with the age is substituted for the intellectual training of the school, the words in the opening essay (p. 39) will continue to be true: "They begin their course with keen interest and lively curiosity. Then shades of the prison-house seem gradually to close upon the growing boy."

FREDERICK SODDY.

BIOLOGICAL PROBLEMS.

Life and its Maintenance: A Symposium on Biological Problems of the Day. Pp. viii+297. (London: Blackie and Son, Ltd., 1919.) Price 5*s.* net.

DESIRE, want, pain, disease, and death, the tools used by Nature for fashioning the race, are equally efficacious for awakening the mental and bodily faculties of the individual. Under their goad the soldier has not only shown himself gifted with an unsuspected degree of intelligence, but, what is more important, has discovered how to use the intelligence of others, so that at the close of the war our scientific arms, creations of the war itself, were more efficient than the corresponding formations in the Army of a nation which had long prided itself on its thorough utilisation of all the means science placed at its disposal. Even among those compelled by age or infirmity to carry on their normal vocations at home, the trifling discomforts and privations to which they were subjected under war's constraints acted as hormones, as adequate stimuli for arousing their slumbering mental faculties, and disturbing for a while the hopeless incuria with which, to the detriment of the body politic, our upper and middle classes are afflicted. Any discomfort, whether it be the presence of a flea or the necessity of absorbing war bread, rouses an appropriate reaction and interest in its removal. Thus it came about that a sufficient number of persons, anxious to devote a certain time to learning about the world around them with special reference to the discomforts under which they were suffering, and willing to devote an hour in the week to this purpose, were found to justify the delivery at University College of a course of lectures which are reproduced in this volume under the general title of "Life and its Maintenance."

The first object of interest to every man is himself, and since at the time of the delivery of these lectures there was a certain amount of food shortage and a reasonable doubt as to the prospects of food supplies in the future, it is natural that most of these lectures are devoted to the subject of food, its effects on man, and the methods of increasing its production in this country.

Prof. Bayliss leads off with a clear, elementary account of the significance of food for the body. This is followed by a reassuring lecture on war bread by Prof. Hopkins. The third lecture, by Miss Hume, deals with accessory food factors, the importance of which was brought into unwelcome prominence by the outbreaks of beri-beri and scurvy among our forces abroad, and the consideration of which, in their relation to infant feeding, must always take an important place in our measures for ensuring the health of the community. Prof. Cushny contributes a judicious and well-balanced lecture on the subject of alcohol, and the various questions relating to the production of food by the improvements of farming methods are dealt with by Dr. Russell, Mr. Stapledon, Dr. Horne, and Profs. Hickson and Tansley.

The last five lectures are of a more miscellaneous import. The shortage of paper prompts Prof. Oliver, who was responsible for editing the whole series, to give a useful summary of the various materials used in the manufacture of paper and to describe certain new plants, notably a grass (*Spartina Townsendii*) growing on the mud flats of Southampton Water, which had been tried for this purpose. Dr. Vernon deals with the relations of industrial efficiency and fatigue. This subject is so closely connected with the question of hours of labour that no one possessed of a vote has a right to say that it does not concern him. This lecture, as indeed the whole collection, is an attempt to rouse the man in the street to take an interest and a part in the search for such knowledge and methods as by their generalisation may increase the efficiency and thereby the prosperity of the nation as a whole. The next few years will be marked by the introduction of one legislative measure after another directed to this end, but probably in many cases ill-conceived from lack of acquaintance among law-givers and people with the intimate character of the problems involved. To those problems which affect the life of the individual this series of lectures will serve as an interesting and authoritative introduction.

SOUTH AUSTRALIAN GEOLOGY.

The Geology of South Australia. (In two divisions.) Division 1, *An Introduction to Geology, Physiographical and Structural, from the Australian Standpoint.* Division 2, *The Geology of South Australia, with Notes on the Chief Geological Systems and Occurrences in the other Australian States.* By Walter Howchin. Pp. xvi + 543. (Adelaide: The Education Department, 1918.) Price 10*s.*

FOLLOWING the example of Mr. Chapman's Australian fossils—an outline of palæontology based on Australian examples for Australian students—Mr. Howchin, of the University of Adelaide, has prepared a general text-book of geology based on Australian illustrations, followed by an account of the geology of South Australia, with shorter summaries of that of the other Australian States. The book should be very useful, as it fills a gap in Australian educational literature, while it supplies geologists in general with an excellent and up-to-date compendium of the geology of South Australia. Mr. Howchin is exceptionally qualified for the work; he is well known for his discovery of the Australian Cambrian glacial deposits, his researches on fossil foraminifera, and his text-book on the geography of South Australia. The first division of the work gives a clear summary of the general outlines of geology; it is especially good in the physiographic portions. The petrology is comparatively elementary, since the book, being published by the South Australian Education Department, is probably intended more for secondary schools than for university students. Australian petrologists may consider that there is inadequate notice of the alkaline igneous rocks; and in an effort at simplification "pyroxene (augite)" is included in the hornblende group, a step which would lead students to overlook the important distinction between the pyroxenes and the amphiboles. The parallelism of these series is also not indicated in the statement as to the composition of augite. There is not much information about economic geology; for example, the author tells us nothing about the oil-fields of South Australia and their prospects. He follows those who extend the petrographic use of the word "mineral" for mineral species into general geology, although mineralogists, such as Miers, adopt the more commonsense practice which does not refuse the term "mineral" to most economic minerals. The author, of course, cannot be consistent, for the term is not used in the latter part of the book in accordance with the restricted definition. In regard to the Australian artesian water, the author adduces evidence that the supply is dwindling from the reduction in size of the mound springs; but those who hold that plutonic water is largely influential in the uplift of the water in the wells do not consider, as is twice stated, that most of the water is plutonic in origin.

Mr. Howchin makes the interesting suggestion that the word "scree," of which the etymology is doubtful, comes from "screed," a fragment; but is it not more probably from "screen," owing to the resemblance to the sloping sheet of angular fragments on a road metal screen? The most important chapter is that on the Lower Cambrian glacial deposits, which extend northward from Adelaide for about 450 miles to a latitude as low as 29½. The author, to whom is due most of the existing knowledge of these beds, shows that they were probably laid down at sea-level. The occurrence of this great sheet of subtropical low-level glacial deposits at the very beginning of the fossiliferous rocks is one of the most significant facts in geological history. Mr. Howchin also tells us the latest information from the trans-continental railway bores as to the extension into Australia of the Cretaceous sea, and shows that in all probability it did not extend across the continent. The book is illustrated by numerous well-selected and excellent illustrations.

J. W. G.

OUR BOOKSHELF.

Annual Reports on the Progress of Chemistry for 1918, issued by the Chemical Society. Vol. xv. Pp. ix + 240. (London: Gurney and Jackson, 1919.) Price 4*s.* 6*d.* net.

THESE important volumes have been issued annually by the Chemical Society since 1905. Their object is to present an epitome of the principal definite steps in advance which have been accomplished in the preceding year for the benefit of workers or students in pure or applied science. They are not popular in any sense of the word. During the war there was necessarily some slackening in the production of results bearing chiefly on purely scientific problems, and the volume for 1918 is somewhat thinner than the volumes issued in previous years. Nevertheless, some advances can be recorded. For very many years the mass of the atom has been regarded as determining its chief properties. This is embodied in Mendeléeff's periodic scheme familiar to every chemist. It is therefore not surprising to find that the new doctrine which assumes some knowledge of the internal constitution of the atom should be rather slowly accepted. But chemical physics or physical chemistry is a department of knowledge which is undergoing rather rapid and bewildering change consequent on advances in positive knowledge. Absorption spectra, the properties of colloids, ionisation and the nature of ions, the nature and source of osmotic pressure, and the relations of isotopes are all subjects of supreme interest, many of which have assumed a totally new form, or have even been recognised only within the last twenty years. The chemical student of the future will need to be a fairly good mathematician if he hopes to follow all that is going on in these several directions. Fortunately there are other large fields of work still open in which this is not an essential condition and where great successes continue to be scored, especially in constitutional and synthetic organic chemistry and its applications to problems in physiology, animal and vegetable. These are all dealt with under appropriate heads in this volume of reports.

Heredity. By Prof. J. Arthur Thomson. Third edition. (The Progressive Science Series.) Pp. xvi+627. (London: John Murray, 1919.) Price 15*s*. net.

The first edition of Prof. Thomson's "Heredity," which appeared in 1908, was reviewed at some length in Nature (vol. lxxviii., pp. 361–63). The book quickly became established as an introduction—at once trustworthy, impartial, and comprehensive—to the many problems that are presented to students of inheritance, and a second edition with some additions and revisions was published in 1912. The third edition is now before us, and the author has taken the opportunity of directing the reader's attention to some of the important advances that have been made by investigators during the last seven years. The size of the book has not been increased from the second edition, so that room for additions has been found by condensing the type-setting on certain pages; this involves a brevity of treatment disappointing to those who would have valued Prof. Thomson's judicious criticism of several recent theories. For example, the studies by T. H. Morgan and his fellow-workers on the inheritance of linked factors in the fruit-flies (Drosophila), and W. E. Castle's work on the relation between heredity and selection in hooded rats, are barely mentioned.

A short list of some important books and papers of the last few years has been added to the bibliography, but the subject and general indexes appear to have escaped a revision which would have greatly increased their value. The paragraph on "Militarism" in the concluding chapter has been rewritten in the light of the experiences of the last five years, and the author emphasises Dr. Chalmers Mitchell's contention that "the struggle for existence as propounded by Charles Darwin and as it can be followed in Nature has no resemblance with human warfare." Again, as one turns the pages of Prof. Thomson's familiar volume, one realises how the study of biology, wisely applied, may become an aid rather than a rival to that of "the humanities." G. H. C.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

A Photoelectric Theory of Colour Vision.

Referring to his letter under the above heading on p. 74 of Nature of September 25, I perceive that Prof. Joly has had ideas similar to mine about an electric stimulation of the terminals of the optic nerve through bombardment of corpuscles flung off under the stimulus of ordinary light.

My argument is strengthened by reflecting that this utilisation of atomic energy, emitted in *quanta* under the stimulation of accumulated almost infinitesimal vibrations of the right frequency, can account for the extreme sensitiveness of the eye and of the sensitive pigments known very low down in the scale of animal life. The great variation of brightness permissible, between wide limits, without much differential physiological result is also natural on this view; so is the fatigue of colour-sensation by temporary exhaustion of a specific potentially radio-active material, until renewed by living tissue.

I should suppose that on this trigger-like basis the eye can form very little estimate of absolute brightness inside the limits above spoken of, though the ear, having no explosive mechanism, might be able to form a scale of loudness. In the main, photometric observations must be comparative.

A pathological condition of the retina, when flashes are perceived without objective stimulus, may be accounted for by overinstability of material and consequent spontaneous emission of corpuscles.

The experiments which Prof. Joly began to try seem to have been just in the general direction which I wished to encourage some young physiological physicist to pursue, only he must be prepared to design or adjust his electrical detecting instrument for extreme sensitiveness. A frog's nerve-muscle preparation could scarcely be responsive without something analogous to rods and cones, or something like an electric organ, and without access to unsheathed terminals. If a mechanical electroscope is employed it must have minute capacity; a silvered quartz filament, with a minimum of attachments, in the field of a microscope may be suggested.

Oliver Lodge.

Reversed Pleochroic Haloes.

In a paper on "The Genesis of Pleochroic Haloes" (Phil. Trans. R.S., vol. ccxvii.) by J. Joly, a theory is advanced accounting for certain structural features of the halo on the assumption that reversal of the halo-image is possible, and may take place under conditions defined in the paper. In support of this a drawing of a halo is given in which an evident inversion or change from positive to negative has occurred, the inner region being light, the outer dark.

Recently, in examining the brown mica extracted from a granite, we have found quite a large number of these negative haloes. All internal features are gone, solarised out of existence; the wide outer band alone remains. They resemble negatives of a much-exposed halo. Their dimensions shows that they possess uranium-charged nuclei. When the nucleus is *very* minute there is no sign of reversal; the halo is normal.

It is possible that the frequency of reversal in this mica is to be ascribed more to special uranium-richness of the nucleus rather than to the antiquity of the rock. The rock is a biotite granite with a white and a yellow felspar. It is said to be from Sinai. One side of the specimen has been exposed to the weather, and the appearance of this side suggests desert conditions.

J. JOLY.
J. H. J. POOLE.

Trinity College, Dublin.

The Spectra of Isotopes.

SOME years ago I made an investigation of the spectra of ordinary lead and lead from pitchblende residues, but I was not able to detect any difference in the spectra. More recently Aronberg (*Astrophys. Journal*, February, 1918) has found a difference in the wave-lengths of the principal line in the spectra of ordinary lead and lead from Australian carnotite amounting to 0·0043 Å. I have made a fuller investigation of the problem by a method of experiment greatly superior to that which I had previously adopted, and the results show that there is a small but real difference in the spectra, which agrees closely with the value found by Aronberg. A difference has also been found between the wave-length of the principal line in ordinary lead and lead from Ceylon thorite.

These results at once suggest that the spectroscope will furnish a simple and comparatively rapid method of distinguishing isotopes, and some measurements have been made of the wave-lengths of the principal line in ordinary thallium and in thallium from pitchblende residues. It has long been suspected that, in addition to lead, some of the metals found in pitchblende may be of radioactive origin, and the results of the wave-length measurements, though for certain reasons they cannot be given the same weight as those relating to lead, suggest that the thallium in pitchblende is an isotope of ordinary thallium and more probably of greater atomic weight. It is hoped to publish shortly an account of the investigation.

THOMAS R. MERTON.

Balliol College, Oxford, September 15.

A British Imperial Antarctic Expedition.

MAY I, through the columns of NATURE, direct attention to the British expedition which I am at present organising and propose to lead to the Antarctic in June next year? The objects of the expedition are briefly as follows:—

(1) To ascertain the position and extent of the mineral and other deposits of economic value already known to exist in Antarctica (*vide* scientific reports of Bruce, Mawson, Scott, and Shackleton), and obtain data for the practical development as a further source of Imperial wealth.

(2) To obtain further evidence of the localities of whales of economic value, and to create British industries in this trade.

(3) To investigate the meteorological and magnetic conditions in the Ross Sea area and at Cape Ann (Enderby Land) in connection with their influence under similar conditions in Australasia and South Africa respectively. That such results are of great economic value has been proved by the station established by the Argentine Government for similar purposes in the South Orkneys.

(4) To circumnavigate the Antarctic continent.

(5) Generally to extend our knowledge of Antarctica, especially with the view of obtaining further scientific data of economic importance.

The expedition proposes to leave England in June, 1920, and to be away for a period of five years. During this period important scientific research will be undertaken on the lines briefly given above. Applications are invited from fully qualified men in the following branches of scientific knowledge:—Geology, meteorology, biology, surgery and physiology, photography, cartography, and hydrography.

The expedition has been well and strongly supported, and I shall be glad if all who are interested will communicate with me at the address given below.

JOHN L. COPE.

66 Victoria Street, London, S.W.1,
September 20.

Luminous Worms.

WHEN I wrote the letter which appeared in NATURE of September 11 (p. 23), I made no reference to my impression that a friend had seen luminous earthworms in Great Britain because I was not aware that he was still in England, and was consequently unable to give accurate details. I found afterwards that this friend, Dr. Edgar Newbery, recently appointed professor of physical chemistry in the University of Cape Town, had not yet left this country, and I was able to write to him for confirmation of the impression in my mind, and I have now received a reply. Writing from Byton Rectory, Presteign, Radnor, Prof. Newbery says:—

"I have seen luminous earthworms on more than one occasion on the grass of our lawn here. (We are really in Herefordshire, though our post town is in Radnor). The soil from which they emerged is a mixture of clay and gravel, but is very fertile. The luminosity was very weak, and gathered in spots or blotches over the body. Small luminous patches were left behind on the grass in the track of the worm, but these faded in a very short time (30 seconds or so). I have seen them both in warm weather and when a slight frost was on the ground, but a very dark night is necessary to render them at all conspicuous, as the luminosity is so weak."

That Prof. Newbery is not confusing luminous earthworms with luminous centipedes is concluded from the next paragraph in his letter:—

"On Tuesday, September 2, I saw a remarkably brilliant luminous centipede in a barley field 100 yards from here. The light was so vivid that it caught my attention at a distance of 12 yards, and the luminous trail left behind it was quite 12 in. long. . . ."

Suggesting the cause of luminosity, Prof. Newbery says: —

"I am inclined to believe that the luminosity of these centipedes and worms is due to slow oxidation of some excretion from the body which may well be affected in quantity and quality by the food available."

So far as centipedes are concerned, I think Dr. Brade-Birks and I shall be able to show, in a forthcoming paper on luminous Chilopoda, that atmospheric oxygen is not necessary for the production of light in the centipedes we have studied, but Prof. Newbery's suggestion about food supply may explain why some individuals of a species are luminous while others are not.

In Verhoeff's "Chilopoda" (Bronn's "Klassen und Ordnungen des Thier-Reichs") there is no reference in the bibliography to Dr. T. L. Phipson's "Phosphorescence, or the Emission of Light by Minerals, Plants, and Animals" (London: Lovell Reeve, 1862); I therefore conclude that this useful work is little known. Phipson cites the experience of Audouin in 1814. In August that year some persons came to him at Choissy-le-Roi, near Paris, where he was on holiday, and told him they had seen an immense number of luminous earthworms in a chicory field not far away. These earthworms turned out to be centipedes. In another chapter Phipson tells us that in 1840 Forestèr wrote to the Academy of Sciences recording luminous earthworms. When this letter was communicated to the Academy, M. Audouin rose and said that he knew of no authentic case of luminous earthworms, but that he could cite numerous cases where luminous centipedes and worms had been confused. Whereupon Duméril, to prove that earthworms sometimes are phosphorescent, quoted the experience of Flaugergues and that of the naturalist Bruguière. It seems that M. Audouin was afterwards convinced of the fact that earthworms were sometimes luminous by the experience of Saigey and Moquin-Tandon, who found them so at Toulouse in 1837. Phipson quotes other evidence, and closes an interesting chapter with words which may confirm Prof. Newbery's suggestion about the relation between the quantity and quality of phosphorescence and the food supply:—

"I may add here," says Phipson, "that I distinctly remember witnessing, when quite a child, the phosphorescence of the earthworm; the light appeared connected with the slimy matter that covers the animal's body. It was whilst digging at night, in a large dunghill, for worms to supply baits for a fishing excursion that my schoolfellows and myself turned up many hundred Lumbrics in a highly luminous condition; but I cannot recollect in what month this happened."

S. GRAHAM BRADE-BIRKS.

16 Bank Street, Darwen, Lancashire,
September 13.

CATALYSIS IN CHEMICAL INDUSTRY.

THE catalytic agent is penetrating peacefully, yet effectively, into modern chemical industry. In explanation, to the lay mind, of the *rôle* of a catalyst in chemical reaction, comparison was recently cleverly drawn between the catalyst and the matrimonial agency. Both serve to bring together and to facilitate the union of others. Both are free after the consummation of the one process to renew their activities in like manner. The catalytic substance has played an important part in the many industries which have been necessary to the maintenance and equipment of the fighting Services with munitions of war. Not less distinctive a part has it played on the home front in the work of victory. The catalyst has been largely employed in the supply of margarine, to which we have grown accustomed. The soap with which we have been cleansed calls, in the process of its manufacture, for the assistance of the catalyst. The glucose which has helped to sweeten our lives, in time of a sugar shortage, is the resultant of yet another catalytic process.

Let us survey a few of the more striking applications of catalysis in industry. Glycerine for dynamite and nitroglycerine is obtained from fats by catalytic hydrolysis, using alkalis or acids as splitting agents. In the modern developments of fat-splitting the discovery of the Twitchell catalyst facilitated, owing to its combined acidic and fatty nature, the rapid working-up of low-grade fats and greases for glycerine and soaps. Sulphuric acid is made by one or other of two catalytic processes. The old or "lead chamber" process uses oxides of nitrogen to assist the process of oxidation of sulphur dioxide. For the stronger acid, the "oleum" or fuming sulphuric acid required in the nitration of toluene and phenol for high explosive, the modern "contact" process is more suitable. The sulphur dioxide and oxygen are caused to combine in the presence of solid contact agents such as platinum or oxide of iron. Chlorine, as well for poison-gas as for the more peaceful requirements of bleaching-powder of sanitation and water purification, is generated from hydrochloric acid by oxidation in the presence of copper chloride as catalyst. That very inert but plentiful constituent of the atmosphere, nitrogen, may now, with the assistance of a suitable catalyst, be caused to combine with hydrogen directly to form ammonia. This may be used for the production of ammonium sulphate for fertiliser, or oxidised in contact with a hot platinum gauze to form oxides of nitrogen, and thus lead to the manufacture of nitric acid or ammonium nitrate. The hydrogen which is necessary for ammonia synthesis is obtained most cheaply and effectively by another catalytic reaction, using water-gas and steam as the raw materials. Town gas and fuel gases generally are freed from obnoxious sulphur compounds present as impurities by catalytic processes of sulphur removal.

It is a matter of difficulty fully to characterise the developments which have attended in several instances the discovery of successful catalytic processes. Perhaps, however, an illustration involving the application of the researches of the brilliant French chemist, M. Paul Sabatier, will serve to demonstrate potentialities and possibilities inherent in academic research. M. Sabatier is the discoverer of the principle of catalytic hydrogenation, and has conducted an exhaustive series of researches into the phenomenon. The application of his results to industry has solved the century-old problem of the economic utilisation of liquid fats. During the last ten years, in ever-increasing measure, liquid fats and oils have been catalytically hydrogenated in presence of reduced nickel as catalyst to yield the more valuable hardened fats which are used in the soap and candle industry, as well as for purposes of food. The economic results of such application are tremendous. Whole tracts of tropical country are being opened up for the production of palm nut and other nut oils. Fish oils are being hardened and deodorised for use in the industry. New uses are being found for hardened cotton-seed, linseed, and similar largely available oils.

Catalytic hydrogenation has also been applied to the enrichment of gaseous fuels. The carbon monoxide of water-gas may be hydrogenated in presence of reduced nickel to give methane with consequent production of a gas of high calorific value and illuminating power. The production of hexahydro-benzol in bulk, by hydrogenation of benzene, is as yet in its infancy, but has a certain future owing to the utility of the product as a volatile fuel for internal-combustion engines. The fact that it is a single compound gives it marked advantages over petrol as a fuel for air transit, since the variability of petrol is a distinct drawback in the case of a fuel upon which such rigorous demands are necessary.

The development of the fine chemical industry in this country involves also an extended use of catalytic reactions. The successful production of synthetic indigo was facilitated by the discovery of the catalytic acceleration of the oxidation of naphthalene by mercuric sulphate, discovered owing to the breakage of a thermometer bulb in the reaction mixture. The production of dye intermediates involves, more and more, the aid of catalysis. Especially, however, in the large-scale preparation of solvents will catalysis contribute convincingly to success. Industrial alcohol may be cited in illustration. Every method by which this important solvent is produced is catalytic. The ordinary process of fermentation and distillation involves the participation of the living catalysts, the enzymes and ferments. The production of alcohol from potato and rice starch is a combined process of hydrolysis and fermentation with the catalytic action of acids followed by enzymes. Similarly, alcohol of the future will be obtained by catalytic degradation of the cellulose content of wood waste, or, synthetically, from acetylene and ethylene, by processes of catalytic hydration and hydrogenation. The potentialities of alcohol as a fuel in the future must not be forgotten, in view of the increasing consumption and prospective exhaustion of oil-fuel reserves. In the meantime these latter, as a result of more rigid scientific control, are being more economically utilised. The "cracking" of oils to yield the more volatile fractions usable in motor-engines is a modern development, the catalytic features of which have not, as yet, been completely realised.

From alcohol as starting-point, catalysis is involved in the production of acetic acid and acetone, the solvents largely required in the preparation of aeroplane dopes and varnishes. From methyl alcohol, a distillation product of wood, catalytic oxidation or dehydrogenation in presence of metallic copper yields formaldehyde, a powerful germicide and disinfectant, and itself the starting-point in the manufacture of bakelite, the artificial vulcanite or amber, a polymerised product formed under the influence of catalytic agents, and increasingly produced for use in electrical insulators and for fancy articles. The demand for formaldehyde is already so great that investigations are in progress with the object of production from sources other than methyl alcohol. The hydrocarbon methane has been suggested in this connection. A process of fractional oxidation of methane should yield formaldehyde. Alcohols and organic acids of varied complexity may be largely utilised in the production of synthetic essential oils and perfumes by processes of catalytic condensation.

The catalogue is not exhaustive, but sufficient has been said to show the paramount importance of catalysis in modern chemical industry. It is evident, therefore, that the modern curriculum of theoretical chemistry should concern itself largely with the scientific principles involved in catalytic reactions. An extended experience with catalysis, both pure and applied, has demonstrated that, from a complete realisation of the theoretical aspects of the problem, progress in the application follows the more rapidly and the more certainly. It is astonishing to note the facility with which new progress is attained by the employment of the scientific principles which have been acquired in a totally different application of catalysis to industrial progress. The records of certain of the Government Departments of investigative work, during the last few years, would be instructive in this regard. The need, therefore, is urgent for a well-trained force of young students, versed in the fundamentals of this modern branch of chemistry, and equipped to take their place in the further developments which lie so close at hand. There are manifold possibilities ahead—numerous processes and agencies catalytic awaiting the facile brain and hand of the investigator.

Hugh S. Taylor.

FROSTS AND AGRICULTURE IN THE UNITED STATES.

The United States Department of Agriculture has recently issued a publication on "Frost and the Growing Season." This consists of a series of maps in colours and some diagrams from which the probable date of the last frost in spring and the earliest in autumn may be seen at a glance. An article on a paper by Mr. W. G. Reed on this subject appeared in the issue of Nature for May 23, 1918, and the present publication is also by the same author.

Frosts are divided into three classes: "light," "heavy," and "killing." The first two terms apply to the amount of the deposit in the form of hoar-frost; the last only is dealt with in the paper, and is defined on an occasion on which the screen temperature fell below 32° F. In a country like the United States there is naturally great variation in the length of the period that is free from frost; not only is there variation in latitude from Florida to the Canadian border, but there is also much difference in the height above mean sea-level. The local topography is also important, for while, in general, frost is more prevalent at the greater altitudes, yet locally a small elevation will prevent a frost, and in enclosed valleys the hill-sides and the hill-tops may be less subject to frosts than the valley bottoms.

Frost records are available from about four thousand regular stations of the Weather Bureau, and of these about six hundred have a twenty years' record. The most noteworthy feature of the critical frost dates is their extreme irregularity. Thus at Peoria, Ill., with a fifty-nine years' record, the latest frost in spring covers a period of nearly fifty days, and the earliest in autumn a period of forty days. The maps are based upon the average dates.

The mountainous character of the country in the western portion of the United States, and the fact that the stations are mostly situated on the lower slopes of the mountains, make mapping very difficult, and it is pointed out that only a general idea of the conditions can be given. For practical purposes this position of the stations should not matter, as they would naturally be in those parts where cultivation was most prevalent.

It appears from the maps that there is no part of the United States except Key West where a frost may not occur, and the line showing a frost in half the years—that is, the line showing the position where a frost is just as likely to occur once in the winter as not to occur—excludes only a small part of Florida and reaches down to latiture 26° N. The line for the last frost before March 1 cuts off the peninsula of Florida and fringes the southern coast as far as New Orleans. In the north frosts are common until the middle of May or even June 1, and in the higher parts of the west, which are only used for grazing, they occur after June 1.

The earliest frost in autumn does not occur until after December 1 in Florida and in parts of the south-west. On the north-western frontier frost may be expected about the middle of September. About one-quarter to one-third of the whole country has a period of 210 consecutive days free from frost, but in the mountainous regions of the west there is a good deal of country in which the period is barely half as long.

Some smaller maps give information as to the frequency of frosts in the different districts one, two, or more weeks before or after the average dates. The whole paper is most interesting, and should be very useful to agriculturists in the United States.

W. H. D.

NOTES.

THERE was a certain inevitableness in the nomination of Mr. Arthur James Balfour for the Chancellorship of Cambridge University. The fact that Mr. Balfour has consented to be so nominated in succession to his late brother-in-law has everywhere been received with enthusiasm. In the history of Cambridge, statesmen, administrators, literary men, and philosophers have succeeded one after another in the roll of Chancellors, but in Mr. Balfour, the most celebrated of living graduates of Cambridge University, all are combined in one man. Mr. Balfour is one of the two honorary fellows of Trinity College, the other being the Right Hon. G. O. Trevelyan. Mr. Balfour was educated at Eton, and entered Trinity College in the late 'sixties. He took his degree in the Moral Sciences Tripos of 1896, in the same year as Dr. Percy Gardner, now the professor of archæology at Oxford. The Balfour family has been most intimately associated with Cambridge; his younger brother Francis, who unhappily perished in the Alps in 1882, was a man of the highest scientific distinction, one who was leading zoologists along new lines of thought; another brother, Gerald, was a fellow of Trinity; one of his sisters married Prof. Henry Sidgwick, and was for many years Principal of Newnham College; and another sister married Lord Rayleigh, whose recent death has deprived the University of a generous Chancellor and a great pioneer in modern physics. A reference to "Who's Who" will show not only the list of honorary degrees, too long to be quoted here, which have been conferred upon Mr. Balfour, but also that he has constantly taken the lead on various boards and committees connected with education. He has been Lord Rector of St. Andrews University, Lord Rector of Glasgow University, and he is Chancellor of Edinburgh University. The announcement that so distinguished a man and scholar has consented to be nominated for the post of Chancellor has met with widespread sympathy and hope amongst the members of the Senate.

ENTOMOLOGISTS, it appears, have not yet solved the problem of what becomes of the house-fly in wintertime. The popular idea that when the cold season comes the house-flies, or such of them as do not die off, retire to some quiet nook or cranny in the house and, like dormice, sleep undisturbed through the winter is still entertained in some scientific and other respectable quarters, although no trustworthy evidence has been found to support it. There are flies and flies; and, as Dr. L. O. Howard was, we believe, the first to suggest, no evidence relating to the hibernation of the house-fly can be trusted until it has first been submitted to expert examination. Since that suggestion was made, a large amount of evidence has been submitted to experts, and now they are almost unanimously agreed that the hibernating house-fly is a wholly mythical creature. But the house-fly must get through the winter somehow, and if not in its perfect state as a fly, then in some other stage or stages of its life, or else we should not be troubled with the pestilent brood year after year in succession. Before the entomologist can tell us exactly how, it looks as if he will need the help of the sanitary officer, the stable-boy, the farm labourer, or even of the Boy Scout, rather than that of the ordinary householder. The search for larvæ and pupæ of the fly is not an easy one, and often involves a great amount of physical labour. In summer-time the pupæ are frequently to be found living at a depth of 2 ft. under the surface of the soil within half a yard of a manure heap. Dr. Gordon Hewitt has searched for them in such places, and in every other likely place, in wintertime, and has never succeeded in finding any alive. But because he, and possibly a few others, have made it and failed, it can scarcely be said that a search of that kind has been exhausted, and that we must fall back upon the hibernating adult fly as the only alternative. There may be no definite hibernating stage in the life of the fly. The insect may continue to breed in the winter, not exactly as it does in the summer or autumn, but at a greatly retarded rate, each stage being more or less prolonged. This probably does not happen to any extent under natural conditions in this country, but the number of places in which it can happen, and probably does happen, under special conditions may be quite sufficient to account for the perpetuation of the fly.

THE officers and other members of council of the Röntgen Society for the session 1919–20 are as follows:—*Pesident*: Dr. Sidney Russ. *Hon. Secretaries:* Dr. Robert Knox and Dr. R. W. A. Salmond. *Hon. Treasurer:* Mr. Geoffrey Pearce. *Hon.*

Editor: Major G. W. C. Kaye. *Council:* Mr. W. E. Schall, Dr. G. H. Rodman, Mr. C. Howard Head, Mr. C. R. C. Lyster, Dr. J. Metcalfe, Mr. E. P. Cumberbatch, Dr. A. E. Barclay, Mr. F. J. Harlow, Dr. W. Makower, Dr. E. A. Owen, Mr. J. Russell Reynolds, and Mr. R. S. Wright.

A congress attended by 350 persons met at Marseilles in January last, under the auspices of the local Chamber of Commerce, to discuss and emphasise the rights of France over Syria. The discussions of the congress were divided into four sections:—Economics, archæology and history, education, and medicine and hygiene. A summary of the main papers of geographical interest is given in *La Géographie* (vol. xxxii., No. 5). M. E. de Marbonne contributed a paper on the geographical unity of Syria, in which he showed that Syria cannot be divided latitudinally, but that the natural divisions of the country extend from north to south, and are separated approximately by meridians from the Mediterranean to the valley of the Euphrates. Various papers of considerable value, although from a distinctive point of view, dealt with the trade and ports of Syria.

At the instigation of the Admiralty, the Royal Geographical Society has taken steps to form a permanent committee on geographical names, on which the Admiralty, War Office, Foreign Office, Colonial Office, India Office, Post Office, Board of Trade, Board of Agriculture, and the Royal Geographical Society are represented The chairman of the Committee is Major-Gen. Lord Edward Gleichen, and Mr. A. R. Hinks is acting povisionally as secretary. The Committee hopes eventually to examine all cases of doubtful nomenclature and spelling in the place-names of the British Empire, accepting, wherever possible, official name-lists such as those provided by the Gazetteer of India, the Board of Geographic names of Canada, etc. Place-names of the British Isles are outside the scope of the Committee, as they are dealt with by the Ordnance Survey. Lists of names will be published at intervals after they have been submitted for approval to the authorities of the country concerned. Correspondence regarding confused or doubtful place-names of which the writer has personal knowledge is invited, and should be addressed to the Secretary, Committee on Place-Names, c/o Royal Geographical Society, Kensington Gore, London, S.W.7.

The Journal of the Royal Microscopical Society for June (part 2, 1919) contains an important paper by Mr. J. Bronté Gatenby on the identification of intracellular structures. Considerable difficulty is often experienced in distinguishing several categories of cell elements. The Golgi apparatus, mitochondria, yolk, and fat are, or contain, substances often identical and generally chemically allied. For this reason care must be exercised in any attempt to identify a given cell body, and it is clearly recognised that the mixture of two or more of the above-mentioned elements may lead to confusion. The characteristics of the various elements of the cell which the zoologist may meet with, and the manner in which they may be distinguished by staining methods and microchemical tests, is indicated in tabular form.

The Review of Work in 1918 of the Rockefeller Foundation has recently been issued. The activities of the foundation include a campaign against tuberculosis in France, which is mainly engaged in coordinating the various agencies already in existence for combating this disease. Demonstrations to test the possibility of ridding a community of malaria by anti-mosquito measures have been carried out in Arkansas with considerable success, and an epidemic of yellow fever in Guatemala has been stamped out. Measures for the control and prevention of hookworm disease have been undertaken in many tropical countries. Medical education is also encouraged by the foundation; the Pekin Union Medical College is being built under its auspices, and grants are made to many missionary hospitals. The total disbursements of the foundation for 1918 amounted to more than 15,000,000 dollars, and war-work expenditure during the war totals nearly 22,500,000 dollars.

In an article published in a recent issue of the *North China Daily News* Mr. Austin J. Clements estimates that to maintain the trade in musk which passes across the Szechuan-Tibetan border, about 100,000 musk-deer must be captured and killed each year. The quantity of musk brought into Tachienlu, the chief centre of the trade, shows no sign of diminution, so that apparently the annual drain, large as it is, has so far had no noticeable effect on the musk-deer population of Eastern Tibet. Mr. Clements thinks it may be feasible to rear musk-deer in semi-captivity, and to collect musk from the animals without killing them. The wholesale slaughter which now goes on is largely unnecessary, since the snaring methods employed lead to the destruction of large numbers of females and immature males, whereas only male deer more than three years of age secrete musk. The article contains a good deal of information regarding the trade in musk, not the least interesting item being the statement that one firm in Tachienlu devotes itself solely to the manufacture of an adulterant, which resembles true musk in all respects save smell, the latter being provided by the addition of a small quantity of genuine musk. In coping with this and other less ingenious forms of sophistication the Chinese merchant is accustomed to rely on his personal judgment of the appearance, taste and smell, etc., of the article offered to him, so that it is not surprising that some authorities believe that all the musk exported from Tachienlu is more or less adulterated.

In connection with the Rat Exhibition held a few months ago in the gardens of the Zoological Society of London, special investigations were made into the various methods of rat destruction. Mr. E. G. Boulenger was placed in charge of this research, and on September 26, in a lecture presided over by Prof. E. W. MacBride, and attended by a large gathering of medical officers of health, sanitary officers, and rat officers, he gave an account of the results obtained. He stated that in the course of his investigations it was ascertained that, not only had the common brown rat very greatly increased in numbers in recent years, but also that the old English black rat, or ship's rat, which was supposed to have been practically exterminated in this country by the commoner species, and to be restricted to ports and ships, had become much more abundant, and the two species of rats were now found in various parts of London living together in harmony. Where rats were present in large numbers, and where it was not practicable to use gas, poisoning was found to be the best and cheapest method to adopt for their destruction. Of all the poisons experimented with, squill, the extract of the bulb of the Mediterranean plant *Scilla maritima*, gave the greatest satisfaction. Good results were also obtained with barium carbonate. Both these poisons, Mr. Boulenger said, were, in the small quantities required to kill rats and mice, more or less harmless to domestic animals. The destructive power of virus was found to be more untrustworthy than that of some poisons. The most successful form of trap consists of a tunnel-shaped cage with open doors at each end, which shut when the rat treads on a platform in the centre of the passage. The common steel gin-trap was specially successful when covered with wire tunnels. A large number of experiments were conducted in order to ascertain whether there was any truth in the statement that rats are influenced by human odour. As a result of these experiments it was found that it was superfluous to avoid handling traps on the assumption that rats are detracted by the odour of man. Sulphur dioxide was found to be the most effective gas, and was recommended for killing rats on ships and in confined spaces. When driven off under pressure, the gas could be used with success in fumigating rat-holes in the open. Details of the research will be found in a "Report on Methods of Rat Destruction," by Mr. E. G. Boulenger, shortly to be published by the Zoological Society, price 6*d*.

THE Proceedings of the United States National Museum (vol. lvi., No. 2288) contains an interesting paper entitled "Descriptions of New Species of Molluscs of the Family Turritidæ from the West Coast of America and Adjacent Regions" by Dr. W. H. Dall. In all, somewhat more than 200 species are considered, of which 181 are new. Of this large number 93 belong to the fauna of the western coast of the United States from the Arctic Ocean to San Diego, California, including one species from Hawaii. Eleven species appertain to the west coast of South America, including the Galapagos Islands; 89 belong to the Panamic fauna and its extension into the Gulf of California. The new species are well figured on twenty-four plates reproduced from excellent microphotographs.

DURING the early days of rubber-planting, seed was put in regardless of its origin, whether from trees yielding large or from trees yielding small quantities of latex. Now, however, so much rubber is planted that there is danger of over-production, and for further plantations (now that capital costs have increased) to have much chance of success they should be planted with seed from the best bearers. Selection of seed is already in progress in Ceylon and elsewhere, and a paper by Whitby ("Variation in *Hevea brasiliensis*," *Ann. of Bot.*, vol. xxxiii., 1919, p. 313) provides useful data which give an idea of the possibilities of improvement in average yield. A large number of trees were tapped on a uniform system (in Malaya), and it was found that nearly 10 per cent. yielded twice the mean or more. If, then, the method of selection indicated in Lock's "Rubber and Rubber-Planting" (p. 101) were adopted, there seems good reason to hope that new plantations might be made yielding much more rubber per acre than the old.

THE possibilities of camphor cultivation in the West Indies has recently been discussed in the *Agricultural News* for May 31 last. The decreasing amount of camphor available for export from Japan, which has hitherto been the main source of supply, has led to experimental growth of the camphor-tree in various West Indian Islands. It has been found that some varieties of the tree yield oil only, while others yield camphor and oil, and this important botanical aspect of the question is being investigated at Kew. With the right variety, the leaves and twigs, as well as the wood and roots, are found to yield camphor on distillation, and the trees will bear severe pruning with little apparent injury. Camphor production appears to be an industry which might profitably be developed in several West Indian islands, where climatic and soil conditions are suitable; for instance, Jamaica, Trinidad, Dominica, and others. Camphor hedges as wind-breaks to lime or cacao plantations might be experimented with, even if extensive areas were not devoted entirely to camphor plantations.

AMONG recent publications of the Board of Agriculture is the first annual report of the Flax Production Branch—a branch formed in 1917 to arrange for the growth of at least 10,000 acres of flax in Great Britain. It is estimated that the 1918 crop will yield about 26,500 tons of straw and seed. The cost of production has been enormous, chiefly owing to the great difficulty in obtaining the large amount of labour necessary for harvesting the crop. Pre-war experiment stations proved the possibility of flax production on a small scale in Great Britain, but it would be obviously unfair to take last year's experience as a guide to the possibility of a large-scale flax industry. The latter will depend on foreign imports and prices, on the development of flax-growing in other countries, and also on the hitherto unattacked problem of the reduction of costs in all the stages of production. Improvements already in sight are the increased straw yield from selected strains, and the progress made with the threshing attachment which makes deseeding on the farm possible. Also, it must be remembered that, failing the large-scale establishment of the flax industry, considerable loss will be sustained in the disposal of the machinery which has been put up during the past year.

THE recently issued volume of the Journal of the Royal Agricultural Society (vol. lxxix., 1918) contains several papers of great interest in connection with the food production campaign carried on during the war. Prof. Bryner Jones describes the results of breaking up grass-land in 1918. This will always rank as one of the most remarkable achievements of British agriculture, contributing as it did so largely to the food-supply of the country in times of great need. It was fitting, therefore, that the technical problems should be recorded and discussed. Teachers and experts will hope that an even fuller account may be published eventually, giving details of soil formations and conditions that will add to its usefulness. Mr. Garrad describes the work of the tractor on the farm. This implement is rapidly revolutionising farm conditions, and is greatly increasing the efficiency of the farm-worker. The defects of present types are set out and suggestions made for the consideration of engineers. Unfortunately, the great enemy of the tractor is the weather; in Mr. Garrad's opinion, it is essentially a fine-weather machine, and has to be laid up in winter. But it works so quickly that it enables a farmer to do much of his work during the fine periods. Mr. J. R. Bond gives an account of modern haymaking machinery, and Mr. Arthur Amos discusses the difficulties of growing red clover.

THE REV. M. SADERRA MASÒ, who has studied the seismic and volcanic phenomena of the Philippine Islands for many years, has recently published the catalogue of earthquakes for the year 1918 (U.S. Weather Bulletin for December, 1918). Excluding after-shocks, the total number of earthquakes is 167, three of which were recorded all over the world. The most important earthquake was that which occurred in Southern Mindanao on August 15 at 12.20 p.m., G.M.T., its epicentre being in 5·5° N. lat. and 124·5° E. long. This shock, the intensity of which reached the highest degree (10) of the Rossi-Forel scale, was followed by thousands of after-shocks (some of them of degrees 7 and 8) during the months of August, September, and October. It was followed by a sea-wave, which swept over the southern coast of Catabato, causing great damage and loss of life. About a month later, on September 13, there were two violent shocks in the Batanes Islands, the first of intensity 8 at 6.56 a.m., the second of intensity 9 at 11.5 a.m., by which the towns of Sabtan and Ivana were destroyed.

THE Bulusan volcano rises on the south-east end of the island of Luzon to a height of about 5000 ft. For centuries—indeed, so far back as the historic record extends—it has been dormant, only occasionally ejecting small jets of steam from numerous vents around its breached and nearly filled-up crater. A few light outbursts with ejection of ashes are reported as having occurred in 1852, 1889, and 1894. Far more important were the eruptions which took place in January, 1916, and October, 1918, and are briefly described by the Rev. M. Saderra Masò in the U.S. Weather Bulletin for January last. The first began on January 16, 1916, and lasted five days, with numerous earth-tremors and rumbling noises and small explosions. The eruption of October, 1918, was more violent, and at the end of December incandescent lava began to pour down a deep ravine on the south-south-west side of the mountain, continuing until the end of March, 1919. The damage caused by the eruptions is of little account; indeed, the plantations on the lower flanks of the volcano have been benefited by the small falls of ashes.

Symons's Meteorological Magazine for September inaugurates the passing of the magazine from the British Rainfall Organisation to the Meteorological Office as a part of the unification of the British Meteorological Services. The Thames Valley rainfall map for August shows the general rains to have ranged during the month from 2 in. to 4 in., the rains being heaviest in the southern districts of Hampshire and Sussex. In London and over a large part of Middlesex the rains measured about 2·5 in., the least rains amounting to 2 in. and less over the estuary of the Thames.

THE Monthly Meteorological Chart of the North Atlantic Ocean published by the Meteorological Office, in addition to the usual information dealing with matters of especial interest to the seaman, has on the face of the chart a note on the increasing storm tendency during the autumn. Attention is directed to the fact that during the winter half of the year both anticyclones and cyclones are of greater intensity than those of the quieter months of summer, the barometer during the winter season both rising higher and falling lower, which accounts for the greater severity of the wind. As an illustration of the irregular track of storms at times, attention is directed to a storm experienced by H.M.S. *Caesar* in the neighbourhood of Bermuda during the early days of September, 1915, when the storm's path seems to have nearly completed a circle and then to have doubled back over a considerable area. To confirm so erratic a path, a minute discussion of neighbouring and surrounding observations seems desirable. Autumn is referred to as the most stormy period for hurricanes in the tropical belt, but the accumulated data for many years show August as the most stormy month for West Indian hurricanes. Charts are given of the North Polar seas for the months from April to August inclusive, taken from the "State of the Ice in the Arctic Seas, 1918," published by the Danish Meteorological Institute.

THE developments of aerial photography during the war seem likely to be put into practical use in peacetime in connection with surveying and cartographic work. In *La Nature* for September 6, P. Dautriche expresses the opinion that the field of application for aero-photography seems to comprise (1) land cartography (revision and explorations); (2) marine cartography or charting; (3) the preparation of large-scale maps and plans for various public works enterprises; and (4) control work (forest sections, the traffic of ports, stations, etc.). His article develops the subject in an elementary way by simple examples of the method of procedure.

A WRITER in *La Nature* (September 6) sketches the development of the French Ministry of Inventions from its inception in 1915. The Department has been responsible, like the British War Inventions Department, for carrying out numerous investigations related to matters of artillery, small arms, lorries, tanks, aircraft, and shipping. One of the most useful inventions which was the outcome of much experiment by Prof. Perrin and his collaborators is a method of acoustic signalling by means of a compressed-air trumpet. The apparatus, which is quite portable, comprises two clarions or bugles having different notes and a compressed-air cylinder. It has a range of several kilometres. Much valuable work was done, too, on the photography of projectiles at extra high speeds. Mention is also made of Prof. Rothé's method of recording wind velocity by means of small anemometers and mills attached to captive balloons, the anemometers closing an electric circuit at intervals of 10 m. of change in wind force.

AN interesting pamphlet has been issued by the Niagara Falls Chamber of Commerce relating to the electro-chemical industries established at the Falls. The power at present utilised amounts to 605,000 h.p., whilst schemes in process of development will absorb a further 420,000 h.p. It is estimated that a total of 2,500,000 h.p., equivalent to more than 16,000,000 tons of coal per annum, may be obtained without impairing the natural beauty of the Falls. The substances produced by the various companies cover a wide range, and include abrasives, refractories, fertilisers, metals and alloys, inorganic compounds, and a variety of organic substances such as chloroform, methyl alcohol, and formaldehyde. When cheap power is available, electro-chemical methods of production often prove cheaper than alternative processes, and to this fact may be attributed the rapid development of hydro-electric schemes in all countries where water-power is available on a sufficiently large scale. The policy of the United States is to utilise water-power to the fullest extent, thereby conserving fuel; and it is worth while considering whether the British Empire could not act as a whole in this connection, particularly in view of the present situation in relation to coal supplies. Judging from the success already achieved at Niagara, it appears probable that a continuously increasing proportion of chemical and metallurgical products will emanate from water-power centres in the future.

WE have received a copy of an interesting pamphlet (obtainable from the editor of the *British Baker*, Messrs. MacLaren and Sons, Ltd., 38 Shoe Lane, E.C., price 1s.) by Capt. Robert Whymper on "The Conditions that Govern Staleness in Bread." For the greater part the report deals with work carried out by Capt. Whymper himself as Assistant Inspector of Bakeries with the Army in France, and it extends over far too large a field for complete abstraction here. The questions studied include the estimation and location of losses occurring in the manufacture of bread, the conditions that govern staleness in bread, changes occurring in bread with age, and the colloid nature of bread-crumb. The conclusions arrived at are as follows:—(1) The cooling of bread takes place in three stages: a steam period, a condensation period, and a drying period, the rate of loss of moisture of the first being four times as great as that of the drying period and five times that of the condensation period. (2) No marked loss of moisture from the centre of the loaf occurs until after 100 hours, and within the latter period the zone of drying is a layer only 1 in. thick adjacent to the outer crust. (3) The loss of water from a loaf on keeping is not responsible for staleness. (4) As the loaf becomes stale there is a fall in the amount of soluble extract of the bread-crumb, followed by a rise, the soluble starch falling rapidly between six and twenty-four hours' cooling. This supports Lindet's view that staleness is due to the retrogression of soluble starch. A similar fall and rise of soluble extract has been observed with starch pastes. Capt. Whymper considers that staleness may be attributed to (i) deposition of solid starch in the bread-crumb by change of temperature and accelerated by the pre-existence of solid starch particles; and (ii) partial polymerisation of starch independent of the deposition mentioned, which tends to crumble the gelatinous nature of the bread-crumb. Changes occurring in the proteins of the bread may also be a cause of staleness.

Messrs. Baillière, Tindall, and Cox have in the press for appearance in their Industrial Chemistry Series:—"Explosives," E. de Barry Barnett; "The Industrial Gases," Dr. H. C. Greenwood; "Animal Proteids," H. G. Bennett; and "The Carbohydrates," Dr. S. Rideal. The following volumes are in preparation for the same series:—"Fats, Waxes, and Essential Oils," W. H. Simmons; "Silica and the Silicates," J. A. Audley; "The Rare Earths and Metals," Dr. E. K. Rideal; "The Iron Industry," A. E. Pratt; "The Steel Industry," A. E. Pratt; "Gas-works Products," H. H. Gray; "Organic Medicinal Chemicals," M. Barrowcliff and F. H. Carr; "The Petroleum Industry," D. A. Sutherland; "Wood and Cellulose," R. W. Sindall and W. Bacon; "Rubber, Resins, Paints, and Varnishes," Dr. S. Rideal; and "Economic Fuel Production in Chemical Industry," Dr. H. S. Taylor.

Erratum.—On p. 84 of Nature of September 25, in the Table in column two, 95·4 appeared under S(aturn) in some copies as 5·4, the 9 having been broken off during printing.

OUR ASTRONOMICAL COLUMN.

The Twenty-four-hour Day.—The spirit of standardisation and unification is abroad, and one of its latest manifestations is the attempt to reduce the various methods of time-reckoning to a single system. Astronomers have made an important contribution to this end in deciding to commence the astronomical day at midnight instead of noon. This reform will commence in the year 1925, an earlier date being inconvenient for the various nautical almanacs. While astronomers will gain, on the whole, by the change, yet in some respects, notably in the case of sets of observations extending on both sides of midnight, it will cause inconvenience; this gives them a certain claim to ask for some sacrifice on the part of the general public in order to achieve the further unification which is now desired; this is the substitution of 24-hour reckoning for the present system of a.m. and p.m.

Twenty-four-hour time has long been used in Italy; it was introduced into the British Army last year, and a few railway companies already use it in their time-tables, where its convenience is so manifest that it is surprising that its introduction has been so tardy. The majority of social functions take place in the afternoon or evening, and it undoubtedly is somewhat more troublesome to say seventeen than five, or twenty-one than nine. *Punch* made some amusing play on this subject when the reform was suggested in 1885; possibly this had something to do with the failure to carry it at that date. However, the fact that astronomers could not then agree to alter the astronomical day deprived the scheme of its driving-power. The auspices are now more favourable, and the report of the Committee, consisting of seven members, just appointed by the Home Secretary will be awaited with interest.

Comets.—Using observations made on August 21, 29, and September 7, Messrs. Braae and Fischer-Petersen have deduced the following elliptical orbit of the comet 1919*b*:—

T = 1919 Oct. 16·861 G.M.T.	log a = 1·23860
ω = 129° 32·11′ } 1919·0	log e = 9·98767
☊ = 310° 43·41′ } 1919·0	log q = 9·68544
i = 19° 11·45′ } 1919·0	Period 72·095 years

The elements are extremely close (within about 5′ in each case) to Gould's elements for 1847 when corrected for precession. The error of the middle place in longitude (great circle) is −0·50′, in latitude +0·51′. The period adopted is simply the observed interval between the two perihelia, uncorrected for perturbations.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ	Mag.
Oct. 1 ...	11 46 46	25 14	9·7836	9·7184	6·8
5 ...	11 45 19	20 52			
9 ...	11 46 13	16 46	9·7130	9·8392	7·3
13 ...	11 49 41	12 49			
17 ...	11 55 30	8 55	9·6856	9·9440	7·9

The comet will be observable as a morning object in Europe until early in December; after that it will pass to the south of the sun, and will be better placed for southern observers. It is very desirable to observe it as long as possible, in order to place the elliptical character of its orbit beyond a doubt.

The physical appearances of the three visible comets are discussed in *L'Astronomie* for September. 1919*a* (Kopff) appeared as a circular nebulosity some 3′ in diameter, gradually increasing in brightness towards the centre, where there was a nucleus of the 12th mag.; no trace of a tail. 1919*b* (Metcalf-Brorsen) was visible to the naked eye on September 5, in spite of strong moonlight. In the telescope it appeared as a large nebulosity, with eccentric condensation, and a short but broad tail pointing S.W. 1919*c* (Metcalf-Borrelly) appeared early in September as a pale nebulosity, 2′ in diameter, with slight central condensation; observation difficult owing to moonlight.

Minor Planets.—A sixth member of the interesting Trojan group of planets (the mean motion of which is the same as that of Jupiter) was found in March last, and provisionally designated 1919 FD. Its mean longitude is 60° greater than that of Jupiter. Prof. Cohn gives the following elements:—

Epoch 1919 March 19·5 G.M.T.

M_0 = 88° 48′ 18·9″
ω = 78° 46′ 7·8″ }
☊ = 336° 55′ 10·5″ } 1919·0
i = 21° 56′ 49·8″ }
ϕ = 4° 55′ 43·4″
μ = 303·190″
log a = 0·712194

Four of the Trojans have longitude 60° greater than Jupiter, and two 60° less.

FLORA OF MACQUARIE ISLAND.

THE recently issued part of the Scientific Reports of the Australasian Antarctic Expedition, 1911–14 (series iii., vol. vii., part 3), entitled "The Vascular Flora of Macquarie Island," by T. F. Cheeseman, contains some important conclusions on the origin and distribution of the southern floras. Macquarie Island is situated on a narrow submarine ridge, surrounded by water more than 2000 fathoms deep, about 600 miles to the south-west of New Zealand. Its greatest length is barely twenty-one miles, and its greatest breadth under four miles. The island is little more than a range of mountains, the exposed ridges bare and wind-swept, while in the hollows are numerous shallow lakes, and the coastal hills are deeply scored by ravines. The climate is marked by a low summer temperature, much cloud and fog, and constant high winds. Dr. J. H. Scott, who visited the island in 1880, describes the landscape as barren in the extreme. There is not a tree or shrub, but long stretches of yellow tussock are varied with patches of the bright green *Stilbocarpa polaris*, the Macquarie Island cabbage, a plant resembling very fine rhubarb in growth, and of Pleurophyllum, a handsome Composite, with long, sage-green leaves and purple flowers. On the hillsides are globular masses of Azorella, forming dense, solid cushions often 4 ft. across. Near the hilltops is an abundant growth of rich brown mosses. Hooker ("Flora Antarctica") mentions seven species of flowering plants and one fern as known from the island. Mr. A. Hamilton, on whose collections the present account is based, spent nearly two years in the island, and Mr. Cheeseman now enumerates thirty flowering plants and four ferns. Of these, three grasses are endemic, while of the remaining thirty-one species eighteen extend to New Zealand, and eleven of these are found in no other country. A remarkable fact is that fifteen, or practically one-half of the non-endemic plants, are also found in Fuegia or the South Georgia to Kerguelen groups of islands. Fuegia lies 4600 miles east of Macquarie Island, with no trace of land between, and South Georgia, further east, at about 5800 miles. Westward there is open sea until Kerguelen Island is reached, about 3250 miles distant. The extraordinarily scanty flora of the South Georgia-Kerguelen-Macquarie areas, which lie between parallels roughly corresponding with the north of England and the centre of France, is probably due mainly, as Prof. Rudmose Brown has suggested, to the short summer with its comparatively low temperature; but the almost continuous westerly gales must also act adversely on plant growth.

After a brief comparative review of the vegetation of the various land areas of the sub-Antarctic zone, Mr. Cheeseman concludes that during Tertiary times there have been only two directions in which the vegetation of the rest of the world can have approached the sub-Antarctic zone and Antarctica itself, or along which an interchange of species could take place, namely, the direction of New Zealand and that of South America. The rich and varied flora of New Zealand, in addition to its obvious Australian, Pacific, and Malayan alliances, has also an evident Andine and Fuegian affinity, which is still greater in the New Zealand sub-Antarctic islands. These islands in early Tertiary times were part of a greater New Zealand, and a northward extension of Antarctica might have reduced the distance between it and the New Zealand area to one capable of being passed by plants and animals. An indication of a former continuous or broken land connection between Antarctica and South America, presumably in Oligocene times, is found in the comparatively shallow bank which curves round by way of the Falkland Islands and South Georgia. The fossil Tertiary flora discovered by Dr. Andersson in Graham Land, comprising species of well-known recent South American and New Zealand genera, is of interest from this point of view. It suggests an Antarctica largely free from ice and snow, and supporting a numerous flora along the shores of the continent. We may imagine a regular exchange of species between Antarctica and Fuegia, and also a passage of species between New Zealand and Antarctica. In this way we may account for the presence of a New Zealand element in the South American flora and a South American element in New Zealand.

The subsequent Glacial epoch caused much extinction of species in the southern flora. At its close Macquarie Island had lost its higher plants except the few grasses which now constitute its endemic flora, Kerguelen had suffered almost as badly, and in South Georgia the whole of the vascular flora had perished. With the advent of a milder climate only two sources of supply remained, Fuegia and the New Zealand area. South Georgia and the Kerguelen group, both favourably placed in the line of the constant westerly winds, received almost the whole of their new flora from Fuegia, while Macquarie Island obtained a large proportion from the comparatively close New Zealand sub-Antarctic islands.

EDUCATION IN BRITISH INDIA.

THE Bureau of Education, India, has issued an interesting quinquennial review of the progress of education in British India for the period 1912–17. The facts are set forth in a statistical abstract covering 100 folio pages. They deal with all forms of education, primary, secondary, professional, and university, under various heads, such as the number of institutions public and private, the scholars in attendance, local and State expenditure, number and qualifications of the teachers, and cost of education in elementary and secondary schools and in professional and university colleges. The statistics differentiate between the various races, together with Europeans and Anglo-Indians, and between the different creeds, including Hinduism, Mohammedanism, and Buddhism. The returns refer only to British India, with an area of 1,034,716 square miles and a population of about 244,000,000, of which number 124,747,805 are males and 119,273,295 females. The Hindus number 163,611,094, Mohammedans 57,419,309, Buddhists 10,642,812, Parsis 86,155, Europeans and Anglo-Indians 265,254, Indian Christians 2,226,464, others 9,989,185—figures of much interest in view of the present Indian unrest. Of this vast number only 7,851,946, in which is included 1,230,419 females, are under instruction in all types of educational institutions, or about 3 per cent. of the population. In 1906–7 only 5,388,632 were under instruction, and in 1911–12 6,780,721.

The number of arts colleges in 1916–17 was 134 with 47,135 students; of professional colleges, 61 with 11,504 students; of special schools, inclusive of training, medical, agricultural, and other technical schools, 4861 with 143,604 students; of secondary schools, 7693 with 1,186,335 pupils; of primary schools, 142,203 with 5,818,730 pupils. In addition to these there were 37,803 private institutions, 3009 of which were advanced with 60,618 pupils, and 34,794 were elementary with 584,020 pupils. The total expenditure on public instruction in 1916–17 was 7,525,537*l*., of which sum there was spent on administration, inspection, scholarships, buildings, furniture, apparatus, etc., 2,239,749*l*. On the arts colleges there was spent 473,583*l*., on the professional colleges 239,961*l*., on the training schools 190,920*l*., on all other special schools 298,474*l*., on the secondary schools 2,128,612*l*., and on the primary schools 1,954,236*l*. There was a total income from fees in 1916–17 of universities, professional colleges, and special technical schools of 107,453*l*., and of secondary schools of 242,620*l*. In 1917 14,799 students matriculated, 4209 qualified for the B.A. examination, 440 for B.Sc., 555 for M.A., and 152 for M.Sc. An elaborate census of education such as this for the United Kingdom would be a welcome contribution to our knowledge of educational affairs.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION C.

GEOLOGY.

Opening Address (Abridged) by J. W. Evans, D.Sc., LL.B., F.R.S., President of the Section.

One of the most striking features of our science is the need in which it stands of a large and widely distributed body of workers, and the opportunities it affords to every one of them of making important contributions to scientific knowledge.

Everywhere someone is needed who will devote his spare time to the examination of the quarries and cliffs, where the materials that build up the solid earth are exposed to view, and who will record the changes that occur in them from time to time; for a quarry that is in work, or a cliff that is being undermined by the sea, constantly presents new faces, affording new information, which must be recorded if important links in the chain of evidence are not to be lost. It is equally important that someone should always be on the look-out for new exposures, road or railway cuttings, for instance, or excavations for culverts or foundations, which in too many instances are overgrown or covered up without receiving adequate attention. It is, again, only the man on the spot who can obtain even an approximately complete collection of the fossils of each stratum, and thus enable us to obtain as full a knowledge as is possible of the life that existed in the far-off days in which it was laid down. In his absence, many of the rarer forms which are of unique importance in tracing out the long story of the development of plants and animals, and even of man himself, never reach the hands of the specialist who is capable of interpreting them. It was an amateur geologist, a country solicitor, who saved from the road-mender's hammer the Piltdown skull, that in its main features appears to represent an early human type, from which the present races of man are in all probability descended. Another amateur, who was engaged in the brick-making industry near Peterborough, has provided our museums with their finest collections of Jurassic reptiles. A third, a hard-worked medical man, was the first to reveal the oldest relics of life that had at that time been recognised in the British Isles; and many more examples could be instanced of the services to geological science by those whose principal life-task lay in other directions.

Such workers are, unfortunately, all too few—fewer, I fancy, now than they were before the pursuit of sport, and especially of golf, had taken such a hold upon the middle classes and occupied so considerable a portion of their leisure hours and thoughts. One might hope that the extended hours now assured to the working classes for recreation would lead to a general increase of interest in science among them, if it were not that the students of that admirable organisation, the Workers' Educational Association, seem almost invariably to prefer economic or political subjects to the study of Nature. In a large county in which I am interested the number of those in every condition of life who are able and willing to take part in geological research might be told almost on the fingers of one hand, and, so far as I am aware, there has not been a single recruit in recent years from the ranks of the younger men or women.

It might be suggested that the prevailing indifference to the attraction of geological research was due to a conviction that after eighty years of work by the Geological Survey, as well as by university teachers and amateurs, there was little left to be done, and that all the information that could be desired was to be found in the Survey publications. Such a belief can scarcely be very widespread, for, as a matter of fact, comparatively few of the general public realise the value of the work of the Geological Survey, and still fewer make use of its publications. Municipal libraries, other than those of our largest provincial centres, are rarely provided with the official maps and memoirs relating to the surrounding areas, and in the absence of any demand the local booksellers do not stock them. This cannot be attributed to the cost, for, though most of the older maps are hand-coloured and therefore expensive, the later maps—at least, those on the smaller scales[1]—are remarkably cheap, and the memoirs are also issued at low prices. The true explanation appears to be that a geological map conveys very little information to the average man of fair education who has received no geological instruction. This is certainly not the fault of the Survey maps, which compare very favourably with those of other countries, and have been greatly improved in recent years. In particular, the introduction of a longitudinal section on each map and the substitution of the vertical section drawn to scale for the old colour index must greatly assist those into whose hands it comes in obtaining a correct view of the succession of the strata and the structure of the country. Some of the maps are, it is true, so crowded with information—topographical and geological—that it is frequently difficult, even for the trained geologist, to read them without a lens. This is largely due to the fact that they are printed over the ordinary topographical maps in which there is a great amount of detail that is not required in geological maps. In India the Trigonometrical Survey are always ready to supply, as a basis for special maps, copies of their own maps printed off plates from which a portion of the topographical features have been erased.

The best remedy, however, would be to extend the publication of the maps on a scale of 6 in. to a mile (1 : 10,560). For many years all geological survey work has been, in the first place, carried out on maps of this scale, but they have not been published except in coal-mining areas. There the geological boundaries are printed, but the colouring is added by hand, which makes the maps comparatively expensive. In other localities manuscript copies of the geological lines and colouring on the Ordnance Survey maps can be obtained at the cost of production, which is necessarily considerable. There is, I believe, a wide sphere of usefulness for cheap colour-printed 6-in. geological maps, especially in the case of agricultural and building land, for which the 6-in. Ordnance maps are already in demand. They afford ample room for geological information, and, accompanied by longitudinal sections on the same scale without vertical exaggeration, their significance would

[1] 1 in. to the mile, 1 : 63,360; ¼ in. to the mile, 1 : 253,440, and 1 in. to 25 miles, 1 : 1,584,000.

be more readily apprehended than that of maps on a smaller scale.

It would be of great advantage if there were a uniform usage by which the position in the stratigraphical series of rock outcrops were indicated by colour and their lithological character by stippling (in black or white or colour), following the ordinarily accepted conventions. This course has been pursued by Prof. Watts in the geological map prepared by him to illustrate his "Geography of Shropshire."

Some explanation, apart from the maps themselves, is, however, needed if they are to be rendered, as they should be, intelligible to the general public. The official memoirs which deal with the same areas as the maps do not afford a solution of the difficulty. Excellent as they are from the technical point of view and full of valuable information, they convey little to the man who has not already a considerable acquaintance with the subject. What is needed is a short explanatory pamphlet for each map, presuming no previous geological knowledge, describing briefly and in simple popular language the meaning of the boundary lines and symbols employed, and the nature and composition of the different sedimentary or igneous rocks disclosed at the surface or known to exist below it in the area comprised in the map. A brief account of the fossils and minerals visible without the aid of a microscope should also be included. The probable mode of formation of the rocks and their relation to one another and the subsequent changes they have undergone should be discussed, and at the same time their influence on the agriculture value of the land and its suitability for building sites, as well as on the distribution and level of underground water, pointed out. Some account, too, should be given of the economic mineral products and their applications. These pamphlets should be illustrated by simple geological sections, views of local quarries and cliffs showing the relative positions of the different rocks, figures of the commoner fossils at each horizon, and, where they would be useful, drawings of the forms assumed by the minerals. Each pamphlet would be complete in itself. This would involve a considerable amount of repetition, but it must be remembered that different pamphlets would have, as a rule, different readers.

During the war publications containing desirable information were circulated widely and gratuitously by the authorities to all public bodies concerned, and there seems no reason why the information laboriously gathered by the Geological Survey in the national interests and paid for out of the public funds should not now receive the same treatment. All municipalities, district councils, public libraries, colleges and schools, both secondary and elementary, should receive free copies of the Geological Survey publications dealing with the area where they are situated or with those immediately adjoining it.

Every facility should, of course, be afforded to the public to make use of the Survey publications. They should not only be on sale at the post offices in the areas to which they relate, but it should also be possible to borrow folding mounted copies of the maps as well as bound copies of the explanations and memoirs, on making a deposit equal to their value. When they were no longer required, the amount of the deposit, less a small charge for use, would be repaid on their return to the same or any other post office and the production of the receipt for cancellation. It would thus be possible, when traversing any part of the country, to consult in succession all the Geological Survey publications of the districts passed through. This system would also enable the permanent residents to refer to the more expensive hand-coloured maps, including the 6-in. manuscript maps, at a comparatively small cost.

The Survey publications should be illustrated in every museum and school in the districts with which they deal by small collections showing the characters of the local rocks, and of the minerals and fossils that occur in them, and care should be taken to see that these collections are maintained in good order and properly labelled.

It would be a good plan for the Survey to appoint a local geologist, an amateur or member of the staff of a university or college, in every area of twenty or thirty square miles to act as their representative and as a centre of local geological interest. He would be expected to given his assistance to other local workers who stood in need of it. He would receive little official remuneration, but inquirers in the neighhood would be referred to him, and where commercial interests were involved he would, subject to the sanction of the central office, be entitled to charge substantial fees for his advice. He would report to the Survey any event of geological importance in the area of which he was in charge—whether it was the discovery of a new fossiliferous locality, the opening of a new quarry,[2] the sinking of a well, or the commencement of boring operations. Many of these matters would be adequately dealt with by local workers, but in other cases it might be desirable for the Survey to send down one of their officers to make a detailed investigation.

One of the most important duties of the Survey, or of its local representative, would be to see that the records of well-sinkings and borings are properly kept, and that where cores are obtained the depth from which each was raised is accurately recorded. At the present time the officers of the Survey make every effort to see that this is done, but they have no legal power to compel those engaged in such operations to give the particulars required. Equally important is a faithful record of the geological information obtained in prospecting or mining operations. This is especially necessary where a mine is abandoned. If care is not then taken to see that all the information available is accurately recorded, it may never be possible later to remedy the failure to do so.

Probably these objects would be much facilitated if engineers in charge of boring or mining operations had sufficient knowledge of geology and interest in its advancement to make them anxious to see that no opportunity was lost of observing and recording geological data. This would be in most cases ensured if every mining student were required to carry out geological research as part of his professional training. It is now recognised that no education in science can be considered to be up to university standard if it is limited to a passive reception of facts and theories without any attempt to extend, in however humble a way, the boundaries of knowledge. In the case of geology such research will naturally in most cases take the form of observations in the field. The important point is that the work must be original, on new lines, or in greater detail than before, and not a mere confirmation of published results. It is only by the consciousness that he is accomplishing something which has not been done before that the student can experience the keen pleasure of the conquest of the unknown and acquire the love of research for its own sake.

There is one respect in which geological workers

[2] It is very desirable that arrangements should be made for the co-operation of the Geological Survey or their local representatives with the Inspectors of Quarries appointed by the Home Office, and that the annual official list of quarries should describe the rocks which are worked, not only by their ordinary economic designations, but also by their recognised geological descriptions.

suffer a heavy pecuniary handicap—the cost of railway fares. This affects both the staff and students of colleges, as well as local workers who are extending their radius of work—an inevitable necessity in the investigation of many problems. It also seriously interferes with the activity of local natural history societies and field clubs, the geological societies and associations of the great provincial towns, and, above all, that focus of amateur geological activity—the Geologists' Association of London. It is difficult to exaggerate the importance of these agencies in the promotion of geological education. Both professional and amateur geologists are deeply indebted to the excursions which are in most cases directed by specially qualified workers, with whom it is a labour of love. At the same time one of their most valuable results is the creation of interest in scientific work in the localities that are visited. Now that the railways are, if report speaks truly, to be nationalised, or at any rate controlled by the State, the claims of scientific work, carried out without reward in the national interest, to special consideration will surely not be ignored. All questions as to the persons to whom such travelling facilities should be extended and the conditions that should be imposed may safely be left to the decision of the Geological Survey, which has always had the most friendly and sympathetic relations with private workers and afforded them every facility and assistance which their comparatively limited staff and heavy duties permitted.

There is at the present time a very urgent need for the provision of further facilities for the analysis of rocks and minerals to assist and complete the researches both of the official surveyors and of private persons engaged in research. The work is of a very special character, and the number of those who have given sufficient attention to it and understand its difficulties and pitfalls is very limited.

The analytical work of the Survey is organised on a very modest scale in comparison with the *personnel* and equipment of the laboratory of the United States Geological Survey, though the quality of the work has been, as a rule, in recent years quite as high. There are two analytical chemists attached to the Geological Survey, and some of the other members of the staff are capable of doing good analytical work. The demand, however, for analyses for economic purposes is so great that it is impossible to carry out all the analyses that would be desirable in connection with the purely scientific work of the Survey itself. There is, consequently, no possibility of their being able to assist private investigators.

In the absence of facilities for obtaining rock analyses, petrological work in this country is at present seriously handicapped. A striking illustration of the inadequate provision for analyses is revealed in the fact that for the whole of the early Permian granitic intrusions in the south-west of England, covering nearly two thousand square miles, and including numerous different types and varieties, there are only four analyses in existence, and of these two are out of date and imperfect. This is all the more remarkable in view of the fact that these rocks are closely connected with the pneumatolytic action that has given us almost all the economic minerals of the south-west of England.

Another direction in which the work of the Survey could with advantage be extended is in the execution of deep borings[3] on carefully thought out schemes by which a maximum of information could be obtained. Both in Holland and Germany borings have been carried out to discover the nature of the older rocks beneath the Secondary and Tertiary strata, and Prof. Watts in his presidential address to the Geological Society in 1912, dwelt on the importance of exploring systematically the region beneath the wide spread of the younger rocks that covers such a great extent of the east and south of England. Prof. Boulton, my predecessor in this chair, has endorsed this appeal, but nothing has been done or is apparently likely to be done in this direction. It seems extraordinary that no co-ordinated effort should have been made to ascertain the character and potentiality of this almost unknown land that lies close beneath our feet and is the continuation of the older rocks of the west and north to which we owe so much of our mineral wealth. It is true that borings have been put down by private enterprise, but, being directed only by the hope of private gain and by rival interests, they have been carried out on no settled plan, and the results, and sometimes the very existence, of the borings have been kept secret. The natural consequences of this procedure have been the maximum of expense and the minimum of useful information.

Unfortunately, in recent years percussion or rope-boring, which breaks up the rock into fine powder, has more and more, on account of its cheapness, replaced the use of a circular rotating drill, which yields a substantial cylindrical core that affords far more information as to the nature of the rocks and the geological structure of the district. If private boring is still to be carried on, the adoption of the latter procedure should be insisted on, even if the difference of cost has to be defrayed by the Government. It is quite true that a considerable amount of useful information can be collected by means of a careful microscopic examination of the minute fragments which alone are available for study, so that the nature of the rocks traversed can be recognised: but the texture of the rock is destroyed, as well as any evidence which might have been available of its larger structures and stratigraphical relations, and almost all traces of fossils. It is, too, impossible to tell with certainty the exact depth at which any particular material was originally located, for fragments broken off from the sides of the bore may easily find their way to the bottom.

A good illustration, and one of many that might be cited, of the misdirected energy that is sometimes expended in prospecting operations was afforded a few years ago by a company that put down a boring for oil through more than a thousand feet of granite without being aware of the nature of the rock that was being traversed. In this case a percussion drill was employed, but a few minutes' examination of the material should have enabled the engineer in charge, supposing he had even an elementary knowledge of geology, to save hundreds of pounds of needless expenditure. The sum total of the funds which have been uselessly expended in this country alone in hopeless explorations for minerals, in complete disregard of the most obvious geological evidence, would have been sufficient to defray many times over the cost of a complete scientific underground survey.

If research is to be carried out economically and effectively, it must be organised systematically and directed primarily with the aim of advancing knowledge. If this aim be well and faithfully kept in view, material benefits will accrue which would never have been thought to be sufficiently probable to warrant the expenditure of money on prospecting.

It is, however, not only in the areas occupied by Secondary or Tertiary rocks that systematic boring is urgently needed. There are many other localities where important information as to the structure of

[3] I have not space to deal here with the shallow borings in soft strata which have been so successfully conducted on the Flanders front during the war by Capt. W. B. R. King, of the Geological Survey.

the rocks could probably be obtained in this manner. Opinion is very much divided as to the relation of the Devonian to the older rocks in South Devon and Cornwall, but there is little doubt that a series of judiciously placed borings would solve the problem without difficulty. In North Devon and West Somerset the question as to whether the Foreland Grits are a repetition by faulting of the Hangman Grits could also be settled at once by borings in the Foreland Grits and in the Lynton beds.

It is not, however, on *terra firma* alone that such investigations may be usefully carried out. The floors of the shallow seas that separate these islands from one another and from the continent of Europe are still almost unknown from the geological point of view, although their investigation would present no serious difficulties. Joly has described an electrically driven apparatus which, when lowered so as to rest on a hard sea-floor, will cut out and detach a cylindrical core of rock, and retain it until raised to the surface. Afterwards he invented a still more ingenious device, in which the force of the sea-water entering an empty vessel is substituted for electrical power, but, unfortunately, neither the one nor the other has actually been tried or even constructed.

Meantime, however, vertical sections up to 80 cm. of the mud of the deep seas have actually been obtained in iron tubes attached to sounding apparatus employed in the course of the voyage of the *Gaussberg*. These reveal a succession of deposits of which the lower usually indicate colder water conditions than the upper.

In many places rock fragments are dredged up by fishing-boats. These should, of course, be used with caution in drawing conclusions as to the distribution of rocks *in situ* on the sea-bottom, as such fragments may have been transported when embedded in ice-sheets or in icebergs or other forms of floating ice, or entangled in the roots of floating trees; but where the rock fragments can be shown to have a definite distribution, as in those described by Grenville Cole and Thomas Crook from the Atlantic to the west of Ireland, and by R. H. Worth from the western portion of the English Channel, they may be regarded as affording trustworthy information as to the geology of the area.

There seems every reason to believe that advances in submarine geology will not be only of scientific interest, but will bring material benefits with them. It seems quite possible that off the shores of Northumberland and Durham there are, in addition to extensions of the neighbouring coalfield, Permian rocks containing deposits of common salt, sulphate of calcium (gypsum and anhydrite), and, above all, potash salts comparable to those at Stassfurt, which have proved such a source of wealth to Germany.

No less important than the work of the Geological Survey is that of our great national museums. I have already alluded to the need for local collections to illustrate the geology of the areas in which they are situated. The museums of our larger cities and our universities will naturally contain collections of a more general character, but it is to our national museums that we must chiefly look for the provision of specimens to which those engaged in research can refer for comparison, and it is imperative that they should be maintained in the highest state of efficiency if the best results are to be obtained from scientific investigations in this country. The ability and industry of the staff of the mineral and geological departments of the Natural History Museum are everywhere recognised, as well as their readiness to assist all those who go to them for information, but in point of numbers they are undeniably insufficient to perform their primary task of examining, describing, arranging, and cataloguing their ever-increasing collections so as to enable scientific workers to refer to them under the most favourable conditions.[4] Even if the staff were doubled, its time would be fully occupied in carrying out these duties, quite apart from any special researches to which its members would naturally wish to devote themselves. The additional expense incurred by the urgently needed increase of the museum establishment would be more than repaid to the country in the increased facilities afforded for research.

There is room, too, for a considerable extension in the scope of the activity and usefulness of our museums in other directions, and more especially in the provision of typical lithological collections illustrating the geology of different parts of the British Empire and of foreign countries.

So far as the United Kingdom is concerned, this requirement has been admirably fulfilled in the museums attached to the Survey headquarters in London, Edinburgh, and Dublin, and there is a smaller collection of the same nature, excellent in its way, at the Natural History Museum. But to obtain a broad outlook it is essential that the attention of geological workers should not be confined to one country, however diversified its rocks may be, and it is impossible to assimilate effectively publications dealing with the geology of other parts of the world without being able to refer to collections of the rocks, minerals, and fossils described.

Such collections should include not only rock specimens in the ordinary sense of the term, but also examples of metalliferous veins and other mineral deposits which present important distinctive features.

The lithological and palæontological collections which I am now advocating should be arranged so that each group of specimens illustrates an area possessing distinctive geological features. Little has hitherto been done in this direction. The mineral department of the Natural History Museum possesses a large and extensive collection of foreign and Colonial lithological specimens arranged according to localities, which is too little known, but it is naturally very unequal and incomplete, some countries being comparatively well represented and others scarcely at all. The geological department of the museum is well provided with palæontological specimens, but these are arranged according to their biological affinities, and they might well be supplemented by a series of typical collections illustrating the fauna and flora of the more distinctive horizons in different areas. This is all the more important, as the mode of preservation may be very different in different places. The provision of such facilities for the study of the geology of other lands is especially desirable in London in view of the number of students of mining and economic geology who receive their training in this country and ultimately go out into the world to find themselves face to face with problems in which a true understanding of the local geology is absolutely essential.

* * * * * *

It is more difficult to arrive at the true interpretation of the phenomena presented by the endogenetic rocks[5] which have come into existence by the action of the forces of the earth's interior, for the conditions of temperature and pressure under which they were formed, whether they are igneous rocks in the narrower sense, or mineral veins, or metamorphic in

4 Even the number of skilled mechanics is quite insufficient, though their work is urgently needed. In the Geological Department provision is made for two only, and at present but one is actually at work.
5 T. Crook, *Min. Mag.*, vol. xvii., p. 87, 1914.

origin, were widely different from those with which we are familiar. In such circumstances the ultimate physical principles are the same, but the so-called constants have to be determined afresh, and a new chemistry must be worked out. It is necessary, therefore, so far as possible, to reproduce the conditions that prevailed—a task which has been courageously undertaken and, to a considerable extent, accomplished by the geophysical laboratory of the Carnegie Institution of Washington.

By artificial means temperatures and pressures have been already produced far higher than those that were in all probability concerned in the evolution of any of the rocks that have been revealed to us at the surface by earth-movements and denudation, for it is unlikely that in any case they were formed at a greater depth than five or six miles, corresponding with a uniform (or, as it is sometimes termed, hydrostatic) pressure of 2000 or 2400 atmospheres, or at a greater temperature than 1500° C. Indeed, it is probable that the vast majority of igneous and metamorphic rocks, as well as mineral veins, came into existence at considerably less depths, and at more moderate temperatures. It is true that most of the rock-forming minerals crystallise from their own melts at temperatures between 1100° C. and 1550° C., but they separate out from the complex magmas from which our igneous rocks were formed at lower temperatures.

It has been found possible at the geophysical laboratory to maintain a temperature of 1000° C. or more under a uniform pressure of 2000 atmospheres for so long a time as may be desired, and, what is equally important, the temperature and pressure attained can be determined with satisfactory accuracy, the temperature within 2° C., and the pressure within 5 atmospheres.

It has been ascertained that such uniform pressure as would ordinarily be present at the depths mentioned does not directly affect the physical properties of minerals to anything like the same extent as the difference between the temperature prevailing at the earth's surface and even the lowest temperature at which igneous rocks can have been formed. It has, however, a most important indirect action in maintaining the concentration in the magma of a considerable proportion of water and other volatile constituents[6] which have a far-reaching influence in lowering the temperature at which the rock-forming minerals crystallise out—in other words, the temperature at which the rock consolidates—and in diminishing the molecular and molar viscosity of the magma, thus facilitating the growth of larger crystals and the formation of a rock of coarser grain. They must also be of profound significance in determining the minerals that separate out, the order of their formation, and the processes of differentiation in magmas.

It is, therefore, obvious that any conclusions derived from the early experiments which were carried out with dry melts at normal pressures must be received with very considerable caution. Nor does much advance appear to have been made, even at the geophysical laboratory, in experiments with melts containing large amounts of volatile fluxes, and yet, if we are to reproduce even approximately natural conditions, it is absolutely necessary to work with magmas containing a proportion of these constituents, and especially water, equal in weight to at least one-third or one-half of the silica present. This will obviously present considerable difficulties, but there is no reason to doubt that it will be found possible to surmount them.

A much more formidable obstacle in realising the conditions under which rocks are formed is the small scale on which our operations can be carried on. There are important problems connected with the differentiation of magmas, whether in a completely fluid or partly crystallised state, under the action of gravitation, for the solution of which it would seem for this reason impossible to reproduce the conditions under which Nature works. Instead of a reservoir many hundreds of feet in depth, we must content ourselves in our laboratory experiments with a vertical range of only a few inches. There are, however, other phenomena that require investigation and that involve a great difference of level in their operation, but do not take place at such elevated temperatures. Such are some of the processes of ore deposition or transference, especially secondary enrichment. Here, with the friendly assistance of mining engineers, but at the cost of considerable expenditure, it might even be possible to experiment with columns several thousand feet in vertical height.

In any attempt to reproduce the processes of metamorphism other than those of a purely thermal or pneumatolytic character, or to imitate the conditions that give rise to primary foliation, we must consider the effects of non-uniform or "directed" pressure involving stresses that operate in definite directions and result in deformation of the material on which they act. Unlike uniform pressure, which usually raises the crystallisation point, directed pressure may lower it considerably and thus give rise to local fusion and subsequent recrystallisation of the rock. At the same time it profoundly modifies the structure, resulting in folds and fractures of every degree of magnitude. One of the most pressing problems of geology at the present moment is to determine the effects of directed pressure in its operation at different temperatures, and in the presence of different amounts of uniform pressure, a factor which has probably an important influence on the result, which must also depend on the proportion and nature of the volatile constituents which are present, as well as on the time during which the stresses are in operation.

The time elements in the constructive or transforming operations of Nature cannot, of course, be adequately reproduced within the short space of individual human activity, or, it may be, that of our race; but I am inclined to think that, even in the case of metamorphic action, the importance of extremely prolonged action has been exaggerated.

In attempting to imitate the natural processes involved in the formation and alteration of rocks and mineral veins, we require some means of ascertaining when we have approximately reproduced the conditions which actually prevailed. It is not sufficient to bring about artificially the formation of a mineral occurring in the rocks or mineral deposits under investigation, for the same mineral can be reproduced in many ways. It is, however, probable that a mineral produced under different conditions is never identical in all its characters. Its habit, or the extent to which its possible faces are developed (a function of the surface tension), the characters of the faces which are present, its twinning, its internal structure, inclusions, and impurities, all vary in different occurrences, and the more closely these can be reproduced the greater the assurance we obtain that an artificial mineral has been formed under the same conditions as the natural product.

For this purpose it is, above all, necessary that there should be in the first place a systematic comparative study of these characters and of the association in which they are found. The results thus obtained should be of the greatest value in indicating the directions along which experimental work would

[6] John Johnston, Journ. Franklin Inst., January, 1917, pp. 14–19.

be most probably successful. They should be supplemented by laboratory studies of the relations of such subsidiary crystallographic characters to the environment in the case of crystals which can be formed under normal conditions of temperature and pressure, and therefore under the immediate observation of the experimenter. Some work has, in fact, already been done on the effects on these characters of the presence of other substances in the same solution.

In the study of the secondary alterations of metalliferous deposits, especially those which consist of the enrichment of mineral veins by the action of circulating solutions, either of atmospheric or intratelluric origin, the study of pseudo-morphs gives, of course, valuable assistance in determining the nature of the chemical and physical changes that have taken place.

The problem of the structure and nature of the earth's interior, inaccessible to us even by boring, would seem at first sight to be well-nigh insoluble, except so far as we can deduce from the dips and relations of the rocks at the surface their downward extension to considerable depths. We can, however, gain important information about the physical condition of the deeper portions from the reaction of the earth to the external forces to which it is subjected, and still more from a study of the "preliminary" earthquake tremors that traverse it, the time occupied in their passage, and the difference in intensity of those that follow different paths. These methods are, however, not applicable to the earth's crust. Its physical characters appear to be distinct from those of the interior, but very little is as yet definitely known about them, except, of course, in the neighbourhood of the surface, and for this reason they are usually ignored in calculating the paths of tremors traversing the earth. It seems to be separated from the deeper portions of the earth by a surface of discontinuity at which earthquake vibrations travelling upwards towards the surface may be reflected. Calculations based on the total time taken by these reflected waves to reach the surface after a second passage through the earth's interior appear to indicate that this surface of discontinuity, whatever its nature may be, is at a depth of about twenty miles, though there can be little doubt that this depth varies considerably from point to point.

There must be numerous surfaces of discontinuity in the earth's crust in addition to that forming its lower limit. Such would be the boundaries between great tracts of granite or granitoid gneiss and the basic rocks that in all probability everywhere underlie them; the surface dividing gneisses and crystalline schists from unmetamorphosed sediments overlying them unconformably; that between hard Palæozoic rocks and softer strata of later age; and the surfaces of massive limestones or sills.

It deserves consideration as to how far it may be possible to add to our knowledge of the earth's crust by experimental work with a view of the determination of surfaces of discontinuity by their action in reflecting vibrations from artificial explosions, a procedure similar to that by means of which the presence of vessels at a distance can be detected by the reflection of submarine sound-waves. The ordinary seismographs are not suited for this purpose; the scale of their record, both of amplitude and of time, is too small for the minute and rapid vibrations which would be expected to reach an instrument situated several miles from an explosion, or to distinguish between direct vibrations and those that may arrive a second or two later after reflection at a surface of discontinuity. As the cylinder on which the record is made would be only in motion while the experiment was in progress, there would be no difficulty in arranging for a much more rapid movement. At the same time it would be desirable to dispense with any arrangement for damping the swing of the pendulum, which would be unnecessary with small and rapid vibrations, and would tend to suppress them. It is possible that it might be better to employ a seismograph which records, like that devised by Galitzin shortly before his death, variations of pressure expressing terrestrial acceleration, instead of one which records directly the movements of the ground. It would, however, probably be found desirable to substitute for the piezo-electric record of pressure employed by Galitzin a record founded on the effect of pressure in varying the resistance in an electric circuit. This is, in fact, the principle of the microphone and most modern telephone receivers, but quantitatively they are very untrustworthy. This would not matter so much for the present purpose, where the time of transmission is the most important feature in the evidence.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Mr. B. M. Jones, Emmanuel College, has been elected to the Francis Mond professorship of Aeronautical Engineering at the University, founded by Mr. Emile Mond in memory of his son, who was killed in the war. This is the first professorship in aeronautics which has been filled in this country. Mr. Jones entered Emmanuel College as an Exhibitioner in 1906. He afterwards became a scholar, and obtained First Class Honours in the Mechanical Sciences Tripos of 1909. From 1910 to 1912 he was employed on aeronautical research at the National Physical Laboratory, and held a research scholarship from the Imperial College, London. In the capacity of an assistant he continued in this work until May, 1913, when he left the National Physical Laboratory to take up the design of rigid airship construction and other aeronautical work for the firm of Sir G. W. Armstrong, Whitworth, and Co. In September, 1914, Mr. Jones joined the Royal Aircraft Establishment, and remained there, carrying out aeronautical research and experimental work until May, 1916. He was then transferred to the Armament Experimental Station, Orford Ness, with the rank of captain, R.F.C., eventually rising to the position of Assistant Controller of Experiment and Research with the rank of lieut.-colonel. His chief activities were directed towards aerial gunnery and aerial bombing, and in order to gain first-hand experience of fighting conditions he qualified as a pilot and served with No. 48 Squadron, R.F.C., in France during the early months of 1916. On being demobilised in March last, Mr. Jones was elected a junior fellow of Emmanuel College, with the post of director of engineering studies at the college.

Sheffield.—The council has received with much regret the resignation of Prof. J. O. Arnold, dean of the faculty of metallurgy and professor of metallurgy in the University since 1889. Steps will shortly be taken to appoint a successor.

Dr. J. G. Stewart has been appointed lecturer in engineering at University College, London.

A chair of laryngology has recently been established in the University of Paris, the first occupant of which is to be Dr. Sebileau.

The sum of 400,000*l*. has been bequeathed to the University of Sydney by Sir Samuel McCaughey.

The University of Brisbane will receive 250,000*l*. from the same source.

PROF. ALEX. FINDLAY desires it to be known that after October 1 his address will not be the University College of Wales, Aberystwyth, but the Chemistry Department, the University, Marischal College, Aberdeen.

THE School of Librarianship, instituted at University College, London, will be opened by Sir Frederic Kenyon on Wednesday, October 8, at 5 p.m. Cards of invitation and particulars of the work of the school may be obtained from the Secretary, University College, Gower-street, W.C.1.

THE programme of University Extension lectures for the coming session has now been issued by the University of London. Central courses are to be held in the University buildings and in the City, while local courses, at some sixty local centres in and around London, will prove of value to the student in the suburbs. The subjects treated cover a wide range, but science occupies a minor position among them. There are to be about ninety courses in all, and these are mainly on literature, economics, history, and architecture, progressive science being represented by two courses only on scientific discoveries and their practical application. Either the local committees of London University Extension centres are not interested in scientific subjects, or the Board is unable to offer a strong panel of science lecturers for their selection.

SOCIETIES AND ACADEMIES.

MELBOURNE.

Royal Society of Victoria, July 10.—Mr. J. A. Kershaw, president, in the chair.—H. G. **Smith**: The essential oil of *Boronia pinnata*, Smith, and the presence of elemicin. The plants were collected at Longwarry, where it grows in great profusion, and the distillation was carried out by Mr. P. R. H. St. John. The product consists largely of elemicin, which has previously occurred only in the order Burseraceæ (Protium, elemi resin), whilst Boronia belongs to the Rutaceæ.—J. T. **Jutson**: The "clawing" action of rain in sub-arid Western Australia. The author describes the erosion on ground generally covered by hard capping due to surface deposits of hard mineral matter. When this capping is broken, miniature waterfalls are formed, and at lower levels basins with crenulated edges, with a gradual reduction of rock material from high to low levels. The "clawing" action of the rills is so marked as to deserve special notice.—J. T. **Jutson**: A striking example of rock expansion by temperature variation in sub-arid Western Australia. This note puts on record an instance of a thin slab of granite parting from the main mass and rising convexly 7 in. from its base before cracking and breaking up.—E. O. **Teale**: The diabase and associated rocks of the Howqua River, near Mansfield, with reference to the Heathcotian problem in Victoria. A study of this interesting area of the Howqua district with its Lower Carboniferous, Upper and Lower Ordovician, and older rocks throws much light on the sequence of the Lower Palæozoic series in other areas. Cherts and bedded ash with radiolaria and sponge-remains are found, similar to those of Heathcote, and an interesting phosphate-breccia with trilobite remains is described, which is closely associated with Upper Ordovician rocks.—F. **Chapman**: An Ostracod and Shell-marl of Pleistocene age from Boneo Swamp, west of Cape Schanck, Victoria. This deposit of marl, which does not now appear to be subject to tidal influence, contains an interesting fauna of fresh- and salt-water Ostracoda, and swamp, land, and marine shells. Two of the Ostracods are new, *Cypris tenuisculpta* and *Limnicythere sicula*. It is probable that in late Pliocene and on to Pleistocene times this area was connected with N.W. Tasmania, as an emergence of Bass Strait of 40 fathoms would show the earliest land connection at these points. This theory is supported by the occurrence of Limnicythere both at Boneo and Mowbray Swamps.

BOOKS RECEIVED.

The English Rock-Garden. By R. Farrer. 2 vols. Vol. i. Pp. lxiv+504+52 plates. Vol. ii. Pp. viii+524+50 plates. (London and Edinburgh: T. C. and E. C. Jack, Ltd.) 3*l*. 3*s*. net.

Motionism, or the World's True Religion. By E. J. M. Morris. Pp. 130. (London: The Caxton Press, Ltd.) 5*s*. net.

Ethnography and Condition of South Africa before A.D. 1505. By Dr. G. M. Theal. Second edition. Pp. xx+466. (London: G. Allen and Unwin, Ltd.) 8*s*. 6*d*. net.

The *Daily Telegraph* Victory Atlas of the World. Part i. (London: "Geographia," Ltd.) 1*s*. 3*d*. net.

The Timbers of India. By A. L. Howard. Pp. 16. (London: W. Rider and Son.) 2*s*. 6*d*.

General Phonetics, for Missionaries and Students of Languages. By G. Noël-Armfield. Second edition. Pp. xii+146. (Cambridge: W. Heffer and Sons, Ltd.) 5*s*. net.

CONTENTS.

	PAGE
The Waste of Youth. By Prof. Frederick Soddy, F.R.S.	89
Biological Problems	90
South Australian Geology. By J. W. G.	91
Our Bookshelf	91
Letters to the Editor:—	
A Photoelectric Theory of Colour Vision.—**Sir Oliver Lodge, F.R.S.**	92
Reversed Pleochroic Haloes.—**Prof. J. Joly, F.R.S., and J. H. J. Poole**	92
The Spectra of Isotopes.—**Dr. Thomas R. Merton**	93
A British Imperial Antarctic Expedition.—**John L. Cope**	93
Luminous Worms.—**Rev. S. Graham Brade-Birks**	93
Catalysis in Chemical Industry. By Dr. Hugh S. Taylor	94
Frosts and Agriculture in the United States. By W. H. D.	95
Notes	96
Our Astronomical Column:—	
The Twenty-four-hour Day	100
Comets	100
Minor Planets	100
Flora of Macquarie Island	101
Education in British India	101
The British Association at Bournemouth:—	
Section C—Geology—Opening Address (Abridged) by **J. W. Evans, D.Sc., LL.B., F.R.S., President of the Section**	102
University and Educational Intelligence	107
Societies and Academies	108
Books Received	108

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THURSDAY, OCTOBER 9, 1919.

MATHEMATICAL TEXT-BOOKS.

(1) *Empirical Formulas.* By Prof. Theodore R. Running. (Mathematical Monographs, No. 19.) Pp. 144. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 7*s.* net.

(2) *Differential and Integral Calculus.* By Dr. H. B. Phillips. *Differential.* Pp. v+162. *Integral.* Pp. v+194. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916–17.) Price 9*s.* 6*d.* net.

(3) *A First Course in the Calculus.* Part i. *Powers of X.* By Dr. W. P. Milne and G. J. B. Westcott. (Bell's Mathematical Series.) Pp. xx+196. (London: G. Bell and Sons, Ltd., 1918.) Price 3*s.* 6*d.*

(4) *Dynamics. Part II.* By R. C. Fawdry. (Bell's Mathematical Series.) Pp. viii+179–355+vii. (London: G. Bell and Sons, Ltd., 1919.) Price 2*s.* 6*d.*

(5) *Solid Geometry, including the Mensuration of Surfaces and Solids.* By Prof. R. S. Heath. Fourth edition. Pp. iv+123. (London: Rivingtons, 1919.) Price 4*s.*

(1) ONE of the most important activities of the practical, as well as of the theoretical, man of science is the discovery of laws. Given a number of observations, the problem is to correlate them in the form of a single analytical expression. The basis of such discovery is the recognition of a curve as being one the equation of which is known. But, strictly speaking, there is only one curve that is really recognisable, and this is the straight line. A piece of a circle can easily be mistaken for a piece of an ellipse, and a parabola for a catenary; but if a sufficiently long piece of a curve is straight, then the curve can be pronounced to be a straight line. If, then, it is possible to plot the results of observation in such a way that the resulting points lie on a straight line (even if there are some casual, experimental errors and consequent deviations), then we can at once deduce the law.

This fact underlies the major part of Prof. Running's monograph. The author summarises the most useful types of laws that are reducible to straight-line laws by means of simple transformations. He also gives practical rules for deciding whether such a law is correct for the given data and for the determination of the constants. Nineteen laws are discussed, and illustrated by means of numerical examples, whilst curves are drawn to show graphically the types of relations given by these laws.

A twentieth law is the Fourier expansion. Chapters are added on the method of least squares, interpolation, and numerical integration. The result is an eminently useful handbook for the scientific researcher and the practical engineer, and a highly commendable adjunct to the more theoretical study of mathematics.

The pedagogy is, however, somewhat defective. It is difficult to imagine such a book in the hands of a student. The philosophy of the subject is scarcely entered into at all, and in places, where an attempt at justification is made, the result is not satisfactory. Also, one question remains unanswered: How is one to guess which law to try? Is one to try them all one after the other until the right one is reached? And what if none of those given is correct? Information on this and other points is very desirable, but none is offered.

One or two definite criticisms must be made. The different schemes in the chapter on Fourier series are not always consistent, and some are incomplete. No explanation is given of the meaning of "weights" in the method of least squares. In the chapter on interpolation the difference formula is proved only for integral values of the argument, and then applied to fractional values. In addition, there are a few misprints and some evidences of carelessness. The book thoroughly deserves a second edition, in which, it is hoped, these and other faults will be rectified.

(2) This is a very good book on the calculus, written in the old style with which we have been familiarised by writers like Edwards and Williamson. It is very well written and compact in form; the diagrams are good, and the exercises excellent. Particular attention is paid to questions of a practical nature. The student who has worked through this book conscientiously will have a good, if dull, appreciation of the subject and its manipulation. A few of the pages are headed "Unconventional Methods," but the thrill one gets on seeing this only leads to disappointment. There is nothing unconventional in an involute or in a parabola rotating about an axis.

The second part (which is also issued separately) includes the usual chapters on differential equations and the usual box of tricks.

This book, like so many others, gives the student the impression that there is just one particular integral of a linear differential equation in which the right-hand side is a function of the independent variable. It is more useful to inform the student that there are, of course, an infinite number of particular integrals, but that one of them is obtainable most readily and directly.

In Ex. 3, p. 10, of the second part it would have been more reasonable to put a negative sign to indicate the retarding effect of friction.

(3) Dr. Milne and Mr. Westcott have given expression to an important and fundamental principle in mathematical pedagogy—namely, the secondary nature of the manipulative art, and the first-rate importance of the ideas and methods of mathematics. They have recognised that the main part of the essence of the calculus, and even the most important practical applications of its processes, can be taught and learnt without using anything but the simplest of all functional types —namely, x^n and combinations of powers of x. When once the student has learnt to differentiate x^n, he is ready for much of the mysterious dis-

cipline that constitutes the black art of the calculus method. He can do dynamical problems without the aid of confusing formulæ; he can measure the volume of a tree; he can enclose land economically; he can draw tangents and normals; he can find radii of curvature; he can even solve differential equations. The authors, having recognised this fact, have acted upon it boldly and frankly, with the result that they have produced a book of a peculiarly suggestive and persuasive kind. Both authors are experienced teachers of mathematics, and the practical touch introduced by the physical propensities of one of them is everywhere noticeable. It is also refreshing to see $dy/dx=f(x)$ treated as a differential equation.

The merit of the book is somewhat marred by a few faults, and especially by the mediocre diagrams. Some are not well produced, whilst others are not even well drawn. The authors, or their artistic representative, seem to have an unfailing belief that a circle in perspective can be represented by two circular arcs intersecting at sharp angles. This is a gratuitous trap for the unwary.

The style is splendid. The preface is worth reading for its own sake, whilst the historical sketch with Isaac Barrow's prayer will interest even such students as are not excited by Guldinus's and Pappus's theorems.

(4) Many teachers have experienced the want of books on mechanics more advanced than the easy text-books used in schools, and not so advanced as the larger treatises intended for specialists in mathematics. Mr. Fawdry's books are supplying this want, and the present volume is a further contribution to the author's series of books on mechanics. This volume forms the second part of his "Dynamics," and discusses such subjects as differentiation and integration as used in dynamics, harmonic motion, and easy two-dimensional rigid dynamics. The work is well done. The experimental hints, the numerical illustrations of dynamical laws and results, and the very practical examples all help to make the subject attractive and intelligible. There is some lack of logic in the arrangement, and the impression one gets is that of scrappiness. The chapter on harmonic motion, *e.g.*, seems out of place in the middle of a discussion of rigid dynamics.

Mr. Fawdry wastes time in proving that the acceleration d^2x/dt^2 can be written vdv/dx. Surely it must be a part of fundamental dynamical doctrine that:

Number of units of force = time rate of momentum;

Number of units of force = space rate of kinetic energy.

This saves much trouble and memory-searching. One cannot feel angry with a student who forgets the trick of "multiplying by twice the velocity" to get the energy equation.

The figure on p. 271 is unfortunate: when a spiral spring is stretched, the pitch is increased.

One can heartily recommend this as a sound book that will be found very useful both in itself and as an introduction to the larger treatises on the subject.

(5) The fact that a new edition is called for of Prof. Heath's "Solid Geometry" proves that it has been found to serve its purpose as an introduction to those parts of the subject that are required for their practical usefulness. The book, while making no pretence to pedagogical originality, is a very good collection of the most useful theorems and problems in solid geometry. It includes the geometry of the regular solids, spherical geometry, and the mensuration of the sphere. There are a large number of examples with some hints for their solution.

S. BRODETSKY.

VAGUENESS AND DISCRIMINATION.

(1) *The Intuitive Basis of Knowledge. An Epistemological Inquiry.* By Prof. N. O. Lossky. Authorised translation by Nathalie A. Duddington. With a preface by Prof. G. Dawes Hicks. Pp. xxix + 420. (London: Macmillan and Co., Ltd., 1919.) Price 16*s*. net.

(2) *Cultural Reality.* By Dr. Florian Znaniecki. Pp. xv + 359. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1919.) Price 2.50 dollars net.

IT is extraordinary how difficult it seems to be (and how fearfully long the argument is) to convince a man that what he is quite ready to believe, until you make him doubt it, is true. Natural realism—the theory that the objects of knowledge are in themselves what they are represented to be in our knowledge, that knowledge is the discrimination by the mind of a reality awaiting discrimination—is, I suppose, the philosophical theory of knowledge we all hold until we are philosophers consciously philosophising. Tables and chairs are just tables and chairs, and would be such, so far as their essential form and matter are concerned, were there no mind, or, as the realist prefers to say, were there no act of discrimination, in the universe. We all believe it, but let us once challenge a realist philosopher to prove it—he may be able to, but, unlike the Rabbi called on to expound the whole of the law and the prophets, not while you stand on one foot.

(1) Prof. Lossky's "Intuitive Basis of Knowledge" is admirably translated and very clear and easy to read. The translator, Mrs. Duddington, is eminently qualified for the work, not merely by her knowledge of the original language, but also by what is far more important, her complete sympathy with the philosophical view of the author. The book is prefaced by a particularly lucid "Introduction" by Prof. G. Dawes Hicks, who, though not in entire agreement with the author, is very sympathetic towards his point of view. Prof. Hicks expresses surprise that a professor in a Russian university should have reached conclusions so strikingly in accord with his own, but, though Petrograd may be a long way from London, it is no further from

Berlin and the German universities than London is, and Prof. Lossky is known to many of us by his part in the International Congresses of Philosophy. He is, in fact, thoroughly cosmopolitan so far as his qualifications in philosophy are concerned. The title of his book might lead the reader to expect a theory in accord with some of the more noticeable modern developments, such as Bergson's doctrine of instinct or Croce's æsthetic activity, but intuition has not any such distinctive meaning for Prof. Lossky. He means by the intuitive basis of knowledge merely the vagueness with which the object of knowledge exists undiscriminated, before it is discriminated. This, of course, is the crucial point of realist theory. What it has to account for primarily is "vagueness," in the precise and not vague meaning of the term. According to the realist theory, tables and chairs are, so far as their basis in reality is concerned, the same for men and for guinea-pigs. Apart from acts of discrimination, men and guinea-pigs are on one level of knowledge. What is that? Well, the answer is what the realists are trying to give us, and perhaps if we are patient and allow them time enough they will succeed.

(2) It is not easy to indicate any particular connection between Prof. Lossky's book and Dr. Znaniecki's "Cultural Reality." Their names might suggest that they share an Eastern European viewpoint, if such there be. But, as Dr. Znaniecki is lecturer in the University of Chicago, it is not surprising that the philosophy of the New World—Pragmatism and New Realism—mainly occupies his attention. "Culturalism" is the thesis that there are an objective reality and a subjective adaptation that both change, and change more profoundly than can be expressed by the advance of knowledge by discrimination. It is an attempt to blend the realist theory that there is an object on which the only mental work is discrimination with the pragmatist theory that we make truth. The idea apparently is that from the two separate worlds of things and values there arises a third reality, which is irreducible to either—cultural reality *sui generis*. The primitive material is not conceived as vague, but as a "concrete chaos of historical reality."

H. W. C.

IRON AND STEEL PRODUCTION IN GREAT BRITAIN DURING THE WAR.

The Iron and Steel Industry of the United Kingdom under War Conditions: A Record of the Work of the Iron and Steel Production Department of the Ministry of Munitions. By Dr. F. H. Hatch. Pp. xii+167. (London: Privately printed for Sir John Hunter by Harrison and Sons, 1919.)

On account of the vastness of the field covered, the variety and complexity of the technical problems involved, and the far-reaching industrial questions raised, the activities of the Iron and Steel Production Department of the Ministry of Munitions during the war form a subject of surpassing interest and importance. The history of this great work has been written by Dr. F. H. Hatch, himself a member of the Department.

The narrative falls naturally into two divisions, namely, (1) that of the small Steel Department which was formed as a branch of the Materials Department, of which Sir Leonard Llewelyn was director, and (2) that of the much larger organisation formed by Sir John Hunter when he became Director of Iron and Steel Production in August, 1916.

Sir John Hunter was confronted with a very difficult task. The demand for various types of steel for munitions and shipbuilding was growing rapidly while the supply of raw materials essential for their manufacture was threatened with curtailment, if not complete suspension, so far as foreign sources were concerned, by the activity of German submarines. The only sound remedy was the development of home resources, but the substitution of lean phosphoric ironstones such as constitute the main portion of British iron ores for the rich ores imported principally from Spain and the Mediterranean, involved such sweeping changes in plant, supplies, inland transport, labour, etc., that it could only have been carried out with difficulty even in peace-time. Under war conditions it was evident that the problem would require the most skilful handling by a carefully organised department. In spite of difficulties which at times appeared to be almost insuperable, Sir John Hunter's "Basic Iron Program" obtained a high measure of success, and enabled the urgent and incessant calls of the great Service Departments for ship plates, shells, and other munitions requiring steel in their manufacture to be punctually and duly met.

It is a remarkable tribute to the inherent but not always obvious organising power of the nation that under the adverse conditions of a great war it should have been possible to raise the steel production of the country to the highest point it has ever reached in the history of the industry. Under the stress of necessity raw materials which had been allowed to lie dormant in this country were rapidly developed and brought to the producing stage. Iron ores in Oxfordshire, coking coal in Scotland, ganister for silica bricks, moulding sands for foundry work, and refractory sands for open hearth furnace bottoms, are instances in point. Whereas in 1913 and 1914 the total steel output was 7·66 and 7·83 million tons respectively, it had risen in 1917 to 9·71 million tons, and during the first half of 1918 it was at the rate of close on 10 million tons per annum. The plans of the Department provided ultimately for an increase to 12 million tons annually. Dr. Hatch suggests two main reasons for the success obtained; these are (1) the trust reposed by Sir John Hunter in the members of his staff, which was entirely reciprocated, and (2) the fact that manufacturers cordially co-operated in the plans of the Ministry and loyally concentrated on war work. According to him, many firms readily fell in with the suggestions of the Department to depart from routine practice and embark on experimental work, often at a considerable financial loss to themselves.

OUR BOOKSHELF.

Pre-History in Essex, as Recorded in the Journal of the Essex Field Club. By S. Hazzledine Warren. (Essex Field Club Special Memoirs, vol. v.) Pp. vii+44. (Stratford, Essex: The Essex Field Club; London: Simpkin, Marshall, and Co., Ltd., 1918.) Price 2*s*. 6*d*. nét.

THE title "Pre-History in Essex" would suggest that the subjects treated in this special memoir are entirely prehistoric. But we find mentioned papers such as "Fifty Years Ago in Essex," "Tree-Trunk Waterpipes," "The Coming of Age of the Essex Field Club" (1901), etc. Indeed, the number of papers on various subjects mentioned is such that in most cases two or three lines comprise all the explanation of their nature.

Among the few subjects to which more space is given are the Deneholes of Hangman's Wood. Mr. Warren does not take the view given in the report on the Denehole Exploration at Hangman's Wood (*E. Nat.* 1, 1887), but considers that "they possess in every way the normal character of comparatively modern chalkpits" (p. 34). Now about half a mile west of Hangman's Wood is the eastern margin of an area of bare chalk extending thence to Purfleet, besides much smaller exposures of chalk near Little Thurrock and East Tilbury, with modern chalkpits in each place mentioned. Hence modern chalkpits at Hangman's Wood, where the chalk is about 60 ft. beneath the surface, where each pit occupies a very small horizontal space, and is separated from the other pits, and shaped so as to show intended separation, are surely incredible. And the evidence is surely in favour of the E.F.C. Exploration view that these deneholes were family stores. Then the notion of the E.F.C. explorers that *dene*holes meant *den*holes was considered by that eminent philologist, the late Sir J. A. H. Murray, to be incorrect, *dene*holes being *Dane*holes.

However, "Pre-History in Essex" will form a decidedly useful list of the papers published by the Essex Field Club since 1880.

T. V. HOLMES.

The Chemists' Year-Book, 1918–19. Edited by F. W. Atack, assisted by L. Whinyates. Vol. i., pp. vi+422; vol. ii., pp. iv+423–1146. (London and Manchester: Sherratt and Hughes, 1919.) Price 15*s*. net 2 vols.

THE chemical pocket-books used in this country before the recent war were chiefly of German origin. Mr. Atack brought out the first edition of his "Year-Book" in 1915: its appearance indicated that, as with sundry other chemical products and adjuncts, we were quite capable of supplying our own requirements in this respect.

A large amount of information has been packed into the two small volumes. Much of the space is devoted to tables showing the chief physical and chemical properties of numerous organic and inorganic substances—their formulæ, molecular weights, boiling-points, and so on. There are also the ordinary tables of specific gravity, solubility, etc., and much useful matter of a miscellaneous kind, including historical references, mensuration data, and lists of scientific journals. In addition, the volumes include a number of short articles which summarise the theory and practice of various branches of chemical technology. Thus, to mention only a few by way of examples, there are sections on electro-chemical analysis, fuels, dairy products, brewing materials, textile fibres, dyestuffs, tobacco, and photography. These condensed accounts serve to furbish up the reader's acquaintance with branches of work in which he may have become "rusty."

Several new sections have been added to the present edition. They include one on agricultural chemistry by Dr. E. J. Russell, and one on the analysis of ceramic materials by Dr. Mellor. Other parts of the work have undergone a general revision, and chemists will find the "Year-Book" a convenient and useful *vade mecum*.

The Geographical Part of the Nuzhat-Al-Qulūb. Composed by Hamd-Allāh Mustawfī of Qazwīn in 740 (1340). Translated by G. Le Strange, and printed for the Trustees of the "E. J. W. Gibb Memorial." Vol. xxiii. Pp. xix+322. (Leyden: E. J. Brill; London: Luzac and Co., 1919.) Price 8*s*.

WE have here an English translation of the original Persian text of the "Nuzhat-Al-Qulūb" published in this valuable series three years ago. The author, Hamd-Allāh, was a man of note in his day, holding the post of Mustawfī, or State Accountant, to Abu Sa'īd, the last of the decadent Ilkhan dynasty, the first Mongol rulers of Persia, and great-grandson of Hulāqu, the conqueror of Baghdad. The author must have been in possession of much geographical and statistical information, and in many ways his account of Persia and Mesopotamia in the middle of the fourteenth century is valuable; but he depended largely on materials collected by other writers, much of which is now available in published texts. The book takes the form of a gazetteer, but, except as regards places like Qazwin, the author's native city, little new information is forthcoming. Perhaps the best chapter is that describing the mines of western Asia producing metals, precious stones, and other minerals. His science is that of his own day, that of the scriptures and traditions of Islam, as when he tells us that one of the chief values of mountains is that they prevent the ground from moving. But the treatise abounds in miracles and folklore. Mr. Le Strange's special local knowledge is well exhibited in his identification of many of the obscure places mentioned in the text. The volume is in every way creditable to the editor and to the trustees of the E. J. W. Gibb Memorial Fund.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Temperature in the Sun.

WHENEVER a spell of hot weather occurs it is common to see published accounts of the "temperature in the sun." These sun-temperatures have little meaning unless the other surrounding conditions are also stated.

Comparatively few people realise that a thermometer indicates nothing except the temperature of the fluid in its bulb, and that to draw any useful inference from that temperature it is necessary to know how the heat which produced it was supplied.

Heat may enter a thermometer from the air by conduction, aided by convection currents and wind, and also by radiation from distant objects. In general, both these sources contribute to the total.

The true temperature of the air is indicated only when the thermometer is screened from the radiation of any body which is not at that temperature, and the ventilated shelters in which meteorologists place their instruments are intended to secure this condition. In ordinary cloudy and windy weather they answer the purpose, but in sunshine and calms the whole shelter becomes heated, and the thermometer readings are too high.

When a thermometer is fully exposed to the sun a large part of the heat received is supplied by radiation, and the apparent temperature will vary with the character of the surroundings, including the nature of the glass of which the bulb is made.

Of the total radiant energy falling on the bulb part is regularly reflected and the remainder scattered or absorbed, but it is only the energy absorbed during its passage through the glass of the bulb which raises the temperature of the contents—at any rate, in mercury thermometers. The limiting temperature is reached when the surface of the bulb loses, by conduction and dark radiation, as much heat as will balance the supply.

If the bulb is smoked there is scarcely any reflection, and thus a bulb coated with lampblack will reach a higher temperature than a black glass bulb, and this, in turn, will be higher than if the glass is transparent, and if the exterior of the bulb is silvered there will be an even greater difference.

Thus, in the same place and in the same sunlight, four different temperatures might be indicated by accurate thermometers, each reading differing from the others by several degrees, the differences depending on the different absorptive and emissive qualities of the glass and its surface.

The actual difference between the apparent "temperature in the sun" and the air temperature may in this country be as great as 50° F. In the tropics I believe it may be considerably more.

Darwin, when in the Galapagos Islands, wrote:—"On two days the thermometers in the tent stood for some hours at 95°, but in the open air in the wind and sun at only 85°. The sand was extremely hot; the thermometer placed in some of a brown colour immediately rose to 137°, and how much above that it would have risen I do not know, for it was not graduated any higher. The black sand felt much hotter. . . ." The true air temperature was probably about 80°, so that the sun's radiation heated the ground 60° or 70° more than air.

I remember seeing in a sunny window in January the thermometer standing at 108° when the room temperature was about 60°; and in the recent warm weather, when the air temperature was about 80°, a thermometer shielded from draught by a thin smoked glass tube indicated 128°.

These facts show how little meaning can be attached to "temperatures in the sun" unless all the conditions are stated.

If a blackened thermometer is enclosed in a good vacuum chamber of transparent glass, and is carefully screened from all ground radiation, its readings in the sun will give a good comparative measure of the transparency of the air to radiant heat; but if the true temperature of the air is required, the thermometer should be surrounded by two or more concentric silvered glass tubes through which a rapid draught is maintained. In this way the effects of radiation are almost eliminated, and all the heat received is supplied by conduction.

A. MALLOCK.

6 Cresswell Gardens, South Kensington.

Percussion Figures in Isotropic Solids.

THE accompanying photographs are of interest as illustrating the manner in which an isotropic solid breaks down under the stresses set up by impact when these exceed the limits of perfect recovery, and have a bearing on the theory of the collision of elastic solids developed mathematically by Hertz.

Figs. 1, 2, and 3 are pictures of the percussion figure, taken from three different points of view, produced on the surface of a thick glass plate by the impact of a polished hard steel ball. Near the centre of the region of contact between the sphere and the plate the stresses are mainly in the nature of a volume-compression, and fracture accordingly does not originate there, but occurs at or near the *margin* of the compressed area in the form of a fine circular crack which spreads inwards into the plate obliquely in the form of a surface of revolution. This is clearly shown in Fig. 1, which is a front view of the percussion figure by reflected light, the dark circle in the middle being the uninjured area of contact between ball and plate. The circular interference-rings seen in the picture are a measure of the separation of

FIG. 1.

FIG. 2.

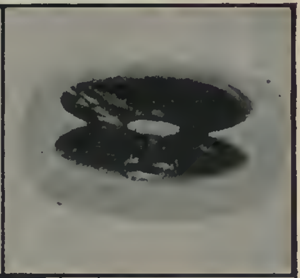

FIG. 3.

the surfaces of the internal fracture within the plate.

Fig. 2 is a side view, and Fig. 3 an oblique view, of the internal fracture seen through the edge of the plate, the lower half of each picture being the image of the upper half formed by the reflection of light at the interior surface of the plate. The circular area of contact from the margin of which the fracture starts appears in Fig. 3 as an elliptic white disc at the centre. It seems clear that the internal fracture practically occurs along the surface of maximum *shearing* stress set up during the impact. C. V. Raman.

210 Bowbazaar Street, Calcutta, August 18.

The Rigidity of the Earth.

An account of an experiment to determine the rigidity of the earth was published in the *Astrophysical Journal* and in the *Journal of Geology*, March, 1914. This gave the ratios of the amplitudes of tides observed in N-S and E-W pipes to the amplitudes computed for the same pipes on the assumption of a perfectly rigid earth as 0·523 and 0·710 respectively.

The work of reducing a new set of automatically recorded observations made by an interference method, which was interrupted by the war, was recently resumed, and it was found that the N-S and E-W ratios were very nearly equal to each other.

It was then noted that $0·523/0·710=0·7366$, and that the cosine of the latitude of Yerkes Observatory, where the experiment was performed, is 0·7363. It seemed highly probable, therefore, that $\cos\phi$ had been introduced erroneously into the computed formula for for N-S tides.

We have just been informed by Prof. Moulton that he has gone over the old formulæ used, and has found that the computer introduced the factor $\cos\phi$ erroneously into the N-S computation.

The N-S ratio should therefore have been $0·523/0·7363=0·710$, which, oddly enough, is exactly equal to the E-W ratio.

The new observations point to a value of about 0·69 for both E-W and N-S ratios.

A. A. Michelson.
Henry G. Gale.

University of Chicago, September 10.

The "Flying Gallop" in Art.

In Nature of August 21 (p. 489) reference is made to a popular article by Mr. C. W. Bishop on "The Chinese Horse," and to the distribution of the artistic motive of the flying gallop dealt with in it. It may be of interest to remark that this problem was first studied and discussed by the famous French archæologist S. Reinach in his "La représentation du galop dans l'art ancien et moderne" (Paris, 1901), and was afterwards expanded by me in my book, "Chinese Pottery of the Han Dynasty" (Leyden, 1909), where also many illustrations of the motive from Chinese art-works are given.

B. Laufer,
Curator of Anthropology.

Field Museum, Chicago, September 10.

MUSEUMS, EDUCATION, AND THE BOARD.

For many years a number of our provincial museums have striven to make their collections of educational value, both to the ordinary citizen through their exhibits and guides, and to the schools through their exhibits and special circulating collections, as well as by talks to the teachers or pupils. The response of the education authorities long continued disappointing, but some eight or ten years ago things began to move more rapidly. Certain pure educationists began to see that there was something of value for them in the museums, and in 1913 the Educational Science Section of the British Association appointed a strong committee to report on the question. The war, though unfortunately preventing the publication of that committee's lengthy report, and hindering museum activities in many directions, has had the result in some towns, notably Manchester, of inducing the schools to lighten their own troubles by seeking the aid of the museums and their staffs.

So well had the movement progressed, thanks mainly to the insistent propaganda of museum officials, individually and through the Museums Association, that at last the Education Act of 1918 and the draft suggestions for the arrangement of schemes thereunder (Circular 1096) took museums into serious account as an educational factor. Museum enthusiasts were delighted. But now comes a move which gives them pause. The Adult Education Committee of the Ministry of Reconstruction has issued an interim report (Cd. 9237) recommending that public libraries and museums should be placed under the control of the local education authorities, and administered by special committees of those bodies, and urging "that the powers and duties of the Local Government Board regarding public libraries and museums should be transferred forthwith to the Board of Education." So reasonable a recommendation would, it is doubtless expected, be welcomed effusively by the institutions concerned. The contrary is the case. The protests of the librarians are quoted—and dismissed—in the interim report itself. They have just been repeated at the meeting of the Library Association in Southport, but we cannot consider them here. As already reported (Nature, July 17, 1919, p. 394), the Oxford meeting of the Museums Association raised so many objections that it appointed a committee to prepare a statement. And now, in a discussion of the Educational Science Section of the British Association, the opposition of the museums found vigorous expression, and such support as the proposal received from one or two curators was only half-hearted. It may be well, therefore, to summarise the arguments.

The Adult Education Committee holds its opinion so strongly that it has condescended to very little argument. We gather more from a paper laid before Section L by Prof. J. A. Green. This assumes that museums are "fundamentally educational in character," and infers that they should form part of the educational machinery of the country. This machinery should be controlled by one authority, and its parts adapted to a common aim. This would change the outlook of the museums and lead them to display their collections in such a way as to dispel "museum headache." The responsibilities of the Education Committees have been extended to adult education, and they would be better able to bring museums into touch with universities and other of the higher educational establishments. Where a museum does not exist already, as in certain towns and in country districts, a live education authority would set one up, so that the number will be increased. Museums suffer from want of funds because few are supported by more than a ½*d.* rate, some not even by that; they would receive grants in aid directly from the Board of Education.

To this the museums reply that they recognise the argumentative force of a pecuniary bribe; but if their work is worthy of this reward, why should it not be given? For the rest, they dispute the premisses. A museum is *not* fundamentally an educational institution. It exists primarily for the collection and preservation of the works of nature or of man, and its highest aim is the advancement of science or of art. The needs of the researcher must never be sacrificed to those of the elementary student or the public. Even the smallest local museum has a duty in this direction, and it is this spirit which keeps the museum alive. Museums which themselves chart the unknown seas of knowledge can best pilot the learners. Organised education is the vehicle of established knowledge, is necessarily limited in scope, and must move on the rigid lines of a syllabus; but the museum must respond to new influences, must extend knowledge, and assemble material for future research. The existing museum committees are not ideal, but neither are the education committees. The curator knows his men, has been moulding their ideas, and has generally found a chairman with large views. He does not wish to see either himself or his chairman controlled by a body the scope of which embraces but a subsidiary part of his museum's activities. If his means of support are to come solely through educational channels, results will be expected through those channels alone. The others will gradually be blocked, the level of aspiration and accomplishment will be lowered, the living water will stagnate. Museum officials, from experience or observation, distrust bureaucratic government; they want men whom they can approach, not an anonymous Board.

Compromise, however, may be possible. Cooperation is desired, though not subordination. Let the education authority advise upon the public exhibition series, and support financially the educational work of the museum in proportion as it approves. But hands off the unseen activities of the museum! Provincial museums may be linked up with one another and with the national museums above and the minor museums below, but the linking should be through a body representative of their own committees and curators. If the source of money must be the Board of Education, so be it; but let it flow to these committees through a separate museum department of the Board. Museums here, as in the United States, have shown what good educational work they can do on their own initiative. Recognise that initiative, and they will respond with more abundant and more fruitful efforts.

THE COALFIELDS OF SPITSBERGEN.

Coal is not a new discovery in Spitsbergen. It has been known for more than 300 years, and about a century ago small cargoes were even brought to Norway. But mining on a serious scale did not begin until some fifteen years ago, while its rapid extension is due to the high price and comparative scarcity of coal during and after the war. There are now at least four mines in Spitsbergen exporting coal in large quantities during the summer months, and several others which will soon reach the export stage.

Coal of at least three ages occurs—Carboniferous, Jurassic, and Tertiary. It is difficult to give the total content, but it may safely be said that Spitsbergen coalfields do not contain less than 5,000,000,000 tons. Bear Island, in addition, has a content of some 8,000,000 tons. The occurrence of drowned fault valleys in the plateau of almost horizontal strata has made the coalbeds easily accessible in most places, and greatly facilitates loading by reducing land transport to a minimum. Practically all the valuable coalbeds lie around the two great inlets on the west coast—Icefjord and Lowe Sound—except a small outlier of Tertiary coal in King's Bay, near the north-west corner of Spitsbergen. The Tertiary coal has attracted most attention, and for the present at least provides most of the export coal. At Longyear City, the prosperous Norwegian mine in Advent Bay, several seams have been located at 755 ft. above sea-level; a 3½-ft. seam is now being worked, and at 815 ft. a 4½-ft. seam is being opened; another seam occurs at 640 ft. The same coal is being worked in Lowe Sound and in Braganza Bay. In the latter place Swedes are exporting large cargoes from their mine in the 3½-ft. seam at a height of 245 ft. It is also being mined successfully by Russians in Green Harbour.

The Tertiary coal has been proved to be a good steam coal of high calorific value, and fairly free from dirt. An average of the analysis of several samples gives about 79 per cent. carbon, 2 to 6 per cent. water, less than 2 per cent. sulphur, and about 4 per cent. ash. The calorific value averages about 7800. The seams appear to maintain a fairly consistent thickness and uniformity in quality over wide areas. Other seams of Tertiary coal also occur, notably a 7-ft. seam of bituminous coal in Advent Bay at a height of 1900 ft. This seam, which is now being mined, shows a slight tendency to pass to lignite, an unusual feature in Spitsbergen Tertiary coal.

The coal of Carboniferous age occurs in the culm beds near the foot of the Carboniferous system. The deposits are very extensive, but have been investigated only recently, and so have attracted less notice than the Tertiary seams. Moreover, the outcrops of these coal seams are generally obscured by enormous screes and slip masses, so that their examination entails a good deal of serious work, including boring operations; but this is well repaid, as the seams are thick, and extend over wide areas round the northern and eastern bays of Icefjord. In the Klaas Billen district valuable seams have been opened up at various heights. Varying from a few inches to about 3 ft. in thickness, they total 6 ft. Early analyses of Carboniferous coal were vitiated by the samples being taken from weathered slip masses, in consequence of which they showed a high proportion of ash. Now, however, that the coal has been reached *in situ*, it proves to be of high quality, clean and lustrous, and, unlike the Tertiary coal, fit for coking. Projects are on foot for extensive mining operations in these fields.

Jurassic coal is widely spread, but less accessible than the other kinds. It was the first coal to be mined, but turned out to be of relatively poor quality, and is now no longer worked.

Mining is continued throughout the year, although the export season at present extends only from June to September. The miners winter in comfortable timber houses, and are well supplied with fresh food, brought from the European mainland in the autumn. There is wireless communication throughout the winter. The restriction of export to four months in the year necessitates good storage facilities for the winter coal and rapid loading in summer both from the dump and direct from the mine, but these problems are being satisfactorily solved. The total coal export of Spitsbergen, which in 1913 was 35,000 tons, rose last year to 65,000 tons, and this year must have reached about 100,000 tons. These figures are, of course, comparatively small, but they will be much increased as several new mines get into working order. The shortage of labour, material, and tonnage still affected the output this season, but it may be said that the prejudice against mining in the Arctic has now been overcome, and Spitsbergen will soon take its due place as one of the important coal-producing countries of Europe.

R. N. R. B.

NOTES.

The Ministry of Munitions has published as a confidential document a highly interesting report of the Commission appointed to visit the iron and steel works of the occupied areas of Germany, also of Lorraine, Luxemburg, and certain portions of Belgium and France. The object of the Commission was to ascertain what developments in iron and steel manufacture have taken place during the war, the present condition of the plants, the future prospects of these areas, and to what extent fuel economy has been advanced therein. As regards the last-named item, Messrs. Cosmo Johns and Lawrence Ennis communicated to the recent autumn meeting of the Iron and Steel Institute a report on the present status of fuel economy in the German iron and steel industry of the occupied territory. This report is now public property, and contains very much interesting material; it may be taken as an indication of the importance of the valuable information which the Commission itself has collected. It is to be hoped that the Ministry of Munitions will see its way to publish the entire report as an ordinary Government publication purchasable in the usual way, so that it may be known by all engaged in the iron and steel industries in this country, as there is no reason why our industries should not be allowed the benefit of the careful studies of this Commission. Such an important document should be made available as widely as possible to all those interested in the subject-matter.

The future of the Royal Botanic Society at Regent's Park has for long been a matter of anxiety, and the recent appointment by Lord Ernle, when President of the Board of Agriculture and Fisheries, of a strong Committee to inquire and report as to what steps should be taken to render the work of the society as useful as possible, from the scientific and educational points of view, was a most welcome step. The Committee, under the chairmanship of Sir David Prain, Director of Kew Gardens, has taken evidence from representative botanists and others, and its report is now available. Apart from the establishment of the gardens at Regent's Park, the primary object of the society, which was incorporated in 1839, was "the promotion of botany and its application to medicine, arts, and manufactures." It is interesting and satisfactory, therefore, to note that the Committee is of the opinion that the usefulness of the work of the society would be enhanced by the organisation and development of botanical work essentially economic in its bearing. The chief suggestions made by the Committee are:—(1) The establishment of a school of economic botany at which a knowledge of economic plants and their products could be obtained; (2) an institute which might be made a centre for research, especially in plant physiology; and (3) a centre for teaching practical horticulture. The first is the most notable and valuable recommendation. The establishment of such a school would supply an undoubted want in this country, where organised instruction in economic botany, especially as regards tropical crop plants, is almost impossible to obtain. The Committee is to be congratulated on so accurately judging the need of the situation. It is greatly to be hoped that the financial means necessary for the successful carrying out of the Committee's recommendations will be forthcoming.

A meeting of the Executive Committee of the United States National Research Council was held at the National Research Council Building, Washington, on April 15 last, and according to an abstract, 21 pages in length, of the minutes, which appears in the July issue of the Proceedings of the National Academy of Sciences, the Council has already made great progress in initiating and co-ordinating research in pure and applied science in the States. It has organised divisions for physical science, chemical science, geology and geography, biology and agriculture, engineering, industrial, educational, and State relations. Each division is presided over by a man of note, and on it there are many representatives of scientific and other societies. The Council will have ample funds at its disposal, the Rockefeller Foundation alone having undertaken to provide 100,000*l.* during the next five years for the promotion of fundamental researches in physics and chemistry primarily in educational institutions. The chairman of the Council receives 2000*l.*, and chairmen of divisions 1500*l.*, per annum, with travelling expenses. The Council is to be congratulated on the speed with which it has accomplished so much.

Dr. Theodore W. Richards, professor of chemistry at Harvard University, has (*Science* announces) been elected president of the American Academy of Arts and Sciences.

The Secretary of the Department of Scientific and Industrial Research informs us that a British Association of Research for the Cocoa, Chocolate, Sugar, Confectionery, and Jam Trades has been formed in accordance with the Government scheme for the encouragement of industrial research. The secretary is Mr. R. M. Leonard, the Manufacturing Confectioners' Alliance, Ltd., 9 Queen Street Place, E.C.4.

A committee has been formed to raise a fund by public subscription for the purpose of establishing a memorial to perpetuate the memory of the eminent services, particularly in the fields of economics and science, rendered to Tasmania by the late Mr. R. M. Johnston, for many years Government Statistician and Registrar-General of that State. Subscriptions are now invited, and should be sent to Mr. T. A. Tabart, jun., honorary treasurer, Cathedral Chambers, Murray Street, Hobart, or Mr. Clive Lord, honorary secretary, c/o Museum, Macquarie Street, Hobart.

By the untimely death of Prof. F. J. Haverfield, Camden professor of ancient history, the University of Oxford has lost a valued member and the first living authority on Roman Britain. Early in life Prof. Haverfield devoted himself to this, his special subject, and his reputation caused Mommsen to entrust to him that portion of the "Corpus Inscriptionum" which dealt with Great Britain. Not only was he a master of the literature of the Romano-British period, but he gave much assistance to excavations at Silchester, Caerwent, and the Roman Wall. He was an admirably stimulating lecturer, and was interested in town-planning in ancient times, on which he wrote a valuable book. Late in life he devoted himself to the question of university finance. It may be said that the Camden chair was never more worthily held by a scholar and practical archæologist. It is a matter of deep regret that ill-health prevented Prof. Haverfield from preparing the authoritative work on Roman Britain which he had planned, and alone could have accomplished.

With the mathematician Philip Edward Bertrand Jourdain there died on October 1 a truly remarkable character. Jourdain lived only thirty-nine years, but the amount and value of the work that he accomplished, considering the disabilities under which he laboured, are almost incredible. He was weakly from infancy, and as a child developed symptoms of the progressive paralytic condition known as Friedreich's ataxia. In spite of his unsteady gait and constant ill-health, he early showed great mathematical and mechanical capacity. He went up to Cambridge in 1898, then already a cripple. During his course at Cambridge he spent some time in Germany and became a fluent and scholarly linguist, speaking and reading several European languages. In 1904, though now physically quite incapacitated, he was awarded the Allen mathematical scholarship for research, and throughout the remainder of his short career his main activities were directed to the prosecution of mathematical investigations. His most important work was the discovery of certain series of infinite numbers. Working with Russell and Whitehead, he showed that certain arithmetical processes could be applied to them, and thus he obtained new and interesting results. He continued on this line of research, and even a few days before his death, of the imminence of which he was fully aware, he succeeded in demonstrating the existence of a previously unsuspected series of infinites. His very last work was the discovery of a formula for the well-ordering of *any* aggregate. Notes of this work are now, we understand, in the hands of Prof. Love. Jourdain contributed extensive mathematical articles to the last edition of the "Encyclopædia Britannica." He founded and edited the *International Journal of Ethics*. He was for some years the English editor, and since the death of Carus in 1918 the chief editor, of the *Monist*. He also made a number of translations of scientific works for the Open Court Publishing Co. Jourdain took the liveliest interest in the movement for encouraging the history of science. He was a contributor to *Isis*, and at the time of his death he had in preparation an article for the "Studies in the History and Method of Science" which it is hoped he may have left in a state ready for publication.

In *Man* for September Col. de Guérin, of Guernsey, expresses the opinion that the megaliths in that island may be much more recent than they were hitherto supposed to be. This view is based on the important discovery of traces of a rudely sculptured human figure on a capstone of the great chamber of the dolmen of Déhus. The relationship of this figure to similar anthropomorphic sculptures in Guernsey and France is obvious, and as these latter, according to Déchellete and others, date at earliest from late in the Neolithic, at the verge of the Æneolithic period, the dolmen of Déhus must be of this age or later. This is confirmed by the discovery in 1847 of a copper knife-dagger in the great chamber of this dolmen. Col. de Guérin fixes also the statue Menhir at the Câtel Guernsey in the first Bronze age. He lays special stress on the evidence of a still earlier sea-borne trade with Brittany in the numerous celts of jadeite and other foreign rocks found in the island.

In the nineteenth volume of *Natural History* (Nos. 4–5, April–May, 1919) Mr. I. M. Clarke describes, with numerous excellent photographs, the new Gaspé bird sanctuaries established by the Canadian Government on Percé Rock and Bonaventure Island, off the Gaspé Peninsula, and, further out in the Gulf of St. Lawrence, the Bird Rocks of the Magdalen Islands. The efforts of ornithologists for bird-protection have at last proved successful with the support of the Hon. Honoré Mercier, Minister of Colonisation, Mines, and Fisheries for the Province of Quebec. In another article on the same subject Mr. A. M. Bailey describes the Hawaiian Island Reservation, which was established in 1909 by Executive Order as a sanctuary for the millions of sea-birds and waders which return there annually to raise their young or to rest while migrating. For this and other generous measures to preserve bird-life, science is indebted to the late Theodore Roosevelt.

Natural History (vol. xix., Nos. 4–5, April–May, 1919) publishes a series of articles on zoological sculpture in art and architecture. Mr. S. B. P. Trowbridge, dealing with architecture, beginning with the palæolithic horse frieze at Cap-Blanc and the horse painting from Altamira, reproduces photographs of the bas-reliefs of Assyria in the British Museum and the Rostra at Rome. In regard to modern art, he accounts for the comparative failure of modern attempts on the ground that "in the art of sculpture, as in all art, there must be sincerity and truth, accuracy in delineation and fidelity in modelling, and the suppression of every detail unnecessary to expression." This idea is pursued in Mr. C. R. Knight's account of the work of contemporary American artists dealing with animal life. The black rhinoceros and African buffalo by Mr. J. L. Clark have some impressive vigour; but the zoological statuary at Washington, described by Mr. R. W. Shufeldt, shows little dignity or power of expression.

The lions, tigers, and buffaloes are distinctly inferior to the Nineveh hunting scenes described in the previous article.

Mr. V. Stefansson describes his successful method of Arctic exploration in an interesting article entitled "Living Off the Country" in the May issue of the *Geographical Review* (vol. vii., No. 5). Mr. Stefansson's well-known adoption of Eskimo habits and diet have enabled him to travel with very light loads and to penetrate far into the unknown for long periods without any anxiety. He contends that from experience he has found that a diet of flesh or fish is quite sufficient to sustain a person in good physical and mental condition, and that salt is not necessary for health. White men whom he has known to have lived for a year or more on an exclusive meat diet have shown no desire to return to the varied and elaborate diet of civilisation. So convinced is Mr. Stefansson of the abundance of food in the Arctic lands and seas he knows that he asserts that any man conversant with the ways of wild animals and the hunting and living methods of the Eskimo can load on one dog-team all the equipment he needs for a journey of several years. Where previous explorers had carried food and fuel, Mr. Stefansson carried neither, choosing to adapt himself to his environment rather than fight it. Instead of taking food and fuel he carried merely the instruments for obtaining them. By economy in the use of ammunition one can obtain as much as two tons of food for a pound of ammunition, or, in other words, ammunition is several thousand times as economical to carry as the most condensed kind of food. The paper deals at length with the methods of Arctic hunting, particularly seal-stalking.

In his presidential address to the seventeenth meeting of the South African Association for the Advancement of Science, held in July last, the Rev. Dr. W. Flint discussed the thorny problem of "Race Consciousness" in the light of modern scientific opinion. He regarded "national consciousness" as a mental tendency which had been fostered among the peoples of Europe, by territorial and linguistic boundaries, and by the propagation of a community of ideas. "Race consciousness," as seen in South Africa and in the Southern States of America, on the other hand, was an inherent proclivity or "property of human nature," and demanded the closest scrutiny and most accurate study on behalf of all men of science if political bankruptcy was to be avoided. In Spanish America racial animosities had been dissolved by miscegenation, but that method was unthinkable as a solution of South African racial difficulties. There was also another plan, the proposal to segregate native races in demarcated territories, but in practice that proved an impossible working policy. There was a third proposal which had been debated, the frank recognition of racial antagonism and the resolution on the part of each race to live within its own armed camp. The solution advocated by Dr. Flint was none of these, but the cultivation and recognition of an "international consciousness," which could be fostered by education and by the recognition on the part of "superior" peoples that every race has its rights, economical, political, and social. Dr. Flint holds that "racial consciousness" can be uprooted and replaced by an intellectual "interracial consciousness," and that racial conflicts can be avoided only by education—of whites as well as of blacks. On the biological significance of "race consciousness" Dr. Flint did not attempt to throw any light; that is a matter which still awaits patient investigation. Everyone interested in the problems of racial contact will find food for thought and subjects for observation in Dr. Flint's presidential address.

The Board of Agriculture has received the following information from the International Agricultural Institute at Rome:—The yield of wheat in Spain, Scotland, Italy, Canada, the United States, India, Japan, and Tunis is estimated at 929,525,000 cwt., or 5·6 per cent. below the 1918 crop, and 1·1 per cent. below the average yield of the five years 1913–17. The estimated production of rye for Italy, Canada, and the United States is given as 48,274,000 cwt., or 7·1 per cent. below last year's production, but 67·3 per cent. above the average crop for the years 1913–17. The barley crop for Scotland, Italy, Canada, the United States, Japan, and Tunis is estimated at 159,397,000 cwt., or 15·1 per cent. below last year's production, and 4·1 per cent. above the average production of the years 1913–17. The estimated production of oats in Scotland, Italy, Canada, the United States, Japan, and Tunis is 491,933,000 cwt., or 18·4 per cent. below the 1918 yield, and 7·2 per cent. below the average yield of the five years 1913–17. The maize crop in Italy, Canada, and the United States is estimated at 1,473,592,000 cwt., or 10·2 per cent. above the 1918 production, and 3 per cent. above the average yield of the years 1913–17.

The flora of Aldabra and other small islands of the western Indian Ocean is the subject of an article by Dr. Hemsley in the Kew Bulletin (No. 3, 1919). Aldabra is an atoll, similar in size to the Isle of Wight, 220 miles north-west of Madagascar, and about 600 miles from the Seychelles Archipelago. Assumption, the nearest island, is about twenty miles distant. Aldabra is densely clothed with vegetation, which is unusually rich for an atoll flora, comprising herbaceous, shrubby, and arboreous species. Excluding species introduced by human agency, the flora comprises more than 170 species of flowering plants, representing 127 genera and 54 families, proportions which are characteristic generally of insular floras. Grasses number 14 species, Rubiaceæ 15, and Leguminosæ 12. The Rubiaceæ constitute the predominating element in the woody vegetation, both as to number and diversity of genera and number of species, but are less conspicuous in the scenery than the mangroves, the figs, and a species of Euphorbia. The vegetation consists of four types:—(1) Mangrove swamp, which fringes the lagoon. (2) Pemphis bush, a dense growth of the hard-wooded *Pemphis acidula* (Lythraceæ), a widely distributed sea-coast plant. (3) Open bush, mostly of low trees and bushes, which are usually leafless in the dry season and flower at the beginning of the rains; herbaceous plants are scarce, and only found in the wet season. Almost all the Aldabra plants are to be found in this type of country. (4) Shore zone, extending round the atoll, varying much in width and supporting some widely distributed littoral species. The coco-nut, of which there are conspicuous plantations, is regarded as an introduced plant. Dr. Hemsley is convinced that this palm is a native of South America, the home of all the numerous species of the genus, and that its present wide distribution is due to human agency. Some particulars are also given of the floras of other islands in the western Indian Ocean, and of their relations with the flora of Aldabra. The data collected point to the common origin of the flora of Aldabra and the neighbouring islands, and indicate that the flora is essentially African and almost without any infusion of a Malayan element, such as exists in the Seychelles and the Mascarene Islands.

OCTOBER is a transition month so far as winds and distribution of atmospheric pressure are concerned in the East Indian Seas, and the Monthly Meteorological Chart published by the Meteorological Office shows that a considerable change is taking place in the general meteorological conditions. To the north of the equator northerly winds are decidedly asserting themselves and the south-west monsoon of the summer months is giving way. In the Bay of Bengal and in the Arabian Sea, October and November are the most stormy months of the year, and cyclones are more numerous than at any other period. The low barometric pressure which has prevailed over the land to the north of India is giving place to higher barometer readings, which causes a diametrically opposite wind circulation. The chart contains an interesting note of sea phosphorescence in the vicinity of Madras on July 3. At 2.10 a.m., in latitude 12° 43′ N., longitude 30° 34′ E., the steamship *Clan Ogilvy* (Capt. W. M. Porterfield) passed through what appeared to be a gigantic wheel, with many "curved" spokes, revolving the same way as the hands of a clock. The phenomenon lasted quite ten minutes, and is said to have been caused by phosphorescence. The wheel was travelling to the eastward. As each "spoke" passed, the ship was lit up.

THAT the war has done a great deal to show the value of the spectroscopic examination of metals and alloys is proved in an article on the subject in *La Nature* (September 6). Considerable information was gleaned regarding the composition of secret German alloys which were investigated by A. de Gramont by his method, and the same remark applies to the composition of the metal used by the enemy in the manufacture of the long-range shells fired upon Paris. The spectroscopic method would seem to be of particular value when applied to the examination of the constituents of alloy steels and commercial alloys, and, as the writer states, is capable of great expansion in this direction.

MESSRS. LEVER BROS., LTD., Liverpool, have lately published an interesting "Cattle Food Calendar" for 1919–20. This contains articles on the scientific side of agriculture written by men competent to speak on their respective subjects. Further, it is illustrated by photographs and pictures of many of the important operations in agricultural science. Among the articles we note "How Mendelism May Help the Stockbreeder," and shorter, but equally interesting, articles on "The Work of the Board of Agriculture," "Plant Diseases," "The Relation between Skin-temperature and the Fattening Quality of Cattle," "The Official Seed-testing Station at the Food Production Department," "The Work of the Rothamsted Experimental Station," "The Breeding of New Wheats," "Warble Maggots in Cattle," "Investigation and Research in Dairying," "Contagious Abortion in Cattle," "Horticultural Research," "The Cheshunt Experimental and Research Station," and "Forestry." The list covers a wide field, and the articles give brief, but useful, summaries of the application of science to agriculture.

OUR ASTRONOMICAL COLUMN.

COMET 1919*c*.—The following is a continuation of the ephemeris of comet 1919*c* (Metcalf-Borrelly) for Greenwich midnight:—

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Oct. 9	15 38 25	5 11	Oct. 21	16 10 14	1 17
13	15 48 38	3 4	25	16 21 39	3 30
17	15 59 14	0 54	29	16 33 30	5 43

Log *r* and log Δ on October 9, 0·1574, 0·3052; on October 25, 0·1106, 0·2884. The comet is an evening object, and is getting inconveniently near the sun.

A FAINT NOVA.—Miss Mackie announces that she has discovered a nova from a study of the Harvard photographs (Harvard Bulletin 691). Its position is R.A. 20h. 3m. 4s., N. declination 17° 24·3′ (1900). It follows a 14th magnitude star by 0·2s. It reached its maximum, 7·2 magnitude, on November 22, 1913, and has now sunk to below 14·5. The position is in Sagitta, within the limits of the galaxy; it is only about 26° from Nova Aquilæ.

HINDU SPHERICAL ASTRONOMY.—Mr. G. R. Kaye has published a paper on "Ancient Hindu Spherical Astronomy" in the Journal and Proceedings of the Asiatic Society of Bengal (vol. xv.). In this he summarises, with the aid of modern mathematical formulæ, the fundamental portions of the principal classical astronomical texts, which date from between A.D. 498 (the *Aryabhatiya*) and about A.D. 1000, when the redaction of the *Surya Siddhanta* now extant was written. Indian trigonometry is, like Indian astronomy, of Greek origin, but the Indians developed the methods received from the Greeks in various ways. There seems to be no doubt that the Indians were the first to introduce the use of sines instead of chords, and to compute tables of sines. But they never went further, and did not make use of the tangent function. They never give a proof of any rule they enunciate. The title of Mr. Kaye's paper refers to spherical astronomy only, but the author also gives a short account of the Hindu notions of the motions of the planets, though this has been done by several previous writers. The Hindu planetary theories differ in several details from those of Ptolemy, and were probably mainly derived from Alexandrian writings from the period between Hipparchus and Ptolemy, now lost. Though there is nothing particularly new in Mr. Kaye's paper, it gives a convenient summary of the principal doctrines taught in the great Indian astronomical text-books.

STELLAR CLUSTERS.—Dr. and Mrs. Shapley contribute another paper to the *Astrophysical Journal* for July on stellar clusters. They give a table of forty-one clusters, of which thirty show ellipticity, eleven are sensibly circular, and one is unsymmetrical. The most elliptical cluster is Messier 19, in which the greatest diameter is about twice the least; this is a much lower degree of flattening than that in the galaxy or the spiral nebulæ. In the case of the circular clusters, the form may be real or it may be due to our being situated near their polar diameters. There is some evidence that clusters near the galactic plane tend to have their equatorial planes parallel to it. At a distance from the galactic plane this no longer holds.

THE AURORA OF OCTOBER 1.

THERE was noteworthy auroral activity on the night of October 1. The display started in the early evening and lasted until well after midnight. As seen in the south of England, the aurora was generally of the glow type. The absence of streamers, etc., was commented on by Mr. W. H. Dines, of Benson Observatory, but Capt. J. E. Cowper noted streamers at Shanklin, Isle of Wight, soon after 22h. 15m.[1] The colour of the glow, which was comparable in effect with bright moonlight, was reported as "pale white" at Benson, "greenish-yellow" at

[1] According to the *Times* of October 3 there was a brilliant display with streamers seen from Worcester Park about 1 30 on October 2. "Curtains" were seen at Newport between 21.30 and 23 on October 1.

Shanklin and also at Ross-on-Wye, and "reddish-yellow" at Newquay.

The display was first noticed at Bristol at 9.15, and the final traces of it disappeared $5\frac{3}{4}$ hours afterwards, viz. at 15h. G.M.T. The appearance was that of a band of luminosity lying just over the northern region of the sky and extending over about 70° from nearly north-west to north-east. From this intense glow streamers occasionally shot upwards, but these quickly broadened and disappeared. They showed a reddish tint, and in several cases could be traced nearly to the altitude of Polaris. The stars of Ursa Major were deeply involved in the aurora, but shone conspicuously amid the light surrounding them.

At first sight a person might have mistaken the aurora for the reflection of a widespread conflagration, but a little watching revealed the precise nature of the event. Clouds covered a large portion of the sky at times, but it seemed curiously to avoid the region affected by the phenomenon, and there were showers of rain at intervals. The brilliancy of the northern light and the darkness of the clouds in other parts offered a striking contrast. Several meteors were seen during the night radiating from a point at $355°+40°$.

A letter from the Isle of Man describes a brilliant aurora visible there at 8.45 G.M.T. on the same night, and continuing with various modifications for several hours.

Dr. C. Chree has supplied the following note on the simultaneous magnetic storm as recorded at Kew Observatory, Richmond:—

"A smart magnetic storm was simultaneously experienced in connection with the aurora. As recorded at Kew Observatory, it began with a well-marked S.C. (sudden commencement) about 16h. 12m. G.M.T. on October 1, and continued until 4h. on October 2. The approximate ranges were 32′ in D, 280γ in H, and 170γ in V. The extreme westerly position was reached at the end of the S.C. about 16h. 16m., the extreme easterly position about 23h. 25m. on October 1. Between 22h. 18m. and 22h. 50m. there was a swing of 29′ to the east. The maximum in H appeared about 17h., the minimum shortly before midnight. After the minimum there was a rapid recovery from the depression. As usual in storms, V was enhanced in the afternoon, the maximum appearing about 19h. 10m. There was, however, a second approximately equal maximum about 22h. 15m. This was preceded and followed by somewhat rapid movements. After $23\frac{1}{2}$h. there was depression in V, the minimum appearing shortly after midnight. The element remained depressed until 4h. on October 2. The curves were fairly quiet for the next twenty-four hours, but disturbance began again about 4h. on October 3, and was active when the sheets were changed about 10h. It may be noted here that the storm itself was quite secondary as compared with the big one in August last, and so, from the purely magnetic point of view, the interest is very moderate."

THE SUDAN IRRIGATION WORKS.

It is an unfortunate circumstance when a controversy respecting the merits of rival schemes for Imperial development works is embittered by charges impugning the good faith of either side, and it is particularly painful when an accusation of this kind is levelled by a Government official of high standing and repute against his colleagues in the Department with which he was formerly associated. We do not propose to discuss the ethical question (it has already been the subject of inquiry by a Foreign Office Committee), but it is unavoidable to mention it as indicating the ground upon which Sir William Willcocks has published his brochure on "The Nile Projects" and the acutely critical spirit in which it is written.

We have already outlined in NATURE for September 18 (p. 67) the schemes actually adopted by their respective Governments, and now in course of execution, for the development of irrigation in Egypt and the Sudan, comprising the formation of a dam on the Blue Nile at Makwar, near Sennar, and of a reservoir at Gebel-el-Auli, on the White Nile; and in the "Notes" columns of the issue for May 22 last (p. 233) we briefly alluded to the alternative proposal advocated by Sir W. Willcocks and designated by him "the Sudd reservoir." The following additional particulars gleaned from the pamphlet before us may be of some interest.

The Blue Nile project, for the irrigation of the Gezirah plain in the Sudan, involves the storage of 463,000,000 cubic metres of water for distribution during the winter season to 300,000 feddâns (acres) about to be exploited in cotton-raising. To meet this requirement a supply of 120–150 cubic metres per second will be necessary at the canal head throughout the winter up to the end of March, although in an occasional year the supply may have to be continued to the middle of April. This would leave three months for the gathering of the crop and the preparation of the ground prior to the next sowing. It is essential to have this period as dry as possible in order to root out the old stalks, which otherwise tend to sprout, as, indeed, happens when the rains supervene. Sir W. Willcocks expresses the apprehension that irrigation supplies will have to be given much later than April 15, and that the sources for Egyptian use will be seriously depleted in consequence.

The White Nile reservoir at Gebel-el-Auli, proposed to be formed by an earthen bank across the river at a point some 50 km. above Khartoum, comes in for the criticism that it will flood a considerable tract of country, disturbing the inhabitants and necessitating their transfer elsewhere, and that the stagnant pools left when the reservoir is low will lead to an increase in mosquitoes. Both these objections were before the Foreign Office Committee, but were not held to be vital. Another point made by Sir W. Willcocks is that a work so remote from Egypt might in the hands of a hostile Power become a serious menace to that country. "An enemy getting possession of the dam and filling it brimful to the height of the earthen bank in a high flood could sweep the Nile Valley as thoroughly as Noah's deluge swept the Euphrates Valley."

Pursuing a trenchant criticism of the estimated cost of the foregoing schemes, Sir W. Willcocks compares them very unfavourably with his own project of utilising as a reservoir the vast tract of swamp known as the Sudd region, where, owing to the dense growth of papyrus and aquatic vegetation, there are "a score of milliards of cubic metres of water standing well above the level of the flat plain as though they were congealed." Such a region, Sir William contends, could be laid under contribution for practically inexhaustible supplies of water more effectively and at less cost.

BRYSSON CUNNINGHAM.

COLLIERY BOILER-PLANTS.

A REPRINT of articles on the performance of colliery steam boiler-plants and the saving to be obtained by their reorganisation, which appeared in *Engineering* for July 25 and August 1 last, has been sent us by the author, Mr. D. Brownlie. The discussion in the articles is based upon results of tests carried out by the author, and a valuable feature is a large table giving details of these results for 100 boiler plants, chiefly of the Lancashire type. Mr. Brownlie's figures indicate that the average net working efficiency of colliery steam-boiler plants is only about 55·5 per cent. By carrying out a re-organisation of such plants on modern scientific lines it is possible to obtain 70 per cent. efficiency, and Mr. Brownlie estimates that about 6,600,000 tons of coal per annum could be saved by the adoption of scientific methods and by more extensive use of refuse coal.

The 100 boiler plants tested have a total of 570 boilers, 500 of these being Lancashire, 2 Cornish, 37 egg-ended, and 31 modern tubular boilers. The average efficiency of the egg-ended boilers is less than 35 per cent., and there appears to be still a fair number of this type at work, in spite of it being hopelessly out of date. It is also of interest to note that the few modern tubular boilers installed are, on the average, giving no better results than the Lancashire boilers, which average 55 per cent. efficiency. This fact obviously indicates improper arrangements in the installation or bad methods of working, or both.

Another point of importance to which Mr. Brownlie directs attention arises from the Final Report of the Coal Conservation Committee, which states that "the policy of collieries has been to set free the best qualities of coal for the market, and to retain for colliery consumption the poorest quality. The returns show that the quantity of ash in some of the fuels used ranges from 50 per cent. to 80 per cent." Mr. Brownlie actually finds an average of 15·5 per cent. ash and coal of 10,500 B.Th.U. used at colliery boiler plants, and most people will support him in his statements that he has never heard of a case of 50–80 per cent. ash; that such instances must be rare; and that the statement in the report is most misleading. In actual fact, 52 per cent. of the coal employed at collieries is high-grade coal; of the remainder, 32 per cent. could be used economically in industry for steam generation, and only 16 per cent. is definitely unsaleable. The highest ash-content of this refuse coal was 35 per cent. Mr. Brownlie maintains that these results are typical of the colliery industry, and the idea that collieries burn chiefly refuse and unsaleable coal is a complete fallacy.

As a matter of fact, there are millions of tons of refuse coal lying unburnt at collieries, and a very large proportion of this refuse could be utilised for steam generation, as has been proved by Mr. Brownlie's firm on a number of colliery plants. The carrying out of this proposition would result in a very large saving in the coal consumption, even after ample deduction for the cost of extra boilers and plant necessary because of the low calorific value. A fair average price for the whole of the coal burnt on colliery boiler plants is to-day about 20*s*. per ton; making allowance for extra labour, plant, and depreciation, and taking 3 tons of refuse coal as equal in practice to 1 ton of saleable coal, the value of refuse coal to-day would be about 8*s*. per ton.

Mr. Brownlie's pamphlet is to be welcomed, partly on account of the strong case for reform presented in view of the need for national economy, and partly on account of the large number of test results which he gives in a form suitable for easy comparison. The pamphlet may be obtained from Messrs. Brownlie and Green, Ltd., 2 Austin Friars, London, E.C.2.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION D.

ZOOLOGY.

Opening Address by Dr. F. A. Dixey, M.A., F.R.S., President of the Section.

One of the results of the great war now happily at an end has been its effect upon science. On the one hand it has checked the progress of scientific investigation; it has done much to destroy international co-operation and sympathy; it has removed from our ranks, temporarily or permanently, many admirable workers. On the other hand it has acted as a great stimulus in many departments of scientific inquiry, and it has given the general public an interest in many scientific questions which have hitherto met with little recognition or encouragement from the people at large. It was perhaps inevitable, but at the same time, as I venture to think, rather to be deplored, that that interest has tended to concentrate itself upon applied more than upon abstract science; that it has been concerned chiefly with the employment of natural knowledge in devising and perfecting new methods of destruction. Terrible as is the power which the present-day engines of warfare have attained, it may be reasonable to hope that some compensation for the mischief and suffering which they have caused may eventually be found in peaceful directions; that the submarine, the aircraft, and even the high explosive may cease to be a terror to civilisation, and in spite of their past history may after all become agents in the advancement of the general welfare:

Hoc paces habuere bonæ, ventique secundi,

will, let us hope, be a legitimate reflection in later times. But for the true scientific worker, I think I may safely assert, the primary object of his studies is the attainment of knowledge for its own sake: applications of such knowledge may be trusted to follow; some beneficial, some perhaps the reverse. Still, whether they do or do not so follow is less a concern of the scientific man than whether his labours have resulted in a fresh advance into the realms of the unknown. I confess to some sympathy with the feeling which is said to be expressed in the regular toast of a certain scientific gathering:—"Pure mathematics, and may they never be of any use to anybody."

For genuine enthusiasm in the cause of science for its own sake, I think that we zoologists may claim a good record. We are by no means unmindful of the great benefits to humanity which have taken their rise more or less directly from zoological science. I need do no more than mention the services to medicine, great at the present and destined to be greater still in the future, that are being rendered by the protozoologist and the entomologist. We may look forward also to results of the highest practical importance from the investigations into the laws of heredity in which we are engaged with the co-operation of our allies the botanists. But what we are entitled to protest against is the temper of mind which values science only for the material benefits that may be got from it; and what above all we should like to see is a greater respect on the part of the public for science purely as science, a higher appreciation of the labours of scientific men, and a greater readiness, in matters where science touches on the common affairs of life, to be guided by the accumulated knowledge and experience of those who have made such matters the subject of constant and devoted study. If the war leads to any repair of the general deficiency in these respects, it will to that extent have conferred a benefit on the community.

Regarding, as I do, my present position in this Section as a great honour and privilege, especially in view of this being the first meeting of the British Association to be held after the war, I hope I may be allowed a few preliminary remarks of a somewhat autobiographical character. As far back as I can remember, zoology has been a passion with me. I was brought up in a non-zoological environment, and for the first few years of my life my only knowledge of the subject was gained from an odd volume of Chambers's "Information for the People." But on being asked by a visitor what I intended to do with myself when I grew up, I can distinctly remember answering, with the confident assurance of seven or eight, "Zoology suits me best"—pronouncing the word, which I had only seen and never heard, as *zoo*logy. By the time I went to school, my opportunities had increased; but I soon found myself engaged in the classical and mathematical routine from which in those days there was little chance of escape. In due course I went to the University with a classical scholarship, which necessitated for the time an even more rigid exclusion of scientific aspirations than before. I mention this because I wish to pay a tribute of gratitude to the College authorities of that day, to whose wise policy I owe it that I was eventually able to fulfil in some measure my desire for natural, and especially biological, knowledge. After two years of more or less successful application to the literary studies of the University, I petitioned to be allowed to read for the final school in natural science. The petition was granted; my scholarship was not taken away, and was even prolonged to the end of my fifth year. This I think was an enlightened measure, remarkable for the time, more than forty years ago, when it was adopted. I only hope that we have not in this respect fallen back from the standard of our predecessors. The avidity with which I took up the study of elementary chemistry and physics, and the enthusiasm with which I started on comparative anatomy under the auspices of George Rolleston are among the most pleasant recollections of my youth. But from the force of circumstances, though always at heart a zoologist, I have never been in a position to give myself unreservedly to that department of biology; and even now, in what I must call my old age, I fear I cannot regard myself as much more than a zoological amateur. My working hours are largely taken up with serving tables.

What moral do I draw from this brief recital? Not by any means that I should have been allowed to escape a grounding in the elements of a literary education, though I think it quite possible that the past, and even the present, methods of school instruction are not ideally the best. My experience has led me to conclude that much of the time spent over the minutiæ of Greek and Latin grammar might, in the case of the average boy, be better employed. But I do not agree that a moderate knowledge of the classics, well taught by a sensible master, is useless from any reasonable point of view. To those of my hearers who appreciate Kipling, I would call to mind the vividly truthful sketch of school life called "Regulus." Let them reflect how the wonderful workmanship of the inspired and inspiring Ode of Horace, round which the sketch is written, must have sunk into the mind of the apparently careless and exasperating "Beetle," the "egregious Beetle" as King calls him, to bear such marvellous fruit in after years. Beetle, as we all know, is no professional scholar, no classical pedant, but a man of the world who has not forgotten his Horace, and upon whose extraordinary literary skill those early school-tasks must have had, whether consciously or not, a dominating influence. How else could he have written "Regulus"? "You see," says King, "that some of it sticks." So it does, if it is only given a fair chance; and in the skirmish between King the classical and Hartopp the science master, both right up to a point and both wrong beyond it, I give on the whole the palm to King. To revert to my own case. I do not regret a word of either the Latin or the Greek that I was obliged to read, nor even the inkling of the niceties of scholarship to which I got, I hope, a fair introduction. But I do think that I might have been allowed to start on scientific work at an earlier period, and that a good deal of the time spent, say, on Greek and Latin prose and verse writing, might in my case have been well spared for other objects.

To generalise what I have been saying. Start teaching your boy or girl on a good wide basis. Nothing is better for this than the old school subjects of classics, history, and mathematics, with the addition of natural science. In course of time a bent will declare itself. Encourage this, even at the expense of other studies desirable in themselves. But do not allow any one subject, however congenial, to usurp the place of a grounding in those matters which are proper to a general education. The time for specialising will come; and when it has arrived do all you can to remove obstacles, pecuniary and other. Do not hamper your historian with chemistry or your zoologist with the differential calculus. If they have a taste for these things by way of diversion or recreation, well and good. But let their action be voluntary.

This, however, is not a fitting occasion for propounding my views on the question of education, and it is time to turn to the immediate object of my address. And here I think I cannot do better than bring before your notice certain facts which have a bearing on the subject of insect mimicry; a subject which for many years past has engaged much of my attention. The facts on all hands are allowed to be remarkable. As to their interpretation there is much diversity of opinion; and indeed, until complete data are forthcoming, this could scarcely be otherwise.

In the first place let us glance at a certain assemblage of butterflies that inhabits New Guinea with some of the adjacent islands. These butterflies, though belonging to different subfamilies, present a resemblance to each other which is too strong to be accidental. Three of them belong to the Pierines, the group which includes the common white butterflies of this country; the fourth is a Nymphaline, not widely removed from our well-known tortoiseshells, red admiral and peacock. The resemblance on the upper surface between two of the three Pierines is not especially noteworthy, inasmuch as they present in common the ordinary Pierine appearance of a white or nearly white ground colour with a dark border somewhat broadened at the apex. But this, an everyday feature in the Pierines, is almost unknown in the very large subfamily to which our present Nymphaline belongs. Still, though sufficiently remarkable to arrest the attention of anyone familiar with these groups, the Pierine-like aspect of the upper surface of this Nymphaline, which is known as *Mynes doryca*, would not by itself have seemed to call for any special explanation. The resemblance would pass as merely an interesting coincidence. But the under surface of the three Pierines, known respectively as *Huphina abnormis*, *Delias ornytion*, and *Delias irma*, presents a striking combination of colour very unusual in their own group; and this peculiar character of the under surface is shared by the Nymphaline *Mynes doryca*. The "long arm of coincidence" could scarcely reach so far as this. Whatever might be said about the likeness seen from above, that the wings beneath should show virtually the same unusual pattern in the Mynes as in the Pierines seems to call for some explanation other than an appeal to chance or accident. Moreover, with regard to the Pierines themselves, the two members of the genus Delias are, of course, fairly closely related; but the Huphina belongs to an entirely distinct genus, separated from Delias by many important structural differences. The two species of Delias perhaps depart less widely in aspect from their nearest congeners than does either the Huphina or the Mynes. The under surface of the Huphina is unexampled in its genus, but the upper surface is quite ordinary. The Mynes, as we have seen, stands alone among its nearest relatives not only in the character of its under surface, but also in the Pierine-like character of its wings above.

We will now turn to another assemblage, which presents us with the same problem from a somewhat different point of view. In south-eastern Asia, with certain of the adjacent islands, is found a genus of large butterflies, called by Wallace Prioneris from the saw-like front margin of the forewing in the male. More than fifty years ago it was remarked by Wallace that the species of Prioneris in several cases seem to mimic those of the genus Delias, and that "in all cases the pairs which resemble each other inhabit the same district, and very often are known to come from the same locality." The parallelism is even stronger than was stated by Wallace, for there is not a single known member of the genus Prioneris which does not resemble a species of Delias, so that Prioneris cannot really be said to have an aspect of its own. *Prioneris clemanthe* and *Delias agostina* form a pair inhabiting the Himalayas, Burma, and Further India. In the same region occur *Prioneris thestylis* and *Delias belladonna*, the striking similarity of which species, especially on the underside and in the female, drew the special attention of Mr. Wallace. A still more remarkable instance is that of *Prioneris sita* of southern India and Ceylon, the likeness of which to the common Indian *Delias eucharis* is spoken of by Wallace as "perfect"; while Fruhstorfer, a hostile witness, testifies to the fact that the Prioneris always flies in company with the Delias, and rests just like the latter with closed wings on the red flowers of the Lantana. *Prioneris hypsipyle* of Sumatra and *P. autothisbe* of Java are like *Delias egialea* and *D. crithoe* of the same two islands. Here again Fruhstorfer says of *Prioneris autothisbe* that it visits the flowers of the Cinchona, "always in company with the similarly coloured *Delias crithoe.*" Wallace remarked on the close similarity between *Prioneris cornelia* of Borneo and *Delias singhapura* of the Malay Peninsula; in this case, it will be noted, the localities, though not far distant from each other, are not identical. But a Delias form which was unknown at the date of Wallace's paper has since been found in Borneo, and this latter butterfly, known as *D. indistincta*, is even more exactly copied by *P. cornelia* than is the *Delias* which first drew Wallace's attention. *Prioneris vollenhovii* of Borneo is a kind of compromise between *Delias indistincta* and, on the underside, *D. pandemia* of the same island, and it may be added that another Bornean Pierine, *Huphina pactolica*, is a good copy of *Delias indistincta*, therefore resembling also the Bornean *Prioneris cornelia* and *P. vollenhovii*.

The memoir, published in 1867, in which Wallace remarked on the parallelism between Prioneris and Delias, contains a noteworthy prediction by the same author. Speaking of *Pieris* (now called *Huphina*) *laeta* of Timor, he says that it "departs so much from the style of colouring of its allies and approaches so nearly to that of *Thyca* (*Delias*) *belisama* of Java, that I should almost look for an ally of the last species to be discovered in Timor to serve as its pattern." Thirty-four years after the expression of this anticipation, Mr. Doherty discovered in Timor an ally of *Delias belisama* which at once suggests itself as the model from which the peculiar and brilliant colouring of *Huphina laeta* has been derived. Fruhstorfer, who is by no means friendly to the theory of mimicry, says of this Delias, which was named splendida by Lord Rothschild, that beneath it is "deceptively like *Huphina laeta.*" But here comes in a curious point. The black forewing with its yellow apex and the orange-yellow hindwing with its scarlet black-bordered costal streak are present on the underside of both the Delias and the Huphina; but the latter butterfly possesses, in addition to these features, a row of scarlet marginal spots on the hindwing which are not to be found on the Delias. In spite of this discrepancy, the likeness is sufficiently striking. But from the same island of Timor, Doherty sent home another Delias which, besides resembling *D. splendida*, possesses a row of scarlet patches in the corresponding situation to those of *H. laeta*. In this latter Delias, however, named *dohertyi* by Lord Rothschild after its discoverer, the brilliant scarlet costal streak is completely absent. The Huphina, therefore, is more like either species of Delias than they are like each other, forming, as it were, a link between them. So that, adopting Professor Poulton's terminology, we may say that, if this is a case of mimicry, one form may possess at the same time the aposemes belonging to two distinct models. I will not now stop to discuss the bearing of this case on current theories, but will only remark that, granting mimicry, the whole assemblage, *D. splendida, H. laeta, D. dohertyi*, may be expected to gain advantage from the blending action of the intermediate *H. laeta*. This I think would happen whether *laeta* is a "Batesian" or "Müllerian" mimic, but the gain to the association in the latter case is certainly the more obvious.

This state of things would be sufficiently curious if it stood by itself. But it does not stand by itself. In Lombok, Sumbawa, and Flores there occurs another member of the peculiar group of Huphina to which *H. laeta* belongs. This butterfly, known as *H. temena*, resembles *H. laeta* in many respects; possessing on the underside of the hindwing a scarlet costal streak and a row of scarlet marginal spots like those of that insect. The forewing, however, differs from that of *H. laeta* in having its ground-colour not uniformly black, but divided between a dark shading to the veins, a dark submarginal band, and series of pale streaks and patches in the interspaces between the veins. The question at once suggests itself: Is there a relation between *H. temena* and one or more species of Delias corresponding to that between *H. laeta* and *D. splendida* and *dohertyi?* The answer to this question is in the affirmative. *Delias oraia*, together with *Delias sumbawana*, both species inhabiting the same three islands as *H. temena*, form with it an assemblage quite comparable with the former triad from Timor. Further, the points in which *H. temena* differs from *H. laeta* have their counterpart in the distinctions between *D. oraia* and *D. splendida* on the one hand, and *D. sumbawana* and *D. dohertyi* on the other. These points are chiefly, in the *temena* assemblage, the less definitely black-bordered costal streak, the more strongly-marked black bordering to the submarginal scarlet spots, and the diversely-coloured as compared with the uniformly black forewing of the Timor insects.

Again, in the island of Bali, *Huphina tamar* would seem to combine certain features of two species of Delias in a similar manner to the cases of *laeta* and *temena* just considered. The underside as a whole, is reminiscent of *D. periboea*, a member, like *D. dohertyi* and *D. sumbawana*, of the eucharis or hyparete group of the genus; while the red costal streak suggests the influence of a representative in Bali of the belisama group, like *D. splendida* and *D. oraia* in the other islands.

Finally, in the island of Sumba we have another member of this remarkable group of Huphinas. *Huphina julia*, the butterfly referred to, so closely resembles *Delias fasciata* of the same island, that even the sceptical Fruhstorfer is constrained to speak of it as a "faithful copy" of that insect. But here once more it is noticeable that one of the most conspicuous features of the Huphina is absent from the Delias. This time it is not, as in the case of *D. splendida*, the submarginal row of scarlet spots on the underside of the hindwing, but it is the scarlet costal streak that is wanting. *Huphina julia* was discovered by Mr. Doherty in the year 1887, and described in 1891. It is interesting, in the light of what is now known of the butterfly fauna of the Lesser Sunda islands, to read what Doherty has to say about the mimicry question in relation to the Delias and Huphina forms that have just been mentioned. Speaking of *H. julia*, he says, "If it stood alone, I should certainly suppose it to be a mimic of some form of *Delias hyparete* yet undiscovered in the island. But both *H. laeta* and *H. temena* require to be accounted for in the same way, and while it is possible that some Timorese Delias may resemble *H. laeta*, I feel sure that *H. temena* can have no such original. It must then be assumed that this group is less pressed by its enemies in the Timorian Islands, and has therefore been able to acquire more brilliant colours than its allies." So far Doherty.

Whatever may be the value of this last hypothesis, we have just seen that the supposed facts on which it rests are non-existent, for (1) the "form of *Delias hyparete* as yet undiscovered" has actually turned up in the person of *D. fasciata*; (2) it is not only possible, but actually the case, that "some Timorese Delias may resemble *H. laeta*"; (3) Mr. Doherty "feels sure that *H. temena* can have no such original," but *Delias oraia* and *Delias sumbawana* have just the same relation to *Huphina temena* as *D. splendida* and *D. dohertyi* to *H. laeta*. In view of these facts it may be not rash to suppose that the apparent absence of a model for the red costal streak of *H. julia* may hereafter be accounted for.

Of the three instances of possible mimetic association which have now been mentioned, I think that only one, viz. the first, has previously been treated in detail. The numbers of cases more or less similar to these three might be very largely extended, but for our present purpose it will be sufficient to confine our attention to those already given. It is probable that to some minds the facts adduced are simply curious coincidences, needing no explanation; but it can scarcely be wrong to suppose that to most students of nature the observed phenomena do call for some attempt at interpretation; and on a review of the evidence it seems clear that the geographical element must enter largely into any explanation that may be offered. On the whole, it is certainly the case that the forms which are supposed to be related by mimicry do inhabit the same localities; the continental Prioneris, for example, is like the continental Delias, and the island Prioneris recalls the island, not the continental, Delias. Moreover, we find the differences between the Delias of Timor, of Sumbawa and Sumba reflected in the associated Huphinas of the same islands. If it be granted that the geographical element is a factor, it is natural to inquire how it works.

It is no doubt true that external geographical conditions are occasionally capable of producing, whether directly or indirectly, a community of aspect in the animals or plants exposed to their influence. The prevalence of a sandy coloration in the mammals and birds of a desert, and of whiteness in the inhabitants of the arctic snow-fields, the spiny character so often assumed by the plants of arid regions, and the general dwarfing of the vegetation that grows close to the sea, may be given in illustration. At first sight these phenomena may seem to be of the nature of direct effects of the environment; quite possibly some of them are so, but I think few observers would deny that they are at least largely adaptive, being used for purposes of aggression or defence. Still, even if we allow the direct effect of the environment, as perhaps we may do especially in the case of the plants, can we frame any hypothesis of the action of geographical conditions which shall lead directly to the assumption of a common pattern in the case of the three or four butterflies from New Guinea? I confess that I am quite unable to do so. If the climate, or the soil, or any other geographical condition in New Guinea is capable of directly inducing so remarkable a combination of colour as we see in these Pierines and Nymphalines, why does it not affect other organisms in a similar way? Why do not other Pierines, for instance, closely related to ornytion and abnormis, share in the same coloration? And considering the characteristic aspect of the underside, which is supposed to be called into being by some unexplained condition peculiar to New Guinea, we may well ask, Why should its most conspicuous features belong in the one case to the forewing and in the other to the hindwing, and *vice versa*, the general effect being the same?

Fruhstorfer, we may note, does not feel these difficulties. "Many Pierids," he says, "present typical examples of that resemblance to other butterflies which has been named mimicry. The origin of this resemblance, however, is now explained by the supposition that the mimics were modified by the same (as yet unknown) influences under which the colouring of the models, mostly Danaids, developed." I think it will be generally agreed that this reference to "unknown influences" is no explanation at all.

It is necessary to take into account the fact that the resemblances of which we are speaking are independent of structural differences, being, in fact, merely superficial. This is a point which is capable of much wider demonstration than I am giving it to-day. But even from the instances now before us I think there cannot be much difficulty in coming to the conclusion that the resemblances are an appeal to vision. They are meant to be *seen*, though by whom and for what purpose may be open to question. Speculations as to recognition and sexual attraction may, I think, in these cases be put out of court; but there remains the theory of warning colours assumed in reference to the attacks of vertebrate enemies. From the fact that the most striking and most conspicuous of these common aposemes or danger-signals belong to the under surface—that is to say, the part chiefly exposed to view during rest—it may be inferred that the enemies to be guarded against are mainly those that attack butterflies, not on the wing, but when settled in repose. Both birds and monkeys are known to feed on butterflies, and there is a good deal of evidence as to their preference for one kind of food over another. I will not stop to give details, but anyone who wishes to study the evidence may be referred especially to the memoirs of Dr. G. A. K. Marshall, Mr. C. F. M. Swynnerton, and Capt. G. D. H. Carpenter.

If the warning-colour interpretation of these resemblances be the true one, we see at once why they are so largely independent of structure and affinity. Being meant to catch the eye, they ride rough-shod, so to speak, over inconspicuous features, such as venation; nor do they respect more than the nature of things obliges them to do the ties of blood-relationship. Then, again, it is obvious why they occur in the same and not in widely different localities; in some instances, as we have seen, their bearers actually flying in company and frequenting the same flowers; for the common aspect, supposing it to be in any sense protective, would only take effect when the sharers in it were exposed to the attacks of the same body of enemies; that is to say, when they inhabited the same locality. And this would be equally true, whether the warning colours are shared between distasteful forms, or whether they are deceptively adopted by forms unprotected by inedibility; whether, in Prof. Poulton's terms, they are synaposematic or pseudaposematic. I do not enlarge upon this part of the question, or upon the theories which are known under the names of Bates and Müller respectively, because these theories have been fully dealt with elsewhere, and I think I may assume that they are familiar to the greater part of my hearers. But that mistaken ideas as to what is really meant by protection and mimicry still prevail in some quarters, is evident from certain remarks of Fruhstorfer in dealing with the genus Prioneris which we have just been discussing. "Wallace," he says, "regards the 'rarer' Prioneris as a mimetic form of the 'commoner' Delias. But I cannot accept his view, since mimicry among the in all respects harmless Pierids appears no sort of protection, and, properly speaking, the smooth-margined Delias should rather copy the armed Prioneris if there is assumed to be mimicry at all." If anyone has no better knowledge than this of what is meant by the theory of mimicry, it is not wonderful that he should consider the subject unworthy of serious attention.

The warning-colour theory, then, gives a rational explanation both of the superficial character of the resemblances and of the geographical factor in their occurrence. But it obviously involves the reality of natural selection; and it is here that some are disposed to part company with the upholders of the theory. I have already referred to the fact that much positive evidence now exists both that butterflies are eaten and that preferences on the part of their enemies exist between one kind and another. I will only remark in passing that the objector on this score sometimes adopts an attitude which is scarcely reasonable, and, perhaps, on that very account is somewhat hard to combat. The kind of objector that I mean begins by saying that the destruction of butterflies by birds and other enemies is not sufficient to give play for the operation of selection. You beg his pardon, and produce evidence of considerable butterfly destruction. To which he replies, "Oh, they *are* eaten, are they? I thought you said they were protected." This is a good dilemma, but the dilemma is notoriously an unconvincing form of argument. If a reply be called for, it may be given like this: "Butterflies are either preyed upon or they are not. If they are, an opening is given for selection; if they are not, it shows the existence of some form of protection." The essence of the matter is that both the likes and dislikes of insectivorous animals, and the means of protection enjoyed by their prey, are not absolute, but relative. A bird that will reject an insect in some circumstances will capture it in some others; it will, for instance, avoid insect A if it can get insect B, but will feed on A if nothing else is to be had; and it is probable that scarcely any insect is entirely proof against the attack of every kind of enemy. The relative nature of protection is readily admitted when the question is not one of mimicry or of warning colours, but of protective resemblance to inanimate objects. All degrees of disguise, from the rudimentary to the almost perfect, are employed; the lower degrees are allowed to be of some service, and, on the other hand, a disguise that is almost completely deceptive may at times be penetrated. This consideration applies also to the objection that the first beginnings of mimetic assimilation can have no selective value. If the rough resemblance to an inanimate object affords some amount of protection, though that amount may be relatively small, why should not the same apply to the first suggestion on the part of a mimic of an approach to the aposeme or warning colour of its model? The position that neither kind of assimilation is of service is intelligible, though not common; but there is no reason why benefit should be affirmed in the one case and denied in the other. There are further considerations which tend to deprive this latter criticism of force; the fact, for instance, that a resemblance to one form may serve as a stepping-stone for a likeness to another; or, again, the existence of clusters, as they may be called, of forms varying in affinity, but embodying a transition by easy stages from one extreme to another. In a case of this sort the objection that may be felt as to two terms in the series arbitrarily or accidentally picked out is seen to be groundless when the whole assemblage is taken together.

Much attention has lately been given to the fact that of individual variations some are transmissible by heredity and some are not; under the latter heading would generally fall somatic modifications directly induced upon the individual by conditions of environment. Whether any other kind of variation belongs to the same category need not for the present purpose come into discussion. But with regard to the undoubtedly transmissible variations, or mutations if we like to call them so, there is, I think, a fairly general consensus of opinion that they need not necessarily be large in amount. A complete gradation, in fact, appears to exist between a departure from type so slight as to be scarcely noticeable, and one so striking as to rank as a sport or a monstrosity. And we know now that where the Mendelian relation exists between two forms, no amount of interbreeding will abolish either type; intermediates, when formed, are not permanent, and if one type is to prevail over the other, it must be by means of selection, either natural or artificial.

In view of all these considerations, I venture to think that there is no reason to dispute the influence of natural selection in the production of these remarkable resemblances. Other interpretations may no doubt be given, but they involve the ignoring of some one or more of the facts. It may fairly be claimed that the theories of Wallace, Bates, and Müller, depending as they do on a basis of both observation and experiment, come nearer to accounting for the facts than any other explanation yet offered. It will, of course, always be possible to deny that any explanation is attainable, or to assert that we ought to be satisfied with the facts as we find them without attempting to unravel their causes. But such an attitude of mind is not scientific, and if carried into other matters would tend to deprive the study of Nature of what, to most of us, is its principal charm. It is quite true that before the validity of any generalisation is accepted as finally and absolutely established, every opportunity should be taken of deductive verification. This has been fully recognised by the supporters of the theory of mimicry, and much has been done to test in this manner the various conclusions on which the theory rests. The verification is not complete, and perhaps never will be, but every successive step increases the probability of its truth; and probability, as Bishop Butler taught, is the guide of life. Meantime it is, one may say, the positive duty of everyone who has the opportunity, to fill up, so far as is in his power, the gaps that still exist in the chain of evidence. Here is an especially promising field for naturalists resident in tropical regions.

Before concluding this address there are two points on which I should like to lay some special emphasis. One is the undesirability—I had almost said folly—of undervaluing any source of information or any particular department of study which does not come within the personal purview of the critic or commentator. "I hold," says Quiller-Couch, "there is no surer sign of intellectual ill-breeding than to speak, even to feel, slightingly of any knowledge oneself does not happen to possess." This is a temptation to which many of us are liable; and falls, I fear, are frequent. It was a matter of sincere regret to me to find one of my most valued scientific friends speaking publicly of the Odes of Horace as a subject comparatively devoid of interest. I can only confess my utter inability to sympathise with my friend's point of view. If he had merely said, "Excellent as those works may be, I have other things to do than to attend to them," I could approve; but that is a different matter. The failing that I speak of is, unfortunately, by no means unknown among scientific men, and is perhaps rather specially prevalent when such subjects as those of my present address are in question. I can recall a very eminent man of science, no longer living, speaking with scarcely veiled scorn of those who occupied themselves with "butterflies in cases." This was in a presidential address to a section of this association. If so little respect is paid by a leader of science to work done in another part of the field, it is perhaps not to be wondered at that one of his Majesty's judges should speak of the formation of a great collection of butterflies—a most valuable asset for bionomic research—as the "gratification of an infantile taste." This or that collector may be an unscientific person, but it would be easy to show that the study of insects in general, and of butterflies in particular, is one of the most efficient of the instruments in our hands for arriving at a solution of fundamental problems in biology.

My second and final point is this: I have not hesitated to affirm my conviction of the importance in evolution of the Darwinian doctrine of natural selection. This necessarily carries with it a belief in the existence and general prevalence of adaptation. I am willing to admit that at times too much exuberance may have been shown in the pursuit of what Aubrey Moore called "the new teleology." "Men of science," it has been said, "like young colts in a fresh pasture, are apt to be exhilarated on being turned into a new field of inquiry; to go off at a hand-gallop, in total disregard of hedges and ditches, to lose sight of the real limitation of their inquiries, and to forget the extreme imperfection of what is really known." This is not the utterance of some cold outside critic, but of a great exponent of scientific method—no other than Huxley himself. It may be true of some of the wilder speculations of Huxley's date. I am by no means sure that there is not truth in it as applied to some of the developments of a later time. But however wide of the mark our suggested explanations and hypotheses may be, the net result of all our inquiries, after the gradual pruning away of excrescences and superfluities, will be a real advance into the realms of the unknown. We may feel perfectly assured that the objections so far brought against our own interpretations are null and void, but we may yet have to give way in the light of further knowledge. "Let us not smile too soon at the pranks of Puck among the critics; it is more prudent to move apart and feel gently whether that sleek nose with fair large ears may not have been slipped upon our own shoulders."[1]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—Under the will of the late Dr. Joseph Wiglesworth, whose interest in bird life is widely known, his ornithological library passes by bequest to the University. This library of more than 1000 volumes, including finely-bound copies of the works of Gould, Seebohm, Dresser, Lilford, Levaillant, and other leading authorities, is probably one of the best in the kingdom. It will be housed in a separate room in the new University buildings, and will be kept up to date. Dr. Wiglesworth gave the residue of his estate to the University after his widow's death for the furnishing and maintenance of this special library. The advantage to a university of facilities for prosecuting specific lines of research can scarcely be overestimated. Situate, as is Bristol, in a district rich in birds, it is to be hoped that the studies to which Dr. Wiglesworth devoted so large a portion of the little leisure obtainable in a busy and fruitful life will be stimulated by a bequest which will serve to keep his own work in remembrance.

CAMBRIDGE.—Dr. A. E. Shipley, Master of Christ's College, has resigned the office of Vice-Chancellor and been succeeded by Dr. Peter Giles, Master of Emmanuel. During his period of office Dr. Shipley devoted himself consistently to progressive measures, and was most active in furthering schemes of scientific importance. He has had two years of very strenuous work under abnormal conditions, and members of the University are grateful to him for the devoted attention he has given to all matters affecting their best interests.

GLASGOW.—During the summer an unusually large number of university lecturers have been promoted to professorial chairs at Glasgow and elsewhere. Prof. Henderson, formerly assistant, and lately professor, at the affiliated Royal Technical College, has been appointed to the Regius chair of chemistry in the University; Dr. T. S. Patterson, Waltonian lecturer, to the Gardiner chair of organic chemistry; Dr. E. P. Cathcart, formerly Grieve lecturer, to the Gardiner chair of physiological chemistry; Dr. C. Browning, formerly lecturer in clinical pathology, to the Gardiner chair of bacteriology; and two other lecturers in the arts faculty have also been promoted to chairs in the University.

The Queen's University of Belfast has elected Dr. A. W. Stewart, lecturer in physical chemistry at Glasgow, to its chair of chemistry, and Dr. T. Walmsley, lecturer in embryology at Glasgow, to its chair of anatomy. Dundee University College (St. Andrews) has appointed Dr. F. J. Charteris, lecturer in pharmacy at Glasgow, to its chair of materia medica, and Dr. J. F. Gemmill, research fellow and formerly lecturer in embryology at Glasgow, to its chair of natural history. Dr. Shaw Dunn, lecturer in clinical pathology at Glasgow, has been appointed professor of pathology in the University of Birmingham. Dr. W. E. Agar, lecturer in zoology and heredity at Glasgow, has been appointed professor of biology in the University of Melbourne. Dr. Leonard Findlay, Gow lecturer in medical diseases of children, has also been

[1] Dowden.

appointed Director of Child Welfare to the International Red Cross organisation at Geneva. Three lecturers in the departments of economics, history, and modern languages have received professorial appointments in other universities.

London.—A course of lectures on "A General Survey of the Globe and its Atmosphere," with practical work, will be given at the Meteorological Office, South Kensington, by Sir Napier Shaw, reader in meteorology in the University, on Fridays at 3 p.m. during the second term, beginning on January 23 next. The informal meetings at the Meteorological Office for the discussion of important contributions to current meteorology in Colonial or foreign journals will be resumed at 5 p.m. on Monday, November 3, 1919, and will be continued on alternate Mondays until March 22, 1920, with the exception of December 29. Students wishing to attend should communicate with the Reader at the Meteorological Office. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission is free by ticket, obtainable on application at the Meteorological Office.

The academic teaching of military science as a subject of curricula for degrees of the University is to be resumed in the session now opening. Some years before the war military science was introduced as an optional subject for the Intermediate and Final Courses for the B.A. and B.Sc. degrees. The syllabuses have recently been revised by the Senate in the light of experience gained during the war, and it is expected that, in view of the large number of students who have gained practical military experience during the war, the subject will attract an increased number of students. The subject can be studied in the University both as a branch of general education and, in the case of candidates for University commissions in the Regular Army, as a preparation for their profession. Both classes of student will be able to obtain practical military training in the University Contingent of the Officers Training Corps. The post-war conditions under which commissions in the Regular Army may be obtained by University candidates have not yet been published.

Sheffield.—Prof. J. O. Arnold, who recently resigned his position as professor of metallurgy and dean of the faculty of metallurgy in the University of Sheffield, has been in failing health for some time, and, much to the regret of the University authorities, he has found himself unable to continue his work. Prof. Arnold was appointed in 1889 professor of metallurgy in succession to the late Prof. W. H. Greenwood at the technical department of the Firth College, which afterwards became a constituent part of University College, Sheffield, and later of the University of Sheffield. The applied science department of the University has kept pace with the applications of science to the steel industry, and taken a prominent part not only in the supply of trained men to these industries, but also in producing in rapid succession a number of valued contributions to the science of metallurgy. Prof. Arnold himself has been an active contributor for many years of valuable papers and researches carried out in the laboratories of his department. In 1912 he was elected a fellow of the Royal Society, and in 1916 a member of the council of the Iron and Steel Institute. He lectured before the British Association during its visit to South Africa in 1905, and he became the first dean of the faculty of metallurgy recently established in the University. His colleagues and friends wish him renewed health and vigour, which they trust may come to him now that he has allowed himself to relinquish some of the strenuous duties which he has performed so successfully for many years.

Dr. Edward Hindle, Kingsley lecturer and Bye fellow of Magdalene College, Cambridge, and assistant to the Quick professor of biology, has been elected to the chair of biology in the School of Medicine, Cairo, Egypt.

Dr. R. H. A. Plimmer, reader in physiological chemistry, University College, London, has been appointed as head of the biochemical department of Craibstone Animal Nutrition Research Institute, which is under the direction of Aberdeen University and the North of Scotland College of Agriculture.

Mr. J. R. Taylor has been appointed to the newly-created post of director of humanistic studies in the Huddersfield Technical College. Mr. Taylor is a graduate of the University of Edinburgh, and for several years past has occupied the position of lecturer to University tutorial classes under the University of Leeds.

News has just reached us of munificent bequests made to educational institutions in the Commonwealth of Australia by the late Sir Samuel McCaughey. Bequests made to the Sydney University, the Brisbane University, soldiers and their dependents, and the Presbyterian Church in New South Wales and Queensland are proportions of the residue of the estate, and the amounts are, therefore, contingent upon the sum realised by the estate. The estimated value of the estate is 1,750,000*l.*, and it is believed that, after certain legacies, amounting to about 230,000*l.*, and the other specific bequests are provided for, the residue of the estate will amount to 1,394,000*l.* Among the specific and the residuary bequests based on this estimate for educational, religious, and charitable purposes, the following are mentioned in the *Sydney Morning Herald*:—Sydney University, 465,000*l.*; Brisbane University, 232,000*l.*; Scots College, Sydney, 20,000*l.*; Sydney Grammar School, 10,000*l.*; North Sydney Church of England Grammar School, 10,000*l.*; Cranbrook Church of England Grammar School, 10,000*l.*; Newington College, 10,000*l.*; and King's School, Parramatta, 10,000*l.* The university bequests are unconditional. The gift to the University of Queensland (Brisbane) will enable that institution to do what it has always wanted to do, and never had the chance of doing: become a university, and more than a place for imparting a certain amount of (chiefly) technical instruction. The political world is rather a troubled one, and the type of Labour Party in power has not taken much interest in higher education. So the University has been cramped for funds, and unable to get much past its initial stage. With the gift to Sydney it is hoped that in a few years' time this institution will be a far bigger force for good than it now is. State education policy has brought secondary education to the people, with the natural result that the University is thronged, and that the buildings have been taxed to the limit of their capacity, the staff, especially on the scientific side, being far too heavily burdened. Now there is a prospect of an end to that condition of affairs, and, as the State will doubtless add to the buildings, the new revenues can go to strengthen the staff and bring in a number of leading men. A great increase in the graduate travelling scholarships is also desired, so that more of the best men of the University may spend some years in England and elsewhere. It is hoped that Cambridge will soon allow a Sydney B.Sc. to enter for the Tripos without making him pass the Little-go.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 15.—M. Léon Guignard in the chair.—E. **Goursat**: Remarks on a problem of vectorial geometry.—H. **Le Chatelier** and B. **Bogitch**: Refractory properties of aluminous materials. In spite of the high melting point of alumina, it has proved in practice to be an unsatisfactory refractory material. Measurements of the resistance to crushing at varying temperatures of alumina bricks, made up in different ways, are given, and it is shown that all become plastic at temperatures between 1200° C. and 1500° C. This explains their failure in steel furnaces, where the temperature exceeds 1600° C. In special types of laboratory furnace, where the material is not required to bear pressure, alumina can be used with advantage, and details are given of the method of building such a furnace capable of sustaining a temperature of 1600° C.—H. **Le Chatelier**: The development of scientific research in the United States.—A. **Foch**: Concerning the period of water-mains with a unique characteristic, furnished with an air-chamber.—L. **Picart** and F. **Courty**: Observations of the Metcalf and Borrelly comets made at the Bordeaux Observatory (38-cm. equatorial). Details of observations made on August 23 (Metcalf), August 31, and September 1 and 4 (Borrelly).—L. **Picart** and F. **Courty**: Further observations on these two comets. Measurements are given for September 5, 9, 10, and 11.—H. **Vanderlinden**: Elements of the comet 1919*c* (Borrelly).—L. **Guillet**, J. **Durand**, and J. **Galibourg**: Contribution to the study of the tempering of certain aluminium alloys. The alloys studied were of the duralumin type, containing about 3·7 per cent. of copper, 0·6 per cent. of manganese, 0·25 per cent. of zinc, and 0·43 per cent. of magnesium. The breaking strain, elastic limit, and hardness all increase with the time after tempering, a remarkable property shown by this alloy alone. The hardness was measured at varying intervals of time after tempering at temperatures of 300° C., 400° C., 450° C., and 500° C., and the transformation point found to lie between 400° C. and 450° C. The increase of hardness with time was only shown when the tempering temperature was above 400° C.—A. **Carpentier**: The fructifications of *Sphenopteris herbacea*.—L. **Daniel**: The stability and heredity of the Cratægomespilus and the Pirocydonia.—V. **Galippe**: The resistance of living intra-cellular agents to the action of certain chemical substances. The microzymas of tissues are not destoyed by glycerol, alcohol, chloroform, or by lapse of time.—M. **Herlant**: New researches on the inhibiting action exercised by the sperm of the mollusc on the fecundation of the egg of the sea-urchin.

BOOKS RECEIVED.

Cattle and the Future of Beef-Production in England. By K. J. J. Mackenzie. Pp. xi+168. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Unexplored New Guinea. By W. N. Beaver. Pp. 320. (London: Seeley, Service, and Co., Ltd.) 25*s*. net.

Spitsbergen. By Dr. R. N. Rudmose Brown. Pp. 319. (London: Seeley, Service, and Co., Ltd.) 25*s*. net.

Modern Engineering Workshop Practice. By H. Thompson. Pp. xi+328. (London: C. Griffin and Co., Ltd.) 9*s*. net.

Catalysis in Theory and Practice. By Dr. E. K. Rideal and Prof. H. S. Taylor. Pp. xv+496. (London: Macmillan and Co., Ltd.) 17*s*. net.

Submarines and Sea Power. By C. Domville-Fife. Pp. viii+250. (London: G. Bell and Sons, Ltd.) 10*s*. 6*d*. net.

An Introduction to General Physiology, with Practical Exercises. By Prof. W. M. Bayliss. Pp. xv+238. (London: Longmans and Co.) 7*s*. 6*d*. net.

Text-book on Wireless Telegraphy. By Prof. R. Stanley. New edition in 2 vols. Vol. i. Pp. xiii+471. Vol. ii. Pp. ix+357. (London: Longmans and Co.) 15*s*. net each vol.

A Practical Handbook of British Birds. Part 4. Pp. 209–272+3 plates. (London: Witherby and Co., September 26, 1919.) 4*s*. net.

DIARY OF SOCIETIES.

TUESDAY, OCTOBER 14.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Lieut. E. W. Pearson Chinnery: Initiation Ceremonies of the Mambare and Kumusi Divisions, British New Guinea.

THURSDAY, OCTOBER 16.

THE INSTITUTION OF MINING AND METALLURGY, at 5.30.—C. M. Harris: Prospecting for Gold and Other Ores in Western Australia.—F. Danvers Power: Coral Island Phosphates in the Making.

OPTICAL SOCIETY, at 7.30.—J. W. French: The Unaided Eye, II.—Chas. W. Gamble: Projection Screens.

TUESDAY, OCTOBER 21.

ZOOLOGICAL SOCIETY, at 5.30.—E. G. Boulenger: Report on Research Experiments on Methods of Rat Destruction at the Zoological Society's Gardens.—Dr. A. Smith Woodward, Prof. F. Wood Jones, Prof. J. P. Hill, Prof. A. Keith, Mr. R. I. Pocock, Prof. G. Elliot Smith, and Others: Discussion on the Zoological Position and Affinities of Tarsius.

CONTENTS.

PAGE
Mathematical Text-books. By Dr. S. Brodetsky . 109
Vagueness and Discrimination. By H. W. C. 110
Iron and Steel Production in Great Britain during the War . . . 111
Our Bookshelf . . . 112
Letters to the Editor:—
Temperature in the Sea.—A. Mallock, F.R.S. . 113
Percussion Figures in Isotropic Solids. (*Illustrated.*)—Prof. C. V. Raman . . . 113
The Rigidity of the Earth.—Dr. A. A. Michelson and Henry G. Gale . . . 114
The "Flying Gallop" in Art.—Dr. B. Laufer . . 114
Museums, Education, and the Board . . . 114
The Coalfields of Spitsbergen. By R. N. R. B. . . 115
Notes . . . 116
Our Astronomical Column:—
Comet 1919*c* . . . 119
A Faint Nova . . . 119
Hindu Spherical Astronomy . . . 119
Stellar Clusters . . . 119
The Aurora of October 1 . . . 119
The Sudan Irrigation Works. By Dr. Brysson Cunningham . . . 120
Colliery Boiler-Plants . . . 120
The British Association at Bournemouth:—
Section D—Zoology—Opening Address by Dr. F. A. Dixey, M.A., F.R.S., President of the Section . . . 121
University and Educational Intelligence . . . 126
Societies and Academies . . . 128
Books Received . . . 128
Diary of Societies . . . 128
(INDEX.)

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THURSDAY, OCTOBER 16, 1919.

THE BANTU LANGUAGES.

A Comparative Study of the Bantu and Semi-Bantu Languages. Sir Harry H. Johnston. Pp. xi+815. (Oxford: At the Clarendon Press, 1919.) Price 3 guineas net.

THE comparatively small number of people in this country who care in the slightest degree about the Bantu languages must long have been aware that this volume was in preparation, and have regretted scarcely less keenly than the author himself the innumerable difficulties which have conspired to keep it from the public. It is to be hoped that the obstacles to the production of the second volume will speedily disappear, as without it a right estimate of the whole work is impossible. It is to contain "an analysis and comparison of the phonology and word-roots, and a comparative examination of the syntax of the Bantu and semi-Bantu languages," and until these are available we shall be compelled to suspend our judgment on many important points.

Even a cursory survey of the first volume, however, fills one with astonishment (when one remembers the author's multifarious activities in other directions) at the amount of patient labour involved in the compilation and arrangement of the 274 vocabularies and the tabulation of prefixes and concords following each group. The three preliminary chapters likewise represent an amount of research out of all proportion to their length, and should be studied by all who wish to become acquainted with Bantu comparative grammar; while even those who want to acquire only some particular Bantu language will find their horizons enlarged and their grammatical path smoothed. That these pages contain some highly controversial—and controverted—propositions does not lessen their value. Bantu studies advance, as did the scholastic learning (no further parallel is intended) by means of continual disputations.

Perhaps the most important of such questions concerns the difference between the prefixes and pronouns, which, though in some cases identical, in others diverge so considerably (*e.g.* *m-* and *yu-* or *a-*, *omu-* and *gu-*) as to make the term "alliterative concord" largely a misnomer. Connected with this is the phenomenon of the initial vowel, or article, which Sir Harry Johnston prefers to call the "preprefix." This, he thinks, has given rise to the pronoun, therein agreeing with Meinhof, but—so far as we can make out—with this difference: Meinhof holds that the prefixes, probably excepting the tenth, consisted of one syllable only—*mu-*, *mi-*, *li-*, *ma-*, etc. To these was prefixed a demonstrative particle of the hypothetical form *γa*, which, through vowel-assimilation and modification or dropping of the consonant, produced in time such forms as *gumu-*, *kumu-*, *umu-*, *gimi-*, *imi-*, *gama-*, *ama-*, etc. (In some cases the consonant, as well as the vowel, was assimilated, giving such forms as *baba-ndu*, *bibi-ndu*, etc.) This "article," or "preprefix," became the pronoun prefixed to the verb.

Sir Harry Johnston's view seems to differ from the above in assuming that the original prefix consisted of two syllables, of which the first afterwards became the subject-pronoun, while the second supplied the object—thus explaining the difference between these in the cases where it exists. But, taking into consideration such a sentence as this, from his *Encyclopædia Britannica* article, "It is possible that some of these prefixes resulted from the combination of a demonstrative pronoun with a prefix indicating quality or number," it is really difficult to distinguish his explanation from Meinhof's.

We must leave to phonetic experts the discussion of the passages with which their science is more immediately concerned—viz. pp. 36–41 and 44; they will probably dissent from some of the author's statements. Even the lay mind is inclined to doubt whether *u* in "but" is the short sound of *a* in "father"; whether the German "ich-Laut" is "almost English *sh*"; and whether the Polish velar *l* ( ) can properly be described as dental. By the "indeterminate labial" (p. 39), bi-labial *f* and its corresponding voiced sounds are probably meant—and these can scarcely be said to result from "indecision on the part of the individual speaker or the tribe as to the utterance of *b* or *w*." Or are we to suppose that the whole Spanish nation halts between two opinions as to the *v* in *huevo* and that in *viejo*? But Sir Harry Johnston has seemed to us, of late, to exaggerate his revolt against pedantry into a too indiscriminate contempt for recent developments of phonetic science, and to fall back on "individual vagaries" or carelessness of pronunciation, somewhat as Socrates accused Anaxagoras of falling back on the *νοῦς*. At the same time, he credits "certain German philologists" with the theory "that we should attribute to the old Bantu some degree of vagueness in consonantal utterance." It is difficult to discover this theory in Meinhof's simple statement that primitive Bantu probably had three stops, all voiceless (*k*, *t*, *p*), and three fricatives, all voiced, *γ*, *l*, *v*. All analogy makes it probable that *γ*, for instance (which still exists in Shambala, where other languages have *g*, *j*, *dz*, *z*, or *y*), should be "the parent of the modern *g*" and some other sounds, but what vagueness of utterance is implied here, more than in any other sound-shifting that could be mentioned? (Meinhof, by the by, nowhere claims *χ*, or in Sir Harry's notation *x*, as "the parent of *k*," though he gives an example of the reverse relation.)

The paragraphs on p. 41 dealing with stress and pitch require some notice. Leaving aside the somewhat confused terminology ("accent *or pitch* of the voice"), we think the statement that the penultimate stress is the "prevailing rule in Bantu" requires some qualification. In Yao and Luganda the accent is on the stem-syllable, not shifting forward when terminations are added (*e.g.* *wángula*, not *wangúla*). The same seems to be the case in Konde and Sango. Again, it is not quite accurate to say that "the use of the high and low tones of the voices for purposes of etymological distinction is not common in Bantu, and is only observable (perhaps) in the Becuana group, and most markedly in the Pañwe languages of the north-west Bantu area." Tones are exceedingly important in Shambala, as Archdeacon Woodward discovered, once they had been pointed out to him; also probably in Konde and Sango; and they certainly exist (no doubt to a greater degree than has yet been observed) in Zulu and Nyanja, to name no others.

The summary, "History of Research into the Bantu Languages," given in chap. i., is exceedingly valuable, and the generous appreciation of work done by predecessors and contemporaries renders it very pleasant reading.

OUR LEGACY OF HOPE.

The Century of Hope. A Sketch of Western Progress from 1815 *to the Great War.* By F. S. Marvin. Pp. vi+352. (Oxford: At the Clarendon Press, 1919.) Price 6*s.* net.

THIS is a historical sketch of the last hundred years, distinctive in its insight and grip and in the place it gives to the development of science and its reactions. The new birth of humanity at the Revolution brought with it a legacy which has been especially expressed in the growth of knowledge and in the growth of freedom. These have had manifold social reactions, as in the political revival of 1815–30, with its increased realisation of the principles of freedom in both domestic and foreign affairs; the socialistic agitation which led on the Revolution of 1848; the practical applications of science, from railways and the telegraph onwards; the diffusion of biological and evolutionist ideas; the demand for schools for all; the increased liberation of religious activity; and the adoption of social reform as a primary objective of government. These are some of the subjects with which Mr. Marvin deals in his vivid and convincing book, and he leads us in conclusion to the international progress which is promised, he thinks, even in the decade of the greatest of wars. "If the war was the greatest, so also was the world-alliance for humanity and international law which brought it to a victorious conclusion. So also, we believe, will the world-union be the greatest, and most permanent, which will arise from the devastated earth and the saddened but determined spirits who are now facing the future with a new sense of hope, which enshrines our sorrows and has overcome our most oppressive fears." Belief in the desirability and practicability of any development is certainly a factor making for its realisation, and "The Century of Hope" shows that this faith is reasonable.

The fine chapter on mechanical science and invention enforces many useful lessons. "The sciences have, broadly speaking, become applicable to useful ends in proportion to the degree in which they have become exact." "Practical applications of science have become more and more abundant in proportion to the mutual aid of the sciences among themselves." The steam-engine "was the fruit of abstract thought applied to practice, and, in its turn, paid back its debt to science by leading to the greatest and most fruitful generalisation which had yet been reached. This was the principle of the conservation of energy, arrived at in 1848." "Society has become, in all these countries where industry has been organised and developed by science, a far more united and stable thing than it was before, or than it is in other regions less advanced in this respect." These sentences illustrate the insight and grip that mark the book. In a few pages Mr. Marvin sketches the development of the evolution-idea from Goethe and Lamarck to Darwin. "The organism in all its parts and with all its instincts was for the first time seen fully as an historical being." "No other part of science, no other episode in the story which we have to trace, affected so powerfully as did the theory of evolution the development of the historical spirit which we distinguished at starting as one of the characteristics of the age. The body of a man is like every social institution, history incarnate, and to Darwin more than to any other the world owes its overwhelming bent for the historical point of view, the desire to know the origins of things, the conviction that it is only by studying their steps that we can arrive at a true comprehension of their nature."

We cannot do more than refer to the lucid chapter on the new knowledge which centres around the discovery of radio-activity, and the inspiring discussion on social and international progress. The book begins and ends with emphasis on the truth that "not economic conditions nor geography nor the ambition of governments is the *primum mobile* in human affairs, but the spirit of man itself seeking greater freedom and expansion." "The spiritual forces are the supreme factors, both in building the individual soul and in giving a common soul to all humanity." "In the history of science and its applications we have the most perfect example of a growing human product in which the diverse races of mankind have all taken a proportionate share as they advanced in civilisation." This is a book that everyone should read, for it shows that from the real world with all its "Hearts of Darkness" we may not unreasonably augur the rising of a Heart of Light.

OUR BOOKSHELF.

Australia: Problems and Prospects. By the Hon. Sir C. G. Wade, K.C. Pp. 111. (Oxford: At the Clarendon Press, 1919.) Price 4*s.* net.

Sir Charles Wade, Agent-General for New South Wales, was Premier of that State during three years especially eventful in the effort to establish State control of wages and industrial unions. His pessimism as to the future of that policy and of the trend of government in this country may be due to the insuperable difficulties he then encountered. The book is based on a series of lectures on the resources and on the industrial and political problems of Australia. The author writes on political questions with expert knowledge. The chapter on the resources of Australia is less trustworthy; thus it says that there is little evidence of a diminishing flow from the artesian wells, in spite of the conclusive evidence to the contrary on the maps of the Queensland Water Supply Department. The exaggerated expectations based on the artesian water near Lake Eyre are also based on incomplete information.

The chapter entitled "Industrial and Social Problems" is probably the most important; it, however, deals only with the attempt to settle some of them by legislation. The author represents the New Zealand attempt to regulate wages by a special law court as a complete failure. He commends the wages boards of Victoria, but considers that system inapplicable where labour is aggressive. The attempt of New South Wales to enforce its labour laws by imprisonment or other penalties he regards as hopelessly impracticable. He shows, on the other hand, that the Australian system of land settlement has been remarkably successful, and the State expenditure on railways and public works a profitable investment. He predicts that the Constitution will be greatly modified in 1921, but does not expect that Australia will accept unification.

The book is a very valuable, up-to-date summary of the trend of industrial legislation in Australia, though the war has so disturbed its development that the conditions now are abnormal. A weighty preface by Sir Charles Lucas refers to the difficulties in the British and Australian comprehension of each other's points of view, and welcomes the book as helpful to that fuller knowledge and closer sympathy which are indispensable for permanent Imperial union.

Resources and Industries of the United States. By Prof. E. F. Fisher. Pp. ix+246. (Boston and London: Ginn and Co., 1919.) Price 3*s*. 9*d*. net.

Prof. Fisher's book is illuminating in that it presents the United States to the reader in such guise as to emphasise the greatness of the progress and the healthiness of the growth of the country. It is addressed to American secondary-school pupils, but merits a much wider public; it is knit together by a doctrine which is new to geography books — the doctrine that human energies should be conserved. The pupils are stimulated to visualise not only the resources and industries, but also the means whereby these may be conserved and made of most use to the community. For example, the United States, which produces two-thirds of the world's petroleum, uses more than it produces because it wastes half the oil that comes from the earth by allowing it to run to waste or to evaporate in open storage tanks. Petroleum is needlessly used to drive engines over 32,000 miles of railroad where electricity could be utilised. The pictures and maps are effective.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Colloid and Saline in Shock and Cholera.

The two letters by Sir Leonard Rogers and Prof. Bayliss in Nature of September 25 are of interest and importance, not only to physiologists and physicians, but also to physical chemists. The two series of observations are not contradictory of each other, but complementary.

There exists in blood plasma and in all living cells a delicate labile balance between the salines or crystalloids and the colloids. These two types of dissolved substances are not present in free condition, but in colloidal adsorption, the one with the other, forming a crystallo-colloidal complex.

This delicate balance is upset in opposite directions in wound-shock and in cholera respectively, saline being in excess relatively to the colloid in the former, and colloid of toxic origin in excess in the latter.

Hypertonic saline is efficacious in cholera because it replaces a defect, and combines with colloids of cells and with toxins which otherwise would combine with each other. In addition, it confers osmotic pressure on the poisonous toxins and hastens them out through the excretory cells. It is, indeed, because of this latter action that its concentration has become subnormal during the attack of cholera.

A colloid like gum-acacia is of no service in cholera, but rather the reverse, because it is an additional claimant for the denuded salines.

On the other hand, after hæmorrhage, as in wound-shock, both colloid and crystalloid are at first diluted, but saline is more fully restored from tissues than the protein colloids. In such circumstances there is no colloid available to hold any hypertonic or isotonic saline which may be injected, and this saline is promptly ejected by the excretory mechanisms; so saline alone is not efficacious. But a colloid of such a type as protein, gelatine, or gum-acacia possesses too great a molecule (or solution aggregate) to be excreted until it is broken down by metabolism, and, in addition to not being able to go out, it anchors salines by passing into labile adsorption with them, and so holds fluid in the vessels, raises pressure, assists the heart by giving fluid to fill it, and saves the cells from denudation of their crystalloids, which beyond a certain point always leads to change in colloidal aggregation and death.

It may be pointed out that such crystallo-colloidal adsorption is likewise the explanation of the important discovery of Ch. Richet, Brodin, and Saint-Girons at Paris that anaphylactic shock can be completely prevented by hypertonic saline. Here also lies the explanation for the prevention of hæmolysis by an active hæmolysin in presence of hypertonic saline as shown some years ago by McCay and Sutherland.

The saline locks up by adsorption the toxin or the immune body, and this can then no longer attack nerve-cells or blood corpuscles.

Under physiological conditions it is this adsorption of saline by colloid which determines the concentration of saline in circulation and cells. This regulation is one of the most ancient in evolution, far more so than regulation of body-temperature, for it holds sway from the teleostean fish to man. Whatever the concentration of the fluid of the external medium in salines from pond-water to sea-water, the salinity of the intimate medium bathing the living cells is always regulated to correspond with between 0·7 and 0·9 per cent. of sodium chloride.

It is strange that the mechanism governing this vital regulation should not have been grasped before. The cells and circulating medium are saturated with colloids, and this amount of 0·7–0·9 per cent. of saline is just the amount the colloids are capable of holding in crystallo-colloidal adsorption. Any more is at once filtered away; any less, and life ceases.

There are many other applications in biology and medicine, but they cannot be treated within the compass of a letter. BENJAMIN MOORE.

14 Frognal, Hampstead.

The Audibility of Thunder.

It has been stated that thunder is not usually heard at a greater distance than about twelve miles. This may be so during the day, but at night it can frequently be heard at a much greater distance from its point of origin. Some years ago I timed an interval between flash and sound over the sea, and found it to be more than two minutes. During the storm of September 5 last my son, Lieut. F. O. Cave, and I timed an interval by a method of counting seconds often adopted by photographers, with which method we were both familiar; one of us made it 140 seconds, the other 141 seconds. The flash was a particularly bright one; we had previously heard fainter thunder corresponding with less bright flashes, which were presumably a good deal further away.

On the night of October 1–2 a thunderstorm passed up-Channel to the south of this locality; any rainfall must have been beyond the Nab and the Warner lightships, as both lights were plainly visible; their distances are 17¾ and 16½ miles respectively if they are in their pre-war positions. With the help of an electric clock, which moves on every half-minute, supplemented by counting seconds, I made one time-interval 120 seconds and another 170 seconds; then with a stop-watch I timed an interval of 189 seconds.

During the storm of October 1–2 the pheasants crowed much more loudly than usual, especially at the early rumbles of thunder, or else the audibility was exceptionally good; probably the latter was the case, as the night was very clear and the air in the valley from which the crowing came would have been colder than the air here, a condition which would probably be favourable for good audibility of sounds coming from the valley, though it would scarcely account for the audibility of the much more distant thunder. It may be worth noting that the false cirrus above the thunder-cloud was lit up by light reflected from the aurora which was extremely brilliant at the time. C. J. P. CAVE.

Ditcham Park, Petersfield, October 6.

OPEN-AIR NATURAL HISTORY.[1]

MR. LOVELL'S book is the outcome of years of patient study, and will be welcome to botanists, entomologists, and bee-keepers. It deals with the inter-relations of flowers and insects, especially as regards pollination; it "treats of plants alive and in the midst of their home surroundings"; it justifies the author's prefatory remark that "the identification of a species should be regarded merely as an introduction and the beginning of a friendship long to be continued." The book is written with enthusiasm and popularly, but it is a scientific record of personal observations of great interest, and it includes some notes on modern theories which should be carefully considered. It is illustrated with conspicuously successful photographs, which have been taken on panchromatic plates to preserve in monochrome the proper colour values.

Beginning with a short historical sketch, in which tribute is paid to Sprengel, Hermann Müller, and Darwin, the author discusses wind-pollinated flowers, the *rôle* of hive-bees especially in relation to blue flowers, the humble-bee's favourite flowers which are mostly irregular in shape, the short-cuts taken to the nectaries, the crab-spiders which lurk in flowers and pounce on the insect-visitors, the "oligotropic" bees that rarely visit more than one kind of flower, the predominantly reddish butterfly-flowers like pinks and some Compositæ, the work of nocturnal moths in relation to flowers like evening primrose and honeysuckle, the fly-flowers like *Linnaea borealis* which is visited by the dance-fly (*Empis rufescens*), and those with nauseous odours like the carrion-flower and the skunk-cabbage, the usually injurious visits of beetles, flowers like wild roses, mulleins, and poppies which are visited for pollen, not nectar.

Mr. Lovell discusses the experimental evidence of the value of having conspicuous flowers and of colour-discrimination on the part of bees. In regard to the latter, however, the discussion is inadequate, for no experiments are conclusive that do not distinguish between colour as such and differences in intensity of illumination. A very interesting general chapter deals with the colours of flowers. Of the 4020 flowering plants in north-eastern America, the greens, whites, and yellows number 3001, while the reds, purples, and blues amount to only 1019. The latter are, on the whole, of more recent origin, and have evolved from the others, the selective agency of insects playing its part. In conclusion, the author discusses the value of bees in connection with fruit-growing, and notably in securing cross-fertilisation, the importance of which is very strongly emphasised.

The author has written a fine book on a fine subject, and his treatment should stimulate further study. We wish that he had been able to devote a special chapter to theoretical considerations, for, though he believes in the transmission of acquired characters, in the efficacy of insects as selective agents, in orthogenesis carrying plants beyond the limits of the advantageous, and in the evolutionary importance of crossing, he says tantalisingly little on these subjects. From an observer of Mr. Lovell's experience we should like to hear more.

(2) Mr. Step has written a delightful book on the industries of insects, which he arranges under headings corresponding with human occupations. He directs attention to the interesting fact that

[1] (1) "The Flower and the Bee: Plant Life and Pollination." By John H. Lovell. Pp. xvii+286. (London: Constable and Co., Ltd., 1919.) Price 10s. 6d. net

(2) "Insect Artizans and Their Work." By Edward Step. (Hutchinson's Nature Library.) Pp. x+318. (London: Hutchinson and Co., n.d.) Price 7s. 6d. net.

(3) "The Seashore: Its Inhabitants and How to Know Them." By F. Robson. Pp. 111. (London: Holden and Hardingham, Ltd., n.d.) Price 1s. 6d. net.

many of the activities are very specific and very intricate, yet there can be no help from parental instruction. "In the vast majority of species the parent is dead long before the daughter comes to that stage of existence when the necessity for making provision for her progeny arises, so the knowledge has to pass by way of transmitted memory. Somewhere in the minute speck of protoplasm constituting the egg of one of the solitary bees there is an infinitesimal particle of nerve matter which contains the secret of how to cut accurate circles and ovals of rose-leaf so that a number of them will overlap and curve into a perfect cylinder. During the greater part of its life the creature that hatches out from that egg will have no need of the secret, but the germ of it will go on developing, and when the insect has attained to the complete bee form there is the idea in the memory cells ready to instruct the nerves that govern the action of wings and legs and cutting jaws." We have quoted this at length, for it expresses Mr. Step's view of the big riddle that lies behind his book. Unfortunately, we do not know how the secret is kept in the egg before there is any particle of nerve matter, or how the insects get the knowledge which forms the contents of the transmitted memory, or whether they really have an idea which instructs the nerves. But the author usually chooses the wise path of keeping to the facts, and gives us a charming account of spinners and weavers, miners and masons, carpenters and wood-workers, upholsterers, wax-workers, paper-makers, tailors, horticulturists, sanitary officers, musicians, burglars, and lamp-bearers. The book is fresh and competent, and the illustrations (two of which are here reproduced) deserve high praise, both the photographs by the author and the drawings by Mr. Carreras.

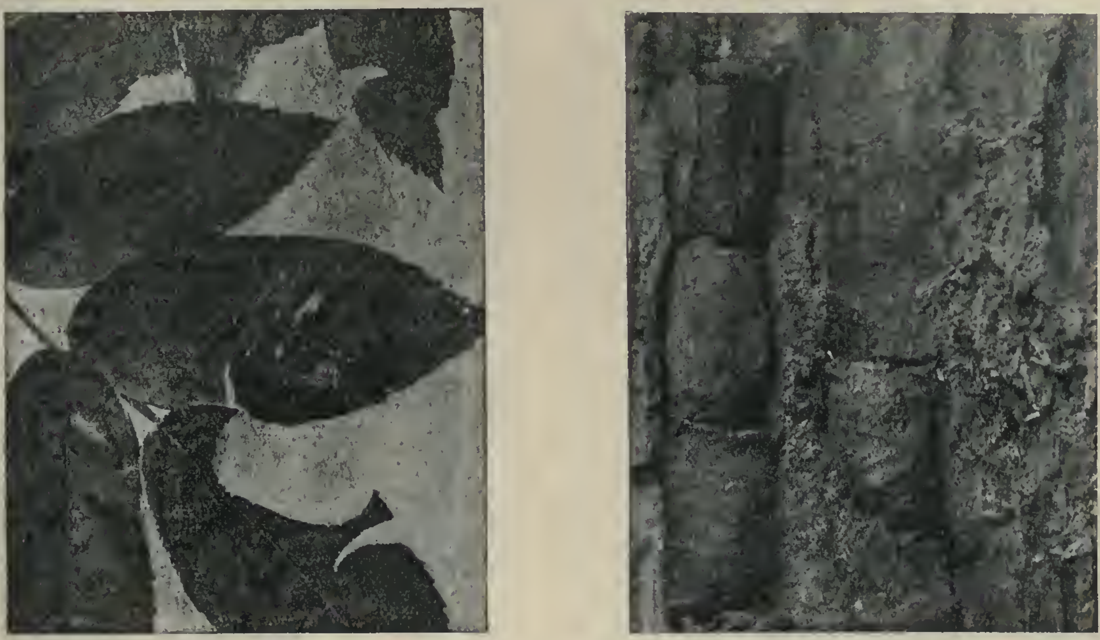

FIG. 1.—Leaf-cutter Bee. The left photo shows the bee at work. The right photo is a section of an old post and shows the thimble-shaped cells made from the cut portions of leaves. From "Insect Artizans and their Work."

(3) Mr. Robson's little book attempts the impossible, and does not succeed. The space is, indeed, inadequate for an interesting account of the inhabitants of the seashore, but it might have been used more skilfully; the illustrations are not very happy; there are several inaccuracies in the brief text; and there are far too many misprints. Several excellent inexpensive guides to the seashore, as much within children's compass as this book is, are readily available.

THE RECONSTRUCTION OF THE FISHING INDUSTRY.

IN November of last year the National Sea Fisheries Protection Association made proposals for a unification of fishery administration, and it embodied these in a "Memorandum" (which was referred to in NATURE of November 28, 1918, p. 248). The memorandum was submitted to Mr. Prothero, who doubtless acquainted the Cabinet with its provisions, but that was all that happened. Eight months afterwards the Government introduced a Bill for the establishment of a Standing Fishery Advisory Committee, and for the removal of the statutory limitation of the salary of the President of the Board of Agriculture and Fisheries!

The 1918 memorandum recommended the creation of a United Kingdom Ministry of Fisheries, but its authors found that they were "up against" the opposition of the Scottish industry. So when a special joint committee of the association prepared a scheme for fishery research, statistics, education, and propaganda they took care to avoid this and other obstacles. They recognised that the only logical way of co-ordinating all British agencies for fishery development was by the setting-up of an Imperial authority; but they also recognised that this ideal was unattainable. Some other statutory body for the co-ordination of research and education would have been agreed upon by the various sections of the British industry, but the committee then found that the fishery Departments were "unlikely to acquiesce in the formation of any central authority other than a Ministry of Fisheries, to be superimposed upon them from without." In the face of *this* formidable opposition the committee had to do the "next best," and, abandoning any really comprehensive way of making use, to the greatest advantage, of all fishery workers, they have made a compromise that may be practicable. In order that as few people as possible may object, they do not recommend the formation of anything in the way of a "Super-Department." Assuming that the existing fishery authorities are to be properly financed and organised as permanent secretariats, and that each of them will then proceed to set up a scientific branch with a director of scientific work, they propose that the three permanent secretaries shall then sit as a joint research board, with such official and non-official assessors as they may nominate. The hope (uncoloured by conviction) is then expressed that the assessors may form the means of communication between the officials, the industry, and the non-official investigators.

The joint research board, so constituted, is not to be, in general, an executive body controlling research. Obviously not, for agreement could not be obtained on points of difference between officials, and departmental privilege would be too great a factor. It is to deliberate on schemes of research and transmit plans and estimates prepared by the departments. But it is recommended that it shall control the collection of fishery statistics, set up a joint editorial board which will publish all results—administrative, statistical, and scientific—in uniform style and with promptitude, and establish and carry on (through an editorial staff) a Fisheries Journal which will be, in the main, popular in character. A strong plea is made for some reform in the manner of publication, for speedy production, for some relief from the exceeding dulness and clumsiness of governmental Blue Books, and for a "break away" from the methods of H.M. Stationery Office.

Considering the things to be investigated, the Committee recognise five categories of research, and set these out in detail: (1) Practical administrative problems to be studied by the departmental staffs; (2) fish culture; (3) industrial research; (4) speculative research; and (5) oceanography. Fish culture is obviously work for the departments, and, since the fishing industry does not seem likely to undertake industrial research itself, this must be done by the Government. Speculative research—a very large category of investigations—ought to be relegated to the universities and marine biological stations, with some other subjects included in the category of industrial research and in that of oceanography. Since the departments must possess and equip sea-going vessels for their practical administrative investigations, it is obvious that they should also carry out the oceanographic observations at sea, but the working up of these should be done by the unofficial State-aided institutions. And so, it is hoped, everybody will be satisfied, and the best use possible made of all the talents.

A provisional scheme for fishery education, training, and propaganda is appended. This includes the training of administrative and scientific officers, and of men occupying responsible industrial posts, by the provision of Government fellowships tenable as post-graduate studentships at the universities; fishery colleges at Liverpool and Aberdeen; fishermen's classes carried on locally and a scheme of fishery apprenticeship. The latter proposals are most interesting. Immediately upon the outbreak of war hundreds of vessels and thousands of men were placed at the disposal of the Admiralty, and, without any special training, the duties of mine-sweeping, patrolling, and escorting were carried out in such a way as to earn loud expressions of admiration and gratitude. There were exceptional losses due to war risks and natural decrease; the training of lads largely ceased during the period of war; the old system of apprenticeship has become obsolete and, in view of naval defence and in the interest of the industry itself, a better class of lad is now desirable. The interesting suggestion is made that a number of the trawl-vessels built during the war by the Admiralty be detailed and equipped as training-vessels, and a scheme of apprenticeship is recommended.

This scheme was worked out in detail by the industry as soon as it was seen that peace was assured. It is an integral part of any attempt at fishery reconstruction and naval defence. It was submitted to the Government nearly a year ago, and it has been "under consideration" ever since then! Meanwhile the Admiralty trawlers are being offered for sale.

Summary of Main Recommendations.

(1) That the Government be requested to provide funds for a comprehensive scheme of research statistics for the fisheries of the United Kingdom on the lines set forth in this report.

(2) That each Fishery Department be provided with a suitable scientific staff under a scientific director with well-equipped laboratories, and with sufficient steamers for research work and for the exploration of our fishing grounds.

(3) That the Fishery Departments be requested to adopt the best means they can devise for securing the uniformity of fishery statistics, and the co-ordination of research work throughout the United Kingdom.

(4) That the Fishery Departments make suitable provision for the publication of scientific reports which

are of importance to the industry, and in particular for the publication monthly of a fishery journal containing all information in regard to scientific results, statistics, statutes, orders, foreign intelligence, commercial information, and all other information likely to be of benefit to those carrying on the industry.

(5) That the Fishery Departments and the Education Departments of the three kingdoms be requested to co-operate in providing a scheme of education on the general lines laid down in the report.

NOTES.

The British Association, as an outcome of the comprehensive review of scientific work during the war, which formed a conspicuous part of the programme of the recent meeting in Bournemouth, has addressed the following resolution to the Prime Minister and the Treasury:—"The British Association for the Advancement of Science, in reviewing the results of scientific method applied to military and other practical arts, recognises that the successful issue of the war has sprung from the efforts of scientific men concentrated on those problems, and with the conviction that the well-being and security of the nation are dependent on the continuous study of such matters, would urge on H.M. Government the necessity for apportioning an adequate sum from that allocated to home administration and the upkeep of the fighting forces for the purpose of a definitely organised scheme of research, as, for example, on problems connected with health, food, and commerce, on explosives, on chemical warfare, and on physical and engineering problems bearing on military work." Similar resolutions, in varying terms according to the special cases, have been forwarded to the First Lord of the Admiralty, the Secretary for War, the President of the Board of Trade, and the Ministers of Health and Food.

The appointment, as recently announced, of Prof. S. J. Chapman to be joint Permanent Secretary of the Board of Trade, owing to the transfer of Sir William Marwood to the Ministry of Transport, will be welcomed by all who know him. Prof. Chapman, who had held the professorship of political economy at Owens College, Manchester, since 1901, acted during the war as head of the temporary Industrial (War Inquiries) Branch of the Board of Trade, and in 1918 was appointed head of a new General Economic Department created for the purpose of assisting the Permanent Secretary in relation to questions involving economic policy. He is a fellow and member of council of the Royal Statistical Society, to the Journal of which, and to that of the Manchester Statistical Society, he has made numerous contributions bearing mainly on the cotton industry of Lancashire.

In the *Times* of October 11 is a letter from Prof. J. Johnstone on the subject of the extension of territorial waters in relation to deep-sea fishing. It is pointed out that the information at present available is not sufficient to enable satisfactory regulations to be drafted, and that, therefore, administrative authorities should not be given legislative powers which they cannot exercise properly. Prof. Johnstone also states that scientific investigation of our sea fisheries has never been properly organised and supported, and is in a worse condition now than it ever was. We agree with him that fishery investigations in this country have been quite inadequate, and we hope in the near future to see the establishment of an organisation for the comprehensive scientific study of the sea, so important for a great maritime nation, on a scale proportionate to the magnitude of our interests.

Changes in the Meteorological Office staff have recently been made, and the following appointments have been announced:—Mr. R. G. K. Lempfert becomes assistant director, and takes general oversight of observations and stations contributing observations to the Office. Mr. Lempfert entered the Meteorological Office in 1902, and has been superintendent of the Forecast Division since 1910. Lt.-Col. E. Gold becomes assistant director, in charge of forecasting. Col. Gold graduated as Third Wrangler in 1902, and was elected Fellow of St. John's College, Cambridge, in 1906; he was Schuster reader in dynamical meteorology from 1907 to 1910, and he then became superintendent of statistics at the Meteorological Office. On the formation of the meteorological section of the Royal Engineers in 1915 he was appointed to the command of the overseas contingent at G.H.Q., France. Capt. D. Brunt is made superintendent of the work for Army services. Capt. Brunt was in the meteorological section of the Royal Engineers during the war, and acted under Col. Gold. Mr. Carle Salter becomes superintendent on the staff of the Meteorological Office for the British Rainfall Organisation. Mr. Salter has recently been assistant director of the British Rainfall Organisation, which has now come under the control of the Meteorological Office.

In connection with the International Meteorological Committee, appointed by the International Conference at Innsbruck, 1905, a meeting of available members was held at the Meteorological Office, London, on July 3–9 last, and a copy of the minutes which have been printed has reached us. Since 1905 the committee has met in Paris (1907), Berlin (1910), and Rome (1913). The July meeting was of a semi-official character, and was really to prepare the way for the Paris meeting, which commenced on September 30. The president, Sir Napier Shaw, in his introductory statement directed attention to the changes caused by the great war, and especially to the new meteorological organisations developed. It was felt that the extent and detail of international co-operation must be much greater in the future than it had been in the past, but the problems are essentially of the same nature as formerly. The great development of aviation has introduced new requirements in respect of information concerning the upper air obtained by pilot-balloons or in other ways. The hours of observation for Europe were considered; 1h., 7h., 13h., and 18h. have become general, but it has been suggested that preference might perhaps be given to 3h., 9h., 15h., and 21h. Consideration was given to North Polar investigation in co-operation with Amundsen's expedition, and there was a proposal for the establishment of a meteorological station in the Island of Jan Mayen for observations from the summer of 1920 to the autumn of 1922. Necessarily much attention was devoted to the coding of messages and to the method and nature of the observations.

The Harveian Oration will be delivered at the Royal College of Physicians by Dr. Raymond Crawfurd on Saturday, October 18, at 4 p.m.

We regret to record that *Engineering* has suffered a severe loss in the death of Mr. B. Alfred Raworth, who had long been a member of the staff, and taken a prominent position in the editorial management during the past thirteen years. Mr. Raworth was a trained engineer, and had considerable experience prior to joining the staff of *Engineering* in 1882. He was a member of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the Institute of Metals.

THE *Engineer* for October 16 records the death of Sir Charles Chadwyck-Healey, who had been intimately associated with our contemporary throughout the greater part of his life. Sir Charles was the only son of the founder of the *Engineer*, and was trained for the Bar, from which he retired after a successful career in 1893. During the war he performed a national service of great utility in fitting out at his own expense the hospital ship *Queen Alexandra*, and commanded her until she was discharged a few months ago.

WE regret to record the death, on October 5, of Mr. G. W. Palmer, who was appointed senior mathematical master and master of the Royal Mathematical School at Christ's Hospital in September, 1911. Educated at Dover College and Trinity College, Cambridge, Mr. Palmer did valuable work as mathematical master first at the Royal Naval School, Eltham, and afterwards at Clifton College, where he became head of the military side. An enthusiast in all matters educational, and a prominent member of the Mathematical Association, he kept in close touch with the best modern ideas on the treatment of his subject. Owing to his strong influence, more time was given to important principles and fresh ideas, while elaborate development in any one direction was avoided or postponed. The result has been that Christ's Hospital boys have shown increased interest in their mathematical work and a high general level of achievement—and this, too, without affecting the standard attained by boys preparing for the universities. During a brief reign of eight years Mr. Palmer accomplished a notable and valuable work of lasting benefit to Christ's Hospital. His death is a very severe loss to the school.

THE Society for the Prevention and Relief of Cancer has issued a pamphlet, "Cancer Research and Vivisection," summarising in tabular form the number of experiments returned by cancer institutes in the last fourteen years. The author holds that animal experiment in cancer is a futile waste of money, and ought to be stopped. Illustrations are reproduced showing infiltrative growth and metastasis-formation in experimental cancer, but the author suggests that experiment can throw no light on these conditions in the human subject. The aims of the society include the provision of hospitals for cancer patients, the statistical study of cancer, and legitimate (*sic*) experiment. No indication is given of what kind of experiments are contemplated, although needles and syringes for animal inoculation are figured in the book. Pamphlets have also been published on the use of violet-leaves and on the influence of tea-drinking. The society has been in existence for seven years, but its efforts seem to have had no effect on cancer mortality.

THE September–October issue of the *Scottish Naturalist* contains some extremely interesting notes by Mr. Donald Guthrie on the birds of South Uist. Among these, Mr. Guthrie remarks of the greylag goose that its wariness baffles description, yet goslings of this species which he hatched out from a clutch of eggs placed under a hen proved as amenable to domestication as ordinary tame geese. In their second year two females of this brood bred near the house without the slightest sign of shyness. A third disappeared for several weeks, then returned with a brood of goslings, and took up her place, accompanied by her family, with the fowls round the house. Her mate, who accompanied her, for a day or two held aloof, but on the third day took his place with the rest and stayed there. Having regard to the interest attached to the oft-discussed theme as to the origin of our domesticated geese, this case is worthy of note.

IN Report No. 1 of the Industrial Fatigue Research Board Dr. H. M. Vernon describes "The Influence of Hours of Work and of Ventilation on Output in Tinplate Manufacture." The tinplate industry is a very strenuous one, especially as concerns the millmen, for they are responsible for rolling out the red-hot tinplate "bars" into thin sheets of steel, which are afterwards tinned. The tinplate mills run continuously from Monday morning until Saturday afternoon, and, as a rule, the men work in eight-hour shifts. If there is a breakdown of machinery or shortage of material, the men are often put on to six-hour shifts instead, and sometimes even on to four-hour shifts, so as to give them all some employment. Consequently one is able to obtain trustworthy evidence as to the effects of such shortened hours on output. Arguing from numerous statistical data collected at a number of tinplate works, Dr. Vernon found that when the men were transferred to six-hour shifts their hourly output went up about 10 per cent., and when to four-hour shifts, it went up 11·5 per cent. This improvement is not so great as would be brought about by a thoroughly efficient system of ventilation, for it appeared that in works without artificial ventilation there was a marked seasonal variation of output, and in the hottest weeks of the year the output was 11–18 per cent. smaller than in the coldest weeks. In the ventilated factories the seasonal variation was much less, but even in them there was plenty of room for improvement. The report is illustrated by photographic reproductions of the millmen under working conditions.

ONE of the commonest and most disfiguring abnormalities of the modern mouth is a forward protrusion of the upper incisor teeth, with which is usually combined a retraction of the chin and a crowding of the lower incisor teeth. On this condition Mr. D. M. Shaw, curator of the Prosthetic Laboratories, Royal Dental Hospital of London, has recently thrown quite a new light (*Lancet*, August 23). He has shown that a certain "perverted functional activity" of the tongue will produce the series of anomalies which dentists have so often to correct in the mouths of modern children—forward protrusion and obliquity in the upper incisors, with retraction and uplift of the lower incisors. Mr. Shaw directs the attention of dentists to the strength with which the tongue can be made to press against the anterior part of the roof of the mouth, particularly behind the upper incisors, thus exerting a much greater power to produce deformity than is used by dentists to correct malposition of the teeth. Tongue-pressure of this nature is particularly common among children, especially when eating soft or pulpy food, being really a form of tongue mastication. This form of mastication appeals to children because it yields a fuller sense of taste if the food is sweet or agreeable than the legitimate use of teeth and gums. The point which is quite new in Mr. Shaw's demonstration is that during the palate-pressure action of the tongue the genio-glossus muscle exerts a retracting action on the chin region of the lower jaw.

A USEFUL article on "The Climate of Liberia and its Effect on Man," by Mr. Emory Ross, appears in the *Geographical Review* for June last. The passages on "European life on the West Coast" in general, on "tropical hygiene," and on "the nervous strain of the tropics" offer conclusive advice to those who may, in an idle moment, have thought of emigration. By immense efforts acclimatisation of the white man might be rendered possible, but at present his relation to the African West Coast "can be only one of tolerance."

THE manganese ores of the Shimoga and adjacent districts are interestingly described by Mr. B. Jayaram, Senior Geologist to the Department of Mines and Geology of Mysore (Records, vol. xvi., part 2, 1917). The author suggests that percolating waters have brought the manganese, and the iron with which it is always associated, from the silicates of the basic chloritic schist series, and have deposited the ores as a replacement of the limestones and grits in which they are now found. The rocks termed limestone and grit are not true sediments, but secondary products of an igneous complex.

ATTENTION was directed to the magnesite deposits of Canada in NATURE, vol. c., p. 490, 1918. Those of Bulong, north-east Coolgardie goldfield, are now described by the Geological Survey of Western Australia (Bulletin 82, 1919). The magnesite, which is in numerous veins a few inches wide, has arisen from the decomposition of a great band of serpentine, and it is suggested that augite as well as olivine has supplied the magnesium required for its formation. The silica set free is probably responsible for the capping of "siliceous laterite, usually opaline in composition," which is stated to occur in the magnesite areas. The value of the magnesite is estimated at *1l.* per ton on the ground, the export value being nearly *4l.* per ton.

ONE of the means by which supplies of potassium compounds were eked out during the war period was the recovery of potassium salts from the flue-dust which occurs as a waste product in the manufacture of Portland cement. The principal methods employed depended upon treatment of the flue-gases by water-sprays or by a process of electrical precipitation. An account of the various installations devised for the purpose has been published by the Department of Mines, Ottawa (Bulletin No. 29, "Potash Recovery at Cement Plants"). It contains descriptions of the recovery systems developed at a number of cement factories in the United States, together with an historical review of the whole question and full references to the literature of the subject.

ATTENTION may be directed to a useful series of articles on the mechanical handling of chemical materials, by Mr. G. F. Zimmer, which have recently appeared in the *Chemial Age* (Nos. 10 to 15). It has been remarked that chemical works in this country are rather poorly equipped with labour-saving machinery. In present circumstances, when the cost of manual labour has increased so greatly, it may be necessary to pay more attention than formerly to devices which will reduce this cost. The articles in question will help to show how this may be done. They are illustrated, and well worth consulting by chemists in charge of factories.

MESSRS. LUMIÈRE AND SEYEWETZ have published in the *British Journal of Photography* (October 3, Colour Supplement) a simplified method for the development of autochrome plates. The developer is prepared of two degrees of concentration, so arranged that if the weaker is applied first to the plate, the time that is taken in producing the first outlines of the image (neglecting the sky) will be exactly the time that the stronger solution will require to complete development. Although a watch or clock may be used for the timing, a simple sand-glass has many advantages. The sand is started running when the weaker solution is applied, then on the first appearance of the image the glass is put on its side; the weaker solution is poured off and the stronger poured on, and the sand-glass put upright. When the sand has flowed back again the development is complete. In the formula given the concentrations of the developers are as 1 to 10.

SIR CHARLES BRIGHT read a paper on "Inter-Imperial Communication, through Cable, Wireless, and Air Methods," before the Section of Economic Science and Statistics at the Bournemouth meeting of the British Association. He pointed out that it is conceivable that national and imperial interests can be adequately provided only by the State controlling at least one complete cable to all points of the British Empire, supplemented by an all-British wireless chain. The recently established Telegraph Communications Board, first urged by the author seventeen years ago, is intended for generally controlling and developing inter-imperial telegraphic and aerial communication in national and public interests. By this scheme all the Government departments concerned (strategic as well as civil) are represented by delegates, who meet periodically to discuss and settle all matters germane to the subject. This should do much towards improving the previously existing arrangements by which the Post Office alone represented the Government. Besides increased cable and wireless facilities being necessary and the war devastations made good, it is highly desirable that improved methods of message condensation should be introduced so as to get the best results from existing facilities. The field open to inter-imperial air communication is considerable; air organisation and air routes are amongst the important questions of the day, and it is suggested that all aerial mail communications should be rationed.

AN important paper on the theory and use of radio-direction-finding apparatus by Capt. A. S. Blatterman, of the U.S. Army, appears in the Journal of the Franklin Institute for September. It is known that in radio stations it is sometimes possible to hear signals when the antenna is disconnected from the apparatus. Hence the passing waves induce sufficient electromotive forces in the coils of the receiver to produce audible signals. An investigation was therefore carried out in the U.S. radio laboratories in 1917 and 1918 to find out the most efficient shape of coil to receive signals directly. As the loudness of the signals varies with the position of the coil, an investigation was also made of the most efficient shape of coil for direction-finding. Elementary theory would lead us to suppose that the coil would be more effective the larger its cross-section and the greater its time-constant. It would also appear that the loudness of the signals is inversely proportional to the square of the wave-length. This, however, is not the case. The experiments recorded in this paper prove that there is a certain size of coil which gives the best results for a given wave-length. This was traced to the fact that the resistance of the coil varies with the wave-length. For very long wave-lengths the resistance has its ordinary value. As the wave-length is shortened, and therefore as the frequency is increased, the resistance increases slowly until it is two or three times its ordinary value, and it then increases with great rapidity. This effect makes the reception bad at high frequencies. There is, therefore, a certain sized coil which produces the best effects. The results of the experiments described prove this conclusively. A thorough investigation is also given of the directional characteristics of this type of receiver, and many curious properties depending on its height above the ground were discovered. Using a properly constructed coil in an ordinary room and a seven-stage amplifier, the signals issued by all the high-power European stations could easily be heard.

OUR ASTRONOMICAL COLUMN.

Ephemeris of Comet 1919*b*.—Messrs. Braae and Fischer Petersen give the following continuation of this ephemeris (for Greenwich midnight) in *Ast. Nach.*, 5008:

	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ
Oct. 17 ...	11 55 29	8 55 N.	9·6856	9·9440
21 ..	12 3 20	5 10		
25 ...	12 12 36	1 36 N.	9·7225	0·0289
29 ...	12 22 44	1 43 S.		
Nov. 2 ...	12 33 18	4 47 S.	9·7962	0·0932

The comet is in perihelion October 16·9, so it should still be an interesting object, though its distance from the Earth has greatly increased. It is rather inconveniently placed in the morning sky, but observations of position are much desired.

The Albedo of Saturn's Rings.—The *Astrophysical Journal* for July contains a paper on this subject by Mr. L. Bell. It is considered that the very high albedo of the brighter parts of the rings indicates that much of the matter forming them exists in the form of optical dust of dimensions comparable with a wave-length of light. Mr. Bell quotes the familiar fact that many substances appear of a lighter colour when powdered than when in large blocks. He gives 15 km. as the thickness of the main parts of the rings, slightly greater at the outside of ring B and the inside of ring A. He suggests that there are dust-clouds of exceedingly small density on each side of the ring-plane, to explain the nebulous patches seen when the ring is edgewise. He points out that light-pressure would come into play in the case of this fine dust, and help in its diffusion. It is supposed that there are some larger lumps in the main rings, and by a combination of dynamical and optical arguments he fixes their diameters as being of the order of 3 metres. Mr. Bell makes use of Prof. Barnard's photographs, and also of those of Prof. Wood in monochromatic light.

The Selection of Sites for Astronomical Observatories.—The importance of studying atmospheric conditions before choosing sites for observatories intended for work of a delicate character on the sun or planets is becoming increasingly recognised. Prof. W. H. Pickering gives some interesting details of the station established by the Harvard Observatory at Mandeville, Jamaica, altitude 2000 ft. (*Popular Astronomy*, August–September). The air is of such extraordinary clearness that the star γ Volantis, magnitude 3·7, is frequently visible to the naked eye, although its maximum altitude is 1° 40′. A photograph is reproduced, taken with a small stationary camera, which shows a very clear trail of β Carinæ, altitude 2° 40′.

Prof. Pickering's experience, contrary to the impression of many astronomers, is that the seeing is at its best when the air is heavily charged with moisture. It will be remembered that much work on Mars has been done at Mandeville in recent years.

FORTHCOMING BOOKS OF SCIENCE.

Agriculture and Horticulture.

Edward Arnold.—Gardens: Their Form and Design, Viscountess Wolseley, illustrated. *Cassell and Co., Ltd.*—The Garden Month by Month, H. H. Thomas, illustrated; Garden Handbook for Beginners, H. H. Thomas, illustrated. *Constable and Co., Ltd.*—Forests, Woods, and Trees in Relation to Hygiene, Prof. A. Henry, illustrated.—*Hodder and Stoughton.*—Chemistry and Bacteriology of Agriculture, E. J. Holmyard, illustrated (The New Teaching Series of Practical Text-books). *Hutchinson and Co.*—Gardens of Celebrities and Celebrated Gardens, J. Macgregor, illustrated. *Macmillan and Co., Ltd.*—Science and Fruit Growing: Being an Account of the Results Obtained at the Woburn Experimental Fruit Farm since its Foundation in 1894, the Duke of Bedford and S. Pickering. *John Murray.*—Conifers and their Characteristics, C. C. Rogers. *Oxford University Press.*—Effects of the Great War upon Agriculture in the United States and Great Britain, Prof. B. H. Hibbard; United States Forest Policy, J. Ise.

Anthropology and Archæology.

W. E. Harrison (Ipswich).—Pre-Palæolithic Man, J. Reid Moir. *Hutchinson and Co.*—The Ruined Cities of Northern Africa, Dr. R. Sturzenbecker, illustrated. *Macmillan and Co., Ltd.*—An Introduction to Anthropology: A General Survey of the Early History of the Human Race, Rev. E. O. James; The Ila-Speaking Peoples of Northern Rhodesia, Rev. E. W. Smith and the late Capt. A. M. Dale, 2 vols., illustrated; Among the Natives of the Loyalty Group, Mrs. E. Hadfield, illustrated. *John Murray.*—Travels in Egypt and Mesopotamia in Search of Antiquities, 1886–1913, Dr. E. A. Wallis Budge, 2 vols., illustrated. *Oxford University Press.*—James Tod's Annals and Antiquities of Rajasthan, edited with an introduction and notes by Dr. W. Crooke, 3 vols., illustrated.

Biology.

A. and C. Black, Ltd.—Outlines of the History of Botany, Prof. R. J. Harvey Gibson. *Cassell and Co., Ltd.*—Under-water Glimpses of Animal Life, Dr. F. Ward, illustrated. *Constable and Co., Ltd.*—The Sea Fisheries, Dr. J. T. Jenkins, illustrated. *Hodder and Stoughton.*—Applied Botany, G. S. M. Ellis, illustrated (The New Teaching Series of Practical Text-books); The Book of a Naturalist, W. H. Hudson; The Mason Wasps; The Sacred Beetle; The Story Book of Birds and Beasts; and The Story Book of Science, each by J. Henri Fabre, translated by A. Teixeira de Mattos. *Henry Holt and Co. (New York).*—The Development of the Chick, Prof. F. R. Lillie, new edition. *J. B. Lippincott Co.*—In Monographs on Experimental Biology and General Physiology: The Nature of Animal Light, Prof. E. Newton Harvey; The Chromosome Theory of Heredity, Prof. T. H. Morgan; Inbreeding and Outbreeding: Their Genetic and Sociological Significance, E. M. East and D. F. Jones; Pure Line Inheritance, Prof. H. S. Jennings; The Experimental Modification of the Process of Inheritance, Prof. R. Pearl; Localisation of Morphogenetic Substances in the Egg, Prof. E. G. Conklin; Tissue Culture, Prof. R. G. Harrison; Permeability and Electrical Conductivity of Living Tissue, Prof. W. J. V. Osterhout; The Equilibrium between Acids and Bases in Organism and Environment, Prof. L. J. Henderson; Chemical Basis of Growth, Prof. T. B. Robertson; and Co-ordination in Locomotion, A. R. Moore. *Longmans and Co.*—A Naturalist's Sketch Book, A. Thorburn, illustrated. *Methuen and Co., Ltd.*—Iron Bacteria, D. Ellis, illustrated. *Oxford University Press.*—Fungal Diseases of the Common Larch, W. E. Hiley, illustrated. *Bernard Quaritch, Ltd.*—Essays in Early Ornithology, J. R. McClymont, illustrated. *G. Routledge and Sons, Ltd.*—The Wonders of Insect Life, J. H. Crabtree, illustrated. *S.P.C.K.*—Joseph Dalton Hooker, Prof. F. O. Bower (Pioneers of Progress: Men of Science). *Witherby and Co.*—A Geographical Bibliography of British Ornithology, H. Kirke Swann, W. H. Mullens, and F. C. R. Jourdain; A Handbook to the Vertebrate Fauna of North Wales, H. E. Forrest; The Birds of France, C. Ingram; A Practical Handbook of British Birds, in parts; Monograph of the Pheasants, W. Beebe, vol. ii.

Chemistry.

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THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY PROF. L. W. LYDE, M.A., PRESIDENT OF THE SECTION.

The International Rivers of Europe.

THIS subject was chosen before the publication of the Treaty of Peace, and was dictated by a wish to combine my geographical creed with the political conditions of an "Americanised" Europe. The Treaty embodies so many of the principles which I wished to emphasise that my treatment should perhaps now be rather historical than political.

My geographical faith is in Outlook; the jargon of to-day is about Leagues of Nations. This is the day of nations and nationalities, and geographers must rejoice in the fact, because civilisation depends on a blend of varied influences—each an individual element, a *genius loci*—and the triumph of nationality must curb that tendency to a drab cosmopolitanism which would crush out all such variety. But these varied influences cannot blend into a progressive civilisation unless they have all possible facilities for friendly meeting; for instance, international rivers should not be, like international finance, anti-national, but really inter-national, "between nations," common to all nations, and encouraging the friendly meeting of diverse political elements and ideas. Liberty always makes for differentiation—in nations as in individuals; and if our international intercourse becomes really "free," the desired variety is guaranteed.

That is why I should like to press the truth that Outlook is, or ought to be, the motto of geography. It is so for many of us, and it ought to be for all. But the word covers both a process and an objective. The outlook is essentially over big Mother Earth; the process is visualisation—the picturing of forms and forces, places and peoples, beyond the horizon, all possible horizons being included in the one great unit of the globe. But the geographical interaction of the man and the place cannot be dissociated—least of all in political geography—from the historical interdependence of group and group. Both alike are concerned with progress. We want to know, therefore, the whole simple truth—what the particular features and phenomena mean as world-features and world-phenomena, *not* what special meaning can be read into them, or extracted from them, by some local and interested political unit. Geography is, first of all, the visualisation of the world and the relations of the various parts of that world.

Now, the one predominant feature of the earth's surface is not land, but water. Nearly all international problems to-day have to do, explicitly or implicitly, with the ocean, *i.e.* with access to cheap water transport on the medium which covers three-quarters of the whole surface of the earth. Even the problem of Alsace-Lorraine, itself perhaps purely a land problem, conceals—especially from the Swiss point of view—a problem of access to the sea; and the problems of Poland, of Italy, of Jugo-Slavia, are obviously sea problems, or sea problems very slightly disguised.

It is a truism that the ocean attracts rivers and their trade and their riverine population. Industry, commerce, even culture, have been starved and stunted in various parts of the world by lack of easy access to the sea. Even your League of Nations idea has more than once approximated to a substantial fact—round the Mediterranean and round the Baltic, facilitated by inter-national or inter-racial rivers. The Hanseatic League was essentially based on the relation of a number of more or less navigable rivers to an inland sea, and that was why it came to include such distant "inland" members as Breslau and Cracow.

Accessibility is now more than ever before a supreme factor in all cultural and economic development, and rivers are still the chief natural intermediaries between land and sea. The first real international attempt to solve the problem of international rivers followed the victory of sea-power over the France of Napoleon the Great; the second has followed the victory of sea-power over this would-be "Napoleon" of Prussia.

Now, I submit that to many of us the mere word "river" by itself suggests, at once and primarily, a physical unity—no doubt, with some variety of relief and climate—and that on this physical unity we are prepared to sanction some social and economic, and even political, unity. But directly you add the qualifying "international," the suggestion changes; the adjective raises a picture not of local features, but of regional relations.

In recent years I have pleaded for the use of rivers as political boundaries—on the ground that they clearly separate lands without at all separating peoples except in time of war; we want to preserve the valuable variety of political and cultural units, but to draw the various units together. Our object is unity, not uniformity. The proposal has been objected to—even by some who are not at heart hostile to the idea of fostering all possible aids to the easy, honourable, friendly intercourse of peoples—on the ground that rivers shift their courses. They do, and trouble has come of this in the past, political trouble as well as economic. The Missouri was a fertile source of inter-State squabbles. But no normal person would *choose* a mud-carrier, like the Missouri, as a political boundary unless there was marked difference of racial type or nationality running approximately along the line of the river. In fact, I would suggest that the troubles along the Upper Missouri were really due to the fact that the river was *nowhere* an inter-State boundary, and therefore each State claimed the right to monopolise it in the particular section. If it had been an inter-State boundary from the first, such a claim would have been obviously absurd. And it was the iniquity of the claim to monopoly that forced the United States, as similar conditions forced the Australian Commonwealth, to take over the control of the inter-State rivers.

The principles behind the control are significant. Thus the Murrumbidgee is entirely within New South Wales, as the Goulburn is entirely within Victoria; but the Murray is an inter-State river—in a double sense, acting as the boundary between New South Wales and Victoria, and emptying through South Australia. New South Wales has entire use of the Murrumbidgee, and Victoria of the Goulburn, but the whole volume of the Murray up to normal low-water level is left to South Australia. In Europe navigation is usually far more important than irrigation. Why should not Europe exercise similar control over the navigable rivers of Europe?

For, geographically, great navigable rivers are essentially a continental feature, *i.e.* really a world feature, for all major continental features must be included in a survey of world features, even if they are minor world features; and the world can recognise no right of a political unit to regional monopoly of the commercial advantages of such a feature to the disadvantage of other political units—least of all, others in the same region. As with the irrigation, when a river is obviously and entirely within an area where identity of culture and sentiment proclaims a natural or national unit, then that unit has a claim—even if it should prove impolitic to press it—to some monopoly of the facilities afforded by that river. But when the river runs through or between two or more such natural or national units, *i.e.* is really international, one of the units has no claim to any monopoly against the other or others.

It was reasonable that expanding Prussia should get to the mouth of the Elbe, and it was certain that Holstein had been both a fief of the Holy Roman Empire and in the German Confederation of 1815, and that succession in Holstein could *not* go in the female line. It was equally certain that Schleswig had never been in either the Holy Roman Empire or the German Confederation, and that succession in Schleswig *could* go in the female line. The reasonable sequel in 1864 would have been for Prussia to purchase Holstein from Denmark, and share the facilities of the international river.

One would not expect such a view to be taken by a Prussian, but that was the actual principle laid down by France nearly one hundred years earlier. The famous Decree of November 16, 1792, asserted that:—"No nation can, without injustice, claim the right to occupy exclusively a river-channel, and to prevent the riparian States from enjoying the same advantages. Such an attitude is a relic of feudal slavery, or at any rate an odious monopoly imposed by force." This was not mere talk. It was followed in 1793 by the complete freeing of the Scheldt and the Meuse to all riparians—France herself being a riparian in each case, for the Scheldt was naturally navigable up to Valenciennes. Somewhat similar rights were extended in 1795 to all riparians on the Rhine—France herself, of course, being again a riparian; and in 1797 the freedom was extended, so far as France was concerned, to the ships of foreign nations, though Holland was able to make the privilege valueless.

The original Decree had not pressed the precise question of internationality. But if the general principle holds—that a great navigable river cannot be monopolised by a single political unit against riparians, even if they are its subjects and of alien "race," still more must it hold when the river in question is fully international, flowing through or between two or more States. Of course, the Rhine, Danube, and Vistula do both.

As a matter of fact, in Europe this principle has been generally accepted for the last century except by Holland. Prussia and Saxony agreed about the Elbe in 1815, and the agreement was extended to Austria, Hanover, and Denmark in 1821. Prussia, Hanover, and Bremen made a similar agreement about the Weser in 1823; and Spain and Portugal made similar agreements about the Tagus and the Douro in 1829 and 1835. Holland, however, has a tarnished record.

One has not an atom of sympathy with the arrogant German demand that "small nations must not be allowed to interfere with the development of great nations, "least of all with that of the greatest of nations," and that Holland, simply on the ground of her small size, should be robbed of her three estuaries in the interest of Germany. But neither has one an atom of sympathy with the Dutch habit of taking advantage of that small size to behave in a mean and unreasonable way on the assumption that no Power except Germany would use force against such a little people. I would like to illustrate the position by an analysis of the problem on a canal, for one must include straits and canals with rivers. Their inclusion may involve some difficulty, but in the most serious case the difficulty is already largely solved. I refer to the Panama Canal during the second year of the war, when British shipping was exactly half as large again as U.S.A. shipping, amounting to very nearly 42 per cent. of the whole traffic. The total result of the war, however, has been a loss of more than 5,200,000 tons of British shipping, involving a reduction of 13·5 per cent. in our carrying power at sea, while the U.S.A. tonnage has increased by nearly 6,730,000 tons, *i.e.* an increase of 382·1 per cent. in the U.S.A. sea-going tonnage (June, 1919).

The case which I propose to analyse is that of the Terneuzen Canal, and I wish to press it with all possible emphasis, because it shows a typical case of quite natural—and, therefore, almost pardonable—human selfishness, and its supporters are guilty of an extraordinary blindness to their own mercantile *advantage.*

Ghent is the second port in Belgium and the first industrial town in Flanders. In the days before the separation of the two countries it was connected with Terneuzen, *i.e.* "open-sea" navigation on the Scheldt, by a canal twenty miles long, of which rather more than half was in "Belgian" and rather less than half in "Dutch" territory, the actual sea connection being, unfortunately, in the Dutch territory.

At the time of the Franco-Prussian War the Belgians decided to enlarge the canal, but had to *waste eight years* in obtaining the consent of the Dutch to the undertaking. Even then the consent was given only on the condition that the Belgians should pay for all work done by the Dutch, give an annual grant of some 13,000*l.* for the upkeep of the new works, and grant Terneuzen reduction of rates on Belgian railways! Some twenty-five years later it became necessary again to enlarge the canal; this was begun in 1895 on condition that Belgium again paid all the cost, that the Dutch had the right to close the locks "whenever they deemed it useful to safeguard Dutch interests," and that various other concessions were granted, *e.g.* about the Antwerp-Rozendaal railway; and the complete agreement was signed in 1902. The total cost was 1,600,000*l.*, a large proportion being spent *on the canal port at Terneuzen*; but the control is entirely in the hands of the Dutch; the Belgian part of the canal is both broader and deeper than the Dutch part, and the larger Belgian boats even now cannot reach Terneuzen! That is to say, after all the cost, the concessions, the delay, etc., the trade of Ghent is still hampered and may be cut off at any moment. Of course, the stupidity of the Dutch in thus crippling their own trade is unpardonable; but what about Belgium? Even then her boats have only reached the Scheldt—a river of little use to Holland, but vital to Belgium.

The case is important, because the two nations have lived together in peace in spite of the serious "international servitude" of Belgium, and because practically everything that Holland has done has been quite legal. Dutch officials claim that "Belgium has enjoyed absolute freedom of navigation"; that "Belgium has in no way been made to feel that she had to use the waterway of a neighbour to get access to the sea"; and that "Holland has been perfectly right in asking Belgium to pay for improvements on a canal which admittedly (!) serves almost exclusively Belgian interests." To a Belgian this is mere mockery. And I submit that, if Belgium has to pay almost the entire cost, she ought to have also almost the entire control; that the traffic is very profitable, the tonnage of Terneuzen being relatively larger than that of any other Dutch town, even Rotterdam; that part of the cost has been due to the canal having formed part of the Dutch polder system; and that, under international control, the total cost would have been met out of the profits on the traffic.

Further, I submit that, although the waterway was originally not artificial at all, but a distributary of the Lys, navigation has *not* been free for Belgium. Facilities have been both denied and delayed. Denials have been rare; but the Dutch refused, in 1907, to forgo customs formalities on cargoes moving only and directly between Ghent and Antwerp, and they have refused to provide fog-signals or beacons at Terneuzen. Preposterous delays have been more or less normal. For instance, the request about the customs was made in January, 1906, and was refused in January, 1907; a request for permission to dredge a sandbank, made on November 11, was granted on the following September 17; and another made on July 9 was granted on December 2.

Even the dimensions on the Dutch part of the canal have prevented any real freedom of navigation. These dimensions were originally agreed upon by a mixed body of experts, and accepted almost verbatim by the Dutch Government in 1895. They were modified in 1902, though the 1902 Convention was not ratified; and, thus modified, the scheme of 1895 was completed in 1910. Now, under international control, it would have been completed much sooner; all unnecessary formalities due to riparian sovereignty would have been avoided; all necessary safety would have been immediately provided for, *e.g.* by dredging or fog-signals; and all improvements would have been adopted on their merits. In the absence of international control Belgium has been subject, as I have indicated, to serious "international servitude," which has involved her in heavy costs and continual annoyances. Yet Holland has, practically from first to last, acted with perfect legality. (I intentionally exclude the undoubted illegality of the closing of the Scheldt in August, 1914, the transport of excessive quantities of sand and gravel for German use during the war, and the free passage through Limburg granted to the retreating German armies.) But if the other things referred to are legal, it is high time that they were made illegal.

It has been typical, too, that when the Dutch have granted any facilities, it has been done by a specific treaty, *i.e.* done as a matter of policy, not of justice. It was from this point of view that they agreed to the Lek and the Waal being recognised as the proper mouths of the Rhine. This emphasis on policy rather than on justice has not, however, been confined to Holland, though she alone still adheres to it. In Europe, in America, in Africa, and even in Asia, there have been, first, attempts to enforce a so-called political right of sovereignty against neighbours, *e.g.* on the Mississippi by Spain, on the St. Lawrence by us, on the Amazon by Brazil, on the Zambezi by Portugal, and then special conventions somewhat on the lines of a treaty of commerce. Such treaties grant commercial facilities, and power of navigation is such a facility; but if the navigation is on a great continental feature, such as an international river, surely the particular facility should be admitted *without* any special treaty.

This claim has been specifically put forward on several occasions. For instance, by the Treaty of Paris (1763) we had the privilege granted to us of "navigation on the Mississippi to the sea," and "*to* the sea" meant "*out onto* the sea." When the river passed under the control of the United States, the conditions were altered. Spain had granted no such facility to them, and she claimed the *political* right to block the estuary against them, while Jefferson claimed that they had a *natural* right to use the whole river, *i.e.* had such a "right in equity, in reason, in humanity." The same question arose on the St. Lawrence, where we claimed the political right to block the lower river against the United States in 1824. The case is specially important because Adams at once admitted the *political* right, *i.e.* the riparian "sovereignty," but claimed—as Jefferson had done—a *natural* right to use the river itself, a right which he based on necessity and on the support of the political Powers of Europe as formulated in many conventions and agreements and commercial treaties.

There had been so many of these that it had become possible to generalise as to a common principle—really the principle of justice; and so the Treaty of Paris in 1814 and the Congress of Vienna had adopted the principle, and had passed general rules in sympathy with it—rules which have been applied to many rivers and even to canals, *e.g.* in the old Kingdom of Poland. In the particular case of the St. Lawrence the water right would not cover any right of portage; but, of course, the international boundary comes to this river from New York State below the last of the rapids.

In 1851 Brazil claimed the political right to block the mouth of the Amazon, but this was universally condemned as a gross misuse of the right of riparian sovereignty, for the mouth of the Amazon is so truly an arm of the sea that it separates two distinct faunas; and, as the Plate was declared free in 1852, Brazil could not in decency exercise her dubious "right." It was not formally given up, however, until 1867; and it lies implicity behind the recent so-called "concessions" to Bolivia.

Portuguese law raised a similar difficulty in 1883 on the Zambezi. Of course, Portugal was our oldest ally, and our relations were very friendly; but, though she neither controlled nor traded with the interior, she claimed the political right to block the estuary against us, and we admitted the *political* right so far as to consent to her imposing duties—which, in theory, might have been prohibitive of all trade.

The Zambezi is specially interesting because it was concerned with one of the first of those land-corridors about which there has been so much discussion lately—the "Caprivi finger." Everyone except our lawyer-politicians knew the real object, the certain meaning, and the probable result of our conceding that strip to Germany—though most of us pictured German troops marching eastward along it to cut the "Cape-to-Cairo" route in Rhodesia, rather than Rhodesians riding westward into Ovamboland. But theoretically the Germans made a demand for access to navigable water on an international river, and we recognised this as a reasonable demand, and granted it. Here, again, we stand historically in a position of great moral strength. Further, if we accept international land-corridors and international air-corridors, we must accept also international water-corridors, such as a navigable river or a narrow strait.

I do not want, however, to press an African example, partly because I do want to repudiate entirely the application of the Berlin Conference to any rivers outside Africa. For in 1884 Africa was essentially a virgin continent, and its inhabitants were completely ignored—in theory by all the deliberators, and in practice also by the nation which had engineered the conference. For one of Germany's essential objects was to converge on the Congo, and squeeze out Belgian interests; and eventually, to do that, she did not hesitate to employ the most unscrupulous propagandists in this country on "Congo atrocities." It was, therefore, part of her scheme to press—what was accepted by the conference—that the Congo should be open to all flags for all commercial purposes, and that *no riparian rights* should be recognised. It was equally to her interest that the International Committee of Administration agreed upon should never be set up, and it never has been; and, of course, in 1911 she used the trouble which she had provoked in Morocco to acquire 100,000 square miles of the French Congo, so that she became a territorial Power in the west as well as in the east of the Congo basin.

The whole question has two aspects—(1) the freedom of the actual navigation, and (2) the administration of the river. The former is largely a matter of equity, and so did not appeal to the Dutch or Portuguese lawyers; the latter is largely a matter of law, and has been much complicated by legal subtleties. But the two are closely connected, for the European rivers with which we are specially concerned, all have a lower course over the plain and an upper course involved in the folds and blocks of Central Europe. They are, therefore, important in the one case merely as carriers by water, and—all things considered, and in spite of superstitions to the contrary—are probably dearer as well as less flexible than the carriers by rail that cross them from west to east; thus the quantity of foodstuffs that reached Berlin—or New Orleans—by water in 1913 was quite insignificant. In the other case, however, they are of supreme importance, for their valleys focus the whole commercial movement, *e.g.* of Switzerland, both by rail and by water. This puts the people of the upper river-basin commercially at the mercy of the holders of the lower; at least a third of the Swiss imports before the war were from Germany, and a fifth of the exports went to Germany—much, in each case, under what the Swiss felt as "compulsion."

In this particular case the people of the Rhine delta were also—politically—at the mercy of the Germans. For the natural outlets of the Rhine basin, such as Rotterdam and Antwerp, had taken on naturally the international character of all great ports, while the river-towns behind them, such as Cologne and Frankfort, were nurseries of intense national feeling, most carefully and criminally fostered by the Government with the declared object of presently imposing that "nationality" upon the "internationalised" port. One way of entirely undermining a position offering such opportunities to the unscrupulous is international control, with its impartial improvement of the waterway *on its own merits.* Thus in 1913 nothing like 1 per cent. of the navigation on the Rhine was British, while more than 65 per cent. was Dutch; but the deepening of the Rhine up to Basel to admit sea-going vessels, *e.g.* from London or Newcastle, would instantly free the Swiss from their slavish dependence on *e.g.* Westphalian coal.

It is the political aspect, however, rather than the economic that I want to press for the moment. The economic aspect is useful only because it can be presented more easily in a statistical form, while the historic—though equally, if not more, illuminating—cannot be applied to recent events. We can see now that Peter the Great did not provide "a gate by which [his] people could get out to the Baltic," only one by which foreigners got into Russia; but we cannot have similar knowledge of the political value to Bohemia of the economically invaluable Elbe-Moldau. We can note, however, that it is essentially a way *out*, for the quantity of down-stream traffic (*e.g.* lignite, sugar, grain) is five times that of the up-stream traffic (*e.g.* iron, cotton, oils).

The agreements already mentioned, with regard to Elbe and Weser, Tagus and Douro, show that freedom of navigation has been granted as a reasonable courtesy for many years by nearly all civilised Powers, though even to this day Holland has persistently blocked progress by her stupid commercial policy and her unique position at the mouths of Rhine and Maas and Scheldt; and the essential principles are illustrated by the irrigation laws of Australia and the United States, where everyone now admits that the individual State cannot have any local standing, any riparian claims, as against the Commonwealth. All States, whatever their size or wealth or population, must be equal, though the natural advantages are with the upper riparians for irrigation as with the lower riparians for navigation.

The serious administrative difficulties are two—concerned respectively with the riparian sovereignty and with the different geographical conditions of different rivers or different parts of the same river; *e.g.* you can easily decrease the pace of the Rhine above Mannheim, but not without increasing the susceptibility to frost.

Historically, riparian sovereignty, in the case of Rhine and Danube, is only a relic of feudal robbery. When they first became part of the civilised world under Rome, there was no such thing as riparian sovereignty. They were public property, which had to be kept in order and improved; and for this purpose the Romans exacted dues, which were spent wholly and solely on the upkeep of the waterway. The Franks continued the same custom on the Rhine, but the feudal system brought in a horde of petty princelings—as impecunious as German princelings have normally been—who completely upset the old *régime*, converted public into private property, and exacted every kind of tax and toll. Unfortunately, because Rhine and Danube had been frontiers for Rome, they had been associated with a strictly military control, and the legacy of this favoured the feudal princelings—as it also helped to poison the whole political development along both rivers, for they got only the worst side of Roman civilisation. Now we must go back to the primitive conditions. If an international river is a world feature, then its world relation is the first consideration. In that case riparians must tolerate representatives of the whole world, or of such parts of the world as are most concerned with the particular river, on the executive for the administration of the river. In most cases, moreover, riparian sovereignty must be limited, even in the interests of the riparians themselves, for the presence of non-riparians on the executive may be, and has been on the Danube, of the greatest value in minimising friction amongst the riparians. In this respect France has played a most honourable part, generally supported by Britain, especially on the Danube, where, *e.g.* Austria tried to exclude Bavaria from the deliberations about the river, and to dominate and intimidate the representatives of the lower riparians. Indeed, it was only "the day before yesterday" that we had the gratification of reading the German decision to "exclude French and British representatives from the Danube Commission on the ground that they had hindered the ships of the more important nations from obtaining *priority* of treatment." What greater compliment could have been paid to us?

The fact only emphasises the vital point referred to above, that different parts of the same river have different conditions and may need different treatment, *i.e.* that even riparians have not all naturally equal use of the river, and that the strongest or the most favourably situated can grossly misuse their opportunities. The Dutch showed this on the Rhine in 1816, and the Austrians on the Danube in 1856. Obviously such differences are, in themselves, potential causes of serious trouble; riparians have not necessarily and naturally real equality even when the executive consists of only one representative from each riparian State. The greater opportunities of expansion, political and economic, on the lower river may favour the growth of a stronger Power; and the State with the largest share of the river or the best position on it has already an advantage over the others. For instance, the Dutch on the Maas and the Russians on the Danube have indulged in "voluntary negligence"; it was in this way that Russia blocked the mouth of the Danube, and that Holland made it impossible for the Belgians to *continue* their commercial navigation on the Meuse down through Holland to the sea, though since the discovery of coal in Limburg the Belgians have—stupidly—turned the tables on Holland to some extent. A low riparian may no more monopolise or ruin navigation on the lower course of a river than a high riparian may poison or exhaust its upper waters. The river is a unit, and its unity is essential to the fulfilling of its duties in the evolution of world commerce; and, therefore, it needs a unity of administration. This is best secured by a commission of riparians and non-riparians, and such conditions facilitate the use of a river as a political boundary.

Nearly all the important details involved in the internationalising of navigable rivers have been illustrated already in the history of Rhine and Danube, and in both cases France has been an admirable guide to Europe. On the Rhine, as I have mentioned, she abolished in 1795 most of the restrictions which had made the river practically useless even to riparians; and that she was not thinking only of her own interests was proved by her attempt—defeated by Holland—to extend the freedom of the river to all nations in 1797. Again, in the Convention of Paris (1804) France enforced unity of administration—sharing this with Germany on the ground that the river was of special concern to herself and to Germany, as she has shared the administration of the Niger with us in recent years on the same ground.

The Rhine thus received a simple, just, uniform administration, which is a model for us now. All tolls were abolished except two—one on the boat and the other on the cargo—which were to be only large enough to meet the upkeep of the waterway, and were to be used for no other purposes. These tolls could be paid in each political area with the coin of that area, but a fixed ratio was maintained between the various coinages.

Of course, in 1815 France was ousted from the bank of the river; and in the reorganisation elaborated by the Congress of Vienna von Humboldt, the Prussian representative, adroitly introduced into the regulations for the Central Commission of Riparian Representatives words which were afterwards made to mean exactly the opposite of the freedom enforced by France, and exactly the opposite of what our British diplomats at the time thought and said that they meant! Not only so, but during the sixteen long years while France remained more or less submerged, Holland was allowed to make the whole scheme ridiculous by the claim that "to the sea" did not mean "out onto the sea," and that a tidal estuary was "sea." The Regulations of Mainz gave each riparian State full sovereignty over its own part of the river, and limited the right of pilotage to the subjects of riparian States; and in 1868 the Regulations of Mannheim further whittled down the old liberal principles of France—to the disadvantage of non-riparians, although they were admitted to rights of navigation. The revised Rhine Navigation Treaty of that year was still in force in 1913, administered by the six riparian States—Holland, Prussia, Hesse, Baden, Bavaria, and Germany (as owning Alsace). Even since 1871 Prussia, as the strongest Power, has hampered the development of non-Prussian ports, using even the most childish tricks with pontoon bridges, choice of wharves, accessibility to rail, etc., against other German States.

Since 1871, too, the Rhine has illustrated another important point—namely, that the traffic on an inland waterway depends largely, perhaps vitally, on the extent to which railways are willing or forced to co-operate; and this has a present importance even from a purely international point of view. One of the results of the Franco-Prussian War was that Prussia bought up a number of private railways in the Rhine valley, and eventually used the profits of the transaction to make a secret fund for aggressive purposes. Now, if properly administered as an international waterway, the Rhine will be perfectly free except for trifling dues on boat or cargo for the expenses of upkeep; and it will compete so favourably with the Prussian railways that their rates will have to be reduced to a minimum. This will cut hard at such differential treatment as has handicapped British trade in the last twenty years, and it will leave no surplus with which the unscrupulous can juggle.

Of course, the Rhine is essentially linked with the Meuse and the Scheldt—politically, economically, historically; and the Powers have long been too lenient or too timid with Holland, possibly because her purely *legal* position appeals to lawyer politicians. The Dutch base their claims to monopolise the estuary of the Scheldt on the Treaty of Munster (1648), but have greatly strengthened their legal position in recent years. The marriage of the Dutch Queen to a German princelet was followed immediately by the intrigue that ended in Belgium definitely granting to Holland in 1892 special rights on the Scheldt in time of war, and Germany strongly supported Holland in getting these rights extended between 1905 and 1908. But the Scheldt is merely an international river; it is navigable into France, and it was only by France waiving her claims in 1839, and proposing a dual control by Belgium and Holland—like that of the Rhine by France and Germany at the beginning of last century, and that of the Niger by France and ourselves now—that Holland ever obtained the power which she has abused. When Napoleon annexed Antwerp, he declared the Scheldt free; and the Rhine Regulations, when extended to the Scheldt, were interpreted as meaning "free for all flags out onto the sea." Even so, the Dutch raised every possible difficulty, and navigation had no fair chance until the railway from Cologne to Antwerp brought in the only kind of influence which the Dutch seem to understand.

We have, therefore, full knowledge of all the essential conditions necessary to ensure the proper administration of international rivers, and shall have no kind of excuse if we are caught napping or misled by plausible and "interested" tricksters. Amongst their last tricks is "the great difficulty of policing such a river, where a German boat may be stopped by a French official." That is not more terrible than a Rumanian boat being stopped by an Austrian official; and the experience on the Danube shows that there is really no difficulty at all—for the simple reason that offenders are always dealt with, naturally and reasonably, by officials of their own nation, just as the various European Powers have the right of jurisdiction over their own subjects in the Belgian Congo. In Article 25 the effete and pharisaical Berlin Act of 1884–85 provided that its regulations for the Congo "shall remain in force in time of war." To-day we are less ambitious, and desire only to further safe, easy, honourable intercourse, in time of peace, between nations that are unequal in size and population, wealth and power, situation and relation to navigation facilities. We have seen that one small nation may ill-treat another small nation from stupidity almost as easily and as grossly as a large nation may ill-treat a small nation from tyranny. In the circumstances it seems necessary to remove from both the stupid and the tyrannical the opportunities for misusing such facilities; and the obvious way of doing this is to make international rivers international in use and in government. Commerce is already a prime factor in the evolution of human brotherhood. Progress towards that ideal may be gauged as well by the price of a banana or a piece of chocolate as by the number of sermons preached on the subject; the sea is already free, made so mainly by British perseverance in clearing it of pirates; it only remains to make navigable rivers equally free, and the opposition comes mainly from those who have talked most loudly about "the freedom of the seas." But "the freedom of the seas" does not means that war is to be removed only from that element on which land-power is weak, while the land-power may still block access to the free sea by the natural avenue—the navigable river.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—On October 10 Mr. A. J. Balfour was duly elected to the office of Chancellor of the University in succession to the late Lord Rayleigh.

DR. ROBERT J. T. BELL, of the University of Glasgow, has been appointed to the chair of pure and applied mathematics in the University of Otago.

THE National Union of Scientific Workers is holding a social evening at 52 St. Martin's Lane, W.C.2, on Thursday, October 30, at 7.30, to inaugurate a London branch of the Union. The meeting will be open to all scientific workers.

THE Lord Strathcona legacy to Yale University, which amounts to about 120,000*l.*, will, *Science* announces, be used as follows: Two professorships in the graduate school will be established, and several fellowships founded, and a memorial building, costing about 50,000*l.*, will be built.

DALHOUSIE UNIVERSITY, Halifax, Nova Scotia, celebrated the centenary of its foundation (1818) on September 11, 12, and 13. Representatives were present from a large number of universities and learned bodies. On September 11, in the Macdonald Memorial Library Hall, President A. S. MacKenzie conferred the degree of LL.D. *honoris causa* on the following gentlemen, those marked with an asterisk being *in absentia*:—David Allison, ex-President of the University of Mount Allison; R. B. Bennett, Calgary; the Right Hon. Sir Robert L. Borden, Prime Minister of Canada *; the Hon. W. J. Bowser, Victoria, B.C., ex-Premier of British Columbia *; G. S. Campbell, Halifax, chairman of the Board of Governors, Dalhousie University; C. H. Cahan, Montreal; T. Cantley, New Glasgow; Dr. M. Chisholm, Halifax; the Hon. Robert E. Harris, Chief Justice of Nova Scotia; H. P. Judson, President of the University of Chicago; the Most Rev. Neil MacNeill, Archbishop of Ontario, Toronto*; I. Pitblado, Winnipeg; the Right Rev. John Pringle. Sydney, Moderator of the General Assembly of the Presbyterian Church in Canada; H. S. Pritchett, President of the Carnegie Corporation of New York*; Prof. W. T. Raymond, University of New Brunswick, Fredericton; S. N. Robertson, Principal of the Prince of Wales College, Charlottetown, P.E.I.; J. Gould Schurman, President of the University of Cornell*; J. Seth, professor of moral philosophy in the University of Edinburgh; F. H. Sexton, Principal of the Nova Scotia Technical College, Halifax; the Rev. Prof. Simeon Spidle, Acadia University, Wolfville; J. Stewart, Halifax; the Rev. Prof. J. J. Tompkins, St. Francis Xavier College, Antigonish; and Dr. F. Woodbury, dean of the faculty of dentistry, Dalhousie University, Halifax. The celebration was a great success in many ways; it was made the occasion of a reunion of old graduates dating back to classes as remote as 1852. Besides a procession of representatives of as many of the classes as could be got together, there were a dinner, a dance, a smoking concert, a regatta, and amateur theatricals. Addresses on the future of the University were given as follows:—On arts and science, by Prof. H. L. Stewart (philosophy); on law, by Prof. MacRae, dean of the faculty of law; on medicine, by Prof. Fraser Harris (physiology), dean of the faculty of medicine; and on dentistry, by Dr. Frank Woodbury, dean of the faculty of dentistry. The urgent need of increased endowments, and, especially in the professional schools, of increased equipment as well, was urged by the speakers. There is a large increase in the number of those entering for the coming session, but the University revenues are as in pre-war days.

The second annual Streatfeild memorial lecture was delivered by Prof. G. T. Morgan at the Technical College, Finsbury, on October 2. In the course of his remarks on "Applied Chemistry in Relation to University Training," Prof. Morgan surveyed the progress of technical education in London from the pioneer college at Finsbury, through the polytechnic movement, to such recent developments as the Imperial College of Science and Technology and the Salters' Institute of Industrial Chemistry. The view which advocates the concentration of instruction and research in applied science into a single large institute, having the status of a specialised university with power to grant degrees in technology, was contrasted with that whereby the technical colleges are to be brought into closer union with the existing University of London. Prof. Morgan pointed out that fundamentally and so far as college training is concerned there is no distinction between pure and applied chemistry. The great generalisations of chemical science must, in any case, be mastered before the student can hope to become competent to enlarge the field of knowledge. Ultimately the difference between university and technical college becomes one of breadth of outlook. In extending the research section of the chemical department at Finsbury, the City and Guilds of London Institute had, during the difficult period of the war, done much to render practicable Streatfeild's ideal of a school of applied chemistry. This objective was an intimate blending of practical elementary training for beginners with specialised investigation in various branches of industrial chemistry carried out by research chemists and other post-graduate workers sent to the college by interested chemical firms. At the present time when considerations of economy are paramount, this mode of developing a technical college of university rank has the merit of involving the least outlay of capital on the part of the educational body, inasmuch as the cost is borne to a considerable extent by those benefiting from the additional facilities.

SOCIETIES AND ACADEMIES.

Sydney.

Linnean Society of New South Wales, July 30.—Mr. J. J. Fletcher, president, in the chair.—Dr. R. J. **Tillyard**: Mesozoic insects of Queensland. No. 6: Blattoidea. The paper deals with eleven specimens from the Ipswich Trias, of which nine are named, being placed in three new genera belonging to the family Mesoblattinidæ, Handl. This family occurs from the Carboniferous onwards to the Jurassic, but reaches its dominant position in the Lias. One of the Ipswich genera, Triassoblatta, n.g., is more archaic than any of the known Liassic genera; while a second, Samaroblatta, n.g., shows close affinity with Mesoblattula, Handl., from the Lias of Dobbertin. The author deals with the venation of the cockroach tegmen, and shows the main lines of its evolution from the Carboniferous onwards. The Ipswich specimens, though none of them are absolutely complete, are, on the whole, very well preserved, so that details like intercalated veins, cross-venation, etc., can be easily made out if present. Most of the tegmina are of moderate size, about 13 mm. or 14 mm. long; but there is one species of Triassoblatta that is much larger. Keys are given for distinguishing the genera and species described, and each new species is figured in the text.—Dr. R. J. **Tillyard**: Studies in Australian Neuroptera. No. 8. Revision of the family Ithonidæ, with descriptions of a new genus and two new species. The members of this family are stout-bodied, moth-like Lacewings, very distinct in their appearance, habits, and life-history from any other representatives of the order. Owing to the inadequacy of Newman's original description of *Ithone fusca*, much confusion has been caused, and two species that were not really even congeneric have been regarded as this species. The doubt as to which was Newman's species had to be cleared up by reference to the type in the British Museum. It was then found that Ithone, Newm., with one radial sector in forewing, is a monotypic genus, all the other species going either into Varnia, Walker, which McLachlan erroneously suppressed, or Heterithone, n.g. (type *Ithone fulva*, Till.). Two new species of this latter genus are described, making in all a total of six species for the family. The genus Nespra, Navás, is suppressed, being the same as Varnia, Walker. A description of the peculiar sand-plough of the female Ithonidæ is given; the insect uses it to plough up the sand when ovipositing. A note is added describing the imaginal mouth-parts, and comparing them with those of the Psychopsidæ. The full life-history of Ithone, which is very remarkable, the larva being a blind melolonthoid grub, is reserved for another paper.—Dr. A. J. **Turner**: Revision of Australian Lepidoptera. Part vi. (last instalment). In this paper fifty-nine species belonging to twenty-six genera (fam. Geometridæ, subfam. Boarmianæ) are dealt with, eighteen species and five genera being described as new.

Royal Society of New South Wales, August 6.—Prof. C. E. Fawsitt, president, in the chair.—G. J. **Burrows**: Volume changes in the process of solution.

The paper contains figures showing the change in volume which takes place when two liquids are mixed or when a solid is dissolved in a liquid. These results are discussed, and also the change in volume which results from the solution of a solid in a mixture of two liquids. A much smaller contraction is observed when a solid is dissolved in a mixture of water and alcohol than when it is dissolved in either of the liquids separately.—G. M. **Bennett** and E. E. **Turner**: Note on organo-metallic derivatives of chromium, tungsten, and iron. Organic compounds containing iron in direct union with carbon play an important *rôle* in animal and plant chemistry, and have an interesting future in connection with pharmacology. An attempt has been made to prepare such compounds, and a few preliminary experiments have been carried out also on similar compounds of chromium and tungsten.

CAPE TOWN.

Royal Society of South Africa, August 20.—Dr. J. D. F. Gilchrist, president, in the chair.—Sir Thomas **Muir**: Note on a sum of products which involves symmetrically the *n*th roots of 1.—C. v. **Bonde**: Note on some abnormalities in the Cape crawfish (*Jasus lalandii*). An account was given of some peculiarities observed among specimens procured for laboratory use in the Zoological Department of the University of Cape Town.

BOOKS RECEIVED.

A Laboratory Manual for Elementary Zoölogy. By Dr. L. H. Hyman. Pp. xvi+149. (Chicago, Ill.: The University of Chicago Press; Cambridge: University Press, 1919.) 1.50 dollars.

A Field and Laboratory Guide in Biological Nature-Study. By Prof. Elliot R. Downing. (The University of Chicago Nature-Study Series.) Pp. 120. (Chicago, Ill.: The University of Chicago Press; Cambridge: University Press, 1918.) 1 dollar.

The Hydrogenation of Oils: Catalyzers and Catalysis and the Generation of Hydrogen and Oxygen. By Carleton Ellis. Second edition, thoroughly revised and enlarged. Pp. xvii+767. (London: Constable and Co., Ltd., 1919.) 36*s*. net.

The Manufacture of Chemicals by Electrolysis. By Arthur J. Hale. (A Treatise of Electro-Chemistry.) Pp. xi+80. (London: Constable and Co., Ltd., 1919.) 6*s*. net.

Insect Pests and Plant Diseases in the Vegetable and Fruit Garden. By F. Martin Duncan. Pp. 95+xii plates. (London: Constable and Co., Ltd., 1919.) 3*s*. 6*d*. net.

The Teaching of Science in the Elementary School. By Gilbert H. Trafton. (Riverside Text-books in Education.) Pp. x+293. (New York: Houghton Mifflin Co.; London: Constable and Co., Ltd., 1919.) 6*s*. 6*d*. net.

Problems of Cosmogony and Stellar Dynamics. By J. H. Jeans. Pp. viii+293+plates v. (Cambridge: At the University Press.) 21*s*. net.

Petrology for Students. By Dr. A. Harker. Fifth edition. Pp. viii+300. (Cambridge: At the University Press.) 8*s*. 6*d*. net.

The Nature of Enzyme Action. By Prof. W. M. Bayliss. Fourth edition. Pp. viii+190. (London: Longmans and Co.) 7*s*. 6*d*. net.

Kingston-upon-Hull Before, During, and After the Great War. By T. Sheppard. Pp. 120. (London and Hull: A. Brown and Sons, Ltd.)

The Condensed Chemical Dictionary. Compiled and edited by the Editorial Staff of the Chemical Engineering Catalogue. Pp. 525. (New York: The Chemical Catalogue Co., Inc.) 5 dollars.

Annuaire de l'Observatoire Royal de Belgique, 1920. Pp. vi+353. (Bruxelles: Hayez.)

Hidden Treasure: The Story of a Chore Boy who Made the Old Farm Pay. By J. T. Simpson. Pp. 303. (Philadelphia and London: J. B. Lippincott Co.) 6*s*. net.

Applied Economic Botany Based upon Actual Agricultural and Gardening Projects. By Dr. M. T. Cook. Pp. xviii+261. (Philadelphia and London: J. B. Lippincott Co.) 7*s*. 6*d*. net.

The Amoebae Living in Man. By Prof. C. Dobell. Pp. vi+155+plates v. (London: John Bale, Sons, and Danielsson, Ltd.) 7*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 16.

THE INSTITUTION OF MINING AND METALLURGY, at 5.30.—C. M. Harris: Prospecting for Gold and Other Ores in Western Australia.—F. Danvers Power: Coral Island Phosphates in the Making.

OPTICAL SOCIETY, at 7.30.—J. W. French: The Unaided Eye, II.—Chas. W. Gamble: Projection Screens.

TUESDAY, OCTOBER 21.

ZOOLOGICAL SOCIETY, at 5.30.—E. G. Boulenger: Report on Research Experiments on Methods of Rat Destruction at the Zoological Society's Gardens.—Dr. A. Smith Woodward, Prof. F. Wood Jones, Prof. J. P. Hill, Prof. A. Keith, Mr. R. I. Pocock, Prof. G. Elliot Smith, and Others: Discussion on the Zoological Position and Affinities of Tarsius.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 5.30.—Arnold Philip: Some Laboratory Tests on Mineral Oils.

WEDNESDAY, OCTOBER 22.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 8.—Thos. Clarkson: Presidential Address.

FRIDAY, OCTOBER 24.

PHYSICAL SOCIETY, at 5.—Dr. N. W. McLachlan: The Effect of Pressure and Temperature on a Meter for Measuring the Rate of Flow of a Gas.—J. H. Shaxby: A Cheap and Simple Micro-balance.—J. W. T. Walsh: The Resolution of a Curve into a Number of Exponentials.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. E. Hopkinson: Presidential Address.

CONTENTS.

	PAGE
The Bantu Languages	129
Our Legacy of Hope	130
Our Bookshelf	130
Letters to the Editor:—	
Colloid and Saline in Shock and Cholera.—Prof. Benjamin Moore, F.R.S.	131
The Audibility of Thunder.—Capt. C. J. P. Cave	132
Open-air Natural History. (*Illustrated.*)	132
The Reconstruction of the Fishing Industry	133
Notes	135
Our Astronomical Column:—	
Ephemeris of Comet 1919*b*	138
The Albedo of Saturn's Rings	138
The Selection of Sites for Astronomical Observatories	138
Forthcoming Books of Science	138
The British Association at Bournemouth:—	
Section E—Geography—Opening Address by Prof. L. W. Lyde, M.A., President of the Section	141
University and Educational Intelligence	146
Societies and Academies	147
Books Received	148
Diary of Societies	148

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THURSDAY, OCTOBER 23, 1919.

FACTS AND FACTORS OF EVOLUTION.

The Causes and Course of Organic Evolution: A Study in Bioenergics. By Prof. John Muirhead Macfarlane. Pp. ix+875. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 17s. net.

THIS book is the outcome of a lifetime of biological reflection and investigation, and will be read with much interest. The author, who left Edinburgh for Philadelphia many years ago, was early disciplined in zoology, as well as botany, but it is to the latter that he has especially devoted himself as professor in the University of Pennsylvania. His treatise is erudite and careful, very instructive, even apart from its theories; it expresses the convictions of a patient and independent thinker; it states a number of piquant conclusions more or less peculiar to the author; and it is carefully written. It covers a very wide range—the origin of organisms upon the earth, the phylogeny of plants and animals, the evolution of morals and man, the ethical factor in organic evolution, the rôle of religion in the ascent of man, the competitive and the co-operative systems among animals and in mankind, the human environment as it has been and is, and the evolution yet to come. We must restrict our attention to a few of the salient features.

(1) Prof. Macfarlane notes that "energy, continuity, and evolution," which may be said to constitute "the triune basis of existence," form the keynote of his book. But all that is distinctive is the prominence given to "energy." The author recognises a series of forms of energy, which he calls thermic, lumic, tonic, chemic, molic or gravic, electric, biotic, cognitic, and cogitic. Biotic energy is associated with protoplasm in general, cognitic with chromatin, and cogitic with neuratin or Nissl substance. The terms "cognitic" and "cogitic" are far from happy, and it is of dubious utility to apply the physical concept of energy to certain aspects of vital activities which remain undescribed when a physical and chemical formulation has been given of the others. If it could be definitely stated—as it cannot—that the particles which ultra-microscopic examination shows in movement in a living nerve-cell are associated with a particular kind of energy, distinct from and yet in a line with such recognised energies as heat and electricity, then there would be an objective basis for a form of positive vitalism, similar to that held by some modern biologists, such as Prof. Marcus Hartog and the late Prof. Richard Assheton; but more evidence of the reality of "biotic energy" is required than Prof. Macfarlane adduces—more evidence than the usually admitted inability to give an adequate description of the most characteristic features of the activities of living creatures in physico-chemical terms. The living organism is a riddle imperfectly read, but our confidence in Prof. Macfarlane's contribution is not increased when we find two or three more particular forms of energy piled on the top of biotic.

(2) The author has discovered, he thinks, overlooked factor in organic evolution, which he calls proenvironment—"the resultant response of an organism to the sum-total of all the environal agents that act on it or on any part of it, and which causes the organism to proenviron a course or pathway that is temporarily *satisfying* to it, and that can alone be taken in virtue of the action of the several environal agents, and the reaction to each of these by appropriate organismal molecules." More briefly, Prof. Macfarlane defines the "law of proenvironment" as "the correlated resultant response by any body to the summated correlation of stimulatory action, that leads to a temporarily *satisfied* state." We rub our eyes; the so-called law of proenvironment takes us back to Herbert Spencer (with his emphasis on equilibrium and "effective response") and farther. Surely it is a commonplace that the lines taken by development and activity alike are resultants of environmental stimuli acting on living organisation which is internally determined by the inheritance and by previous experiences so that its responses are on the whole adaptive. We confess that we see very little in Prof. Macfarlane's discovery, and we doubt whether the capacity of giving a more or less satisfying unified response to a variety of external stimuli is a factor of evolution at all, except in the sense that every organism is a factor in its own evolution. It is a fundamental fact of life. The "five organic factors that are form-producing," the co-operative action of which is "pentamorphogeny," are Heredity, Environment, Proenvironment, Selection, and Reproduction. But there would have been heredity, environment, proenvironment, and reproduction though there were no evolution, and what would Darwin say to leaving Variability out of the Pentarchy?

(3) The author contends vigorously that "the main and dominant lines of animal evolution have all originated in fresh water or on land, and that only side lines have assumed a marine life, though these have often branched out profusely into species, and even have given off again groups that have in rare cases returned to a fresh-water or a land life." This is a good-going heresy, and the author supports it with learning and ingenuity. It is directly counter to the conclusion of most authorities, who hold that the probabilities are in favour of a marine origin of most of the phyla. Prof. Macfarlane makes out such a strong case that we feel how uncertain these speculative conclusions are. In our ignorance of the actual beginning of most of the phyla it is difficult to prove the erroneousness of the view that the buds were in fresh water, though the blossoms may have been in salt. We submit, however, a few considerations:

(*a*) At this distance of time appeals to present-day numbers of fresh-water and marine species in any particular phylum cannot be of much value in reference to origins, but there is some utility in thinking of the numbers of types in the two habitats, and of cases where the enormous majority of the types in a phylum are in the one or the other. Now, if we begin with the lowest phyla of Metazoa, the Sponges and Cœlentera, we find in both cases the vast majority of types in the sea and a very small minority in fresh water. The most natural—though not inevitable—inference is that the present-day habitat of the vast majority is the original habitat. The Echinoderms represent a well-defined phylum, all the living representatives of which are marine. The types at the base of the Chordate phylum—namely, Enteropneusts, Tunicates, and Lancelets—are all marine, which is again significant. Many similar cases might be given, but Prof. Macfarlane advances counter cases, and actual demonstration is out of the question.

(*b*) If we take a number of notable advances, such as paired unjointed limbs or parapodia, such as body-segments or metameres, such as genuine pre-oral appendages, such as the annulate or the chordate type of nervous system, such as true gill-clefts, such as a dorsal axis, and ask where they began, the evidence from present-day forms and from palæontology is on the whole in favour of the answer: In the sea. But Prof. Macfarlane brings forward counter instances, and no doubt the fresh waters have been a very educative school of life.

(*c*) Types with direct life-histories are very generally, though not always, less primitive than related types with larval stages, and the tendency of fresh-water animals to have little in the way of larval stages (telescoping these, according to our theory) is very striking except along a few lines, such as that of aquatic insects, which are no doubt primarily terrestrial. And it is not difficult to see why it should be so.

(*d*) For most of the types of fresh-water animals it is possible to give a plausible pedigree, starting from marine or terrestrial forms.

(*e*) It is a significant fact, emphasised by Quinton, that the blood of land animals, such as mammals, is in the proportion of sodium, potassium, and calcium ions almost identical with sea-water. It is difficult to interpret this except as a hint of pedigree.

(4) It is impossible to do justice in a few lines to Prof. Macfarlane's long discussion of the phylogeny of animals. He regards Rotifers—in spite of the specialisation of most of them—as "the foundational group" of the simpler Metazoa, and he has the hardihood to place a ciliated Infusorian and a Rotifer side by side, for "the lines of stereogenesis in the Rotifera remain fundamentally as in ciliate Infusoria." We do not profess to know much about stereogenesis, but the juxtaposition of a Rotifer not only with an Infusorian, but also with a larval Entomostracan and a larval Gastropod strains our morphological faith. It must be a foundational creature indeed which is like three things so different. The author traces the main line of ascent from the Rotifers through Turbellarians, Nemerteans, Cyclostomes, Cæcilians, to Marsupials and higher Mammals. The difficulties involved in side-tracking Tunicates and Lancelets and in dragging Cyclostomes and Cæcilians on to the direct line of ascent seem to us to be insurmountable. But this is largely a matter of opinion. It seems to be truer of phylogeny than of statistics that if you pick your data you can prove anything you like. There are, naturally enough, some loose ends in Prof. Macfarlane's arguments. These are of two kinds—matters of fact, as when he says that the eggs of Cyclostomata undergo holoblastic segmentation, which is not true of Myxinoids; and matters of interpretation, as when he says of the Cæcilians: "the active gliding habits and slippery skin, also, scarcely serve to set up the needed irritable stimuli that would start paired limbs as a response-result." This surely verges on the poetical.

(5) A useful chapter on "higher" animals expounds the not unfamiliar idea that along different lines and at different structural levels animals rise to approximately equal complexity of behaviour. Thus octopus, spider, ant, crow, and elephant are types that rise high along different lines of structural advance. This is sound enough, though it is time that Sir Ray Lankester's distinction between the "little brain" and the "big brain" types of cleverness was recognised in all such comparisons, but what seems to us quite in the air is Prof. Macfarlane's theory that the "energising stimuli" of a complexified environment excite the biotic system of the body and the cogitic cells of the brain to new adjustments and adaptive changes, "all of which are more or less shared by and influence the generative cells, which in turn affect the succeeding organisms hereditarily." In other words, without any submission of evidence, we are asked to return to the credulity of Lamarckism. The author says: "To repeat once more our fundamental position: flows of energy, often and steadily repeated from sense-collecting centres, start stereo-energetic stimulation-acts, that inevitably affect the brain-cells, and these by expenditure of cogitic energy give rise to proenvironal responses that constantly tend to place the organism for the time being in 'satisfied' relations to its environment." In so saying he seems to us to be stating with unnecessary technicality the fact that living creatures adjust themselves within limits to their surroundings; but when he suggests that the elephant's trunk evolved by the transmission of the results of individual "proenvironal reponses," we feel bound to say "napoo."

(6) In regard to the Ascent of Man, the author lays emphasis (as Anthony, Wood Jones, and others have done) on the evolutionary importance of the emancipation of the hand which "stimulated the brain to increased flows of energy and so increased complexity and growth." "In all such advance by environal stimulation-action and brain reaction, followed by proenvironal outreach-

ing and succeeding response, the great law of proenvironment is constantly at work." Again, we have the same fallacious hysteron proteron. Surely the emancipation of the hand was the outcome of variations of structure and habit which are left unexplained (not that *we* can explain them); surely the cerebral initiative that put the free hand to manifold tests and found for it a thousand uses was and is a cause, not a consequence; moreover, the hereditary entailment of individual gains is a hypothesis, not a proven fact. We wish to make clear that when Prof. Macfarlane speaks of "the capacity of an organism for perceiving and then positively growing or moving toward an environment that is most satisfying for it," he is not defining any new "law of proenvironment," but referring to the fundamental fact that the organism is a self-preservative agent. In so far as other evolutionists have forgotten this and made the organism a passive pawn in a game, or a portmanteau of potentialities which require only liberating stimuli, Prof. Macfarlane's thesis is of great service. He has hold of the open secret that the organism shares in its own evolution.

(7) Our admiration is commanded by the two chapters in which the author gives an appreciation of the two great ways—competitive and co-operative—in which organisms answer back to the difficulties and limitations that beset them, though we do not think he realises what Darwin clearly expressed, that a co-operative reaction to a crisis is as much part of the struggle for existence as a competitive one. We wish that we had space to refer to the concluding chapters on human evolution, which are marked by a splendid earnestness and a truly evolutionistic hope. We can only refer to the cope-stone of Prof. Macfarlane's hierarchy of substance. Just as biotic energy is associated with protoplasm, cognitic energy with chromatin, cogitic energy with neuratin, so there is "spiritic energy"—a still more condensed mode—which "has so functioned as to energise the more aspiring and lofty souls of humanity to widest outreachings, toward the most profound questions of the world and the universe." "The phenomena, the experiences of human life in the past millennia especially, powerfully suggest to the writer that built up on, energised by, linked into complex relations by, a combined bio-cognito-cogitic union is a still more complex substance than the protoplasmatin, chromatin, or neuratin, probably resident in some part of the gray frontal matter of the brain, and which hypothetically we may call the *spiritin*." No man understands his brother's philosophy, and we do not know what Prof. Macfarlane is getting at by his quaint and uninviting system of substances and energies. There may be some, however, to whom it makes the riddle of the organism—body-mind and mind-body—clearer; and we are sure of this, that there are facts enough in the volume to reward even the learned, and that the whole work is marked by resoluteness and sincerity.

J. A. T.

AMERICAN UNIVERSITIES.

(1) *The America of To-day. Being Lectures delivered at the Local Lectures Summer Meeting of the University of Cambridge,* 1918. Edited by Dr. Gaillard Lapsley. Pp. xxv+254. (Cambridge: At the University Press, 1919.) Price 12*s.* net.

(2) *The Voyage of a Vice-Chancellor.* Pp. ix+139. (Cambridge: At the University Press, 1919.) Price 6*s.* net.

(1) THIS volume of lectures delivered at Cambridge in the summer of 1918 contains only two chapters of direct technical interest to the readers of NATURE—namely, that of Prof. J. W. Cunliffe, on "American Universities: their Beginnings and Development," and that by Dr. G. E. MacLean on "State Universities, School Systems, and Colleges in the United States of America." The first of these gives a very interesting account of the English origins of American universities, of the effect of the different environments in bringing about a gradual departure from the English model, the injection of German influence, and the subsequent growth along more independent lines. The similar process of development is traced by Dr. MacLean with respect to the State-supported institutions, which have no direct counterpart in Great Britain. A very clear account is given of the various ways in which State and federal subsidy is provided for these institutions, and there is a brief discussion of the type of administrative organisation which has grown up. Both Prof. Cunliffe and Dr. MacLean rightly emphasise the ideals of universal education which have led to such a large expenditure of public money upon the school system as a whole. The result is, perhaps, that the reader unfamiliar with the situation would get too rosy a picture of the state of affairs. Not that there is any loss of faith in the ideals, but that, as Dr. MacLean points out, there is a strong feeling that great changes of method are necessary, and, indeed, such changes are constantly under discussion and under trial. Though they have no direct bearing on the subject of education, chaps. iii. and iv., by Lord Eustace Percy, on "State Municipal Government" and "Social Legislation," read in conjunction with those on education, will give a fairer idea of the tremendous problems presented by education in America and of the political and social difficulties involved in their solution.

(2) Such an important journey as that of the British University Mission in the autumn of 1918 to Canada and the United States will doubtless be the subject of formal and formidable reports both in England and America, but it is well to have also such an intimate and clever personal record of daily happenings as Dr. Shipley has given us in this volume. Though the account, in diary form, is very brief, one gains a clear impression of the differing characteristics of the various institutions and regions which were visited. As one reads of the unbroken series of banquets and

luncheons to which the commission was ruthlessly exposed, the number of speeches which they were forced to make, and the other at least equal number to which they were compelled to listen, one is impressed by the fact that this academic group "did their bit" in a very real sense. One also wonders whether the present demand for a reduction in the hours of labour could not be directed towards a change in the customs of after-dinner speaking, resulting in a great conservation of the nervous energy of the world. It is to be hoped that the journey which is here so gracefully described is but the first of many, perhaps less formal but more leisurely, which will be undertaken by academic and scientific men of both countries. It would be a pity if the greater intimacy and understanding, which war conditions have undoubtedly brought about between the men of science of England and America, should for any cause be allowed to lapse. C. E. M.

OUR BOOKSHELF.

The Statesman's Year-book. Statistical and Historical Annual of the States of the World for the Year 1919. Edited by Sir John Scott Keltie and Dr. M. Epstein. Fifty-sixth Annual Publication. Revised after Official Returns. Pp. lii+1476. (London: Macmillan and Co., Ltd., 1919.) Price 18*s*. net.

ONE turns to the new volume of this ever-welcome annual with considerable interest in view of the present fluid condition of international affairs. The coloured map shows the condition of Europe in June of this year, the accession to political sovereignty of Iceland, Poland, and Czecho-Slovakia is recognised by their treatment in new and separate sections, and the introductory pages contain the League of Nations Covenant, a summary of the peace terms to Germany, and a continuation of the diary of the war. The Iceland section summarises the consequences of the Act of Union of November, 1918, which makes the connection between Denmark and Iceland, in other than certain temporary arrangements, entirely due to the fact that both States have the same King. Although it has not been possible to include statistics regarding the dismembered Austro-Hungarian Empire, various estimates have been included—*e.g.* the new Austrian Republic has a population of some ten millions, of whom 90 per cent. are Germans; the probable population of Yugo-Slavia is twelve to thirteen millions. There are brief summaries of the results already achieved by British administrators in Mesopotamia, and of the newly independent kingdom of Hejas.

The Boys' Own Book of Great Inventions. By Floyd L. Darrow. Pp. ix+385. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1918.) Price 12*s*. 6*d*. net.

THIS book contains a popular and interesting account of the more important inventions of the last hundred years. One chapter is devoted to the gyroscope; six to telegraphy and telephony, with and without wires; two to aviation; and one each to the submarine; the steam engine; petrol, oil, and gas engines; the use of machinery in agriculture; the development of electricity; the evolution of artificial illumination; fire and high temperatures; some notable achievements in chemistry; the story of iron and steel; and Galileo and the telescope. The treatment is unusual. The author in most cases first appeals to general interest by describing practical achievement. He then gives an account of the theory, and concludes with a few experiments which the boy may perform for himself.

The style is good, the information is accurate, and the explanations are generally clear. The experiments are to the point, but, appearing as they do detached from the descriptions of the apparatus and process, they appear to be scrappy and unsatisfactory. Many of them are quite unnecessary in the case of a boy who is doing science at school, and to a boy who is not they would not all prove helpful. We prefer description and explanation, even where that involves experiment, to be more closely associated.

The value of some of the half-tone blocks is much reduced by printing two or three on a page, which renders them indistinct.

Apart from these minor defects, the book is first-rate, and will form an excellent gift for a boy who is interested in scientific achievement.

E. C.

Interpolation Tables or Multiplication Tables of Decimal Fractions. Giving the Products to the Nearest Unit of All Numbers from 1 *to* 100 *by* 0·01 *to* 0·99 *and from* 1 *to* 1000 *by* 0·001 *to* 0·999. By Dr. Henry B. Hedrick. Pp. ix+139. (Washington: Carnegie Institution of Washington, 1918.)

THE simplest description of these tables is to say that they give such results as $0·302 \times 441 = 133$ with the certainty (barring errors in the tables) that the third digit in the product is correct. Taking out such a product from the tables is an easy operation, requiring very little time; probably, with practice, the use of the book would be as expeditious as that of an ordinary slide-rule, and the results more trustworthy.

Various other ways of using the tables are explained in the introduction. The editor also gives interpolation formulæ, and worked applications to astronomy, etc., in which these tables are used.

This publication appeals to a large body of computers and scientific workers, and affords another instance of the wise enterprise of the directors of the Carnegie Institution. They have already earned the gratitude of arithmeticians by their tables of primes and factors, and they are doing a public service by thus undertaking the cost of printing works at which no ordinary publisher would look for a moment.

The printing and arrangement of the tables seem to be all that could be desired.

G. B. M.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

The Doubly Refracting Structure of Silica Glass.

I have recently observed that "silica glass" possesses a remarkable crystalline or quasi-crystalline structure when examined in the polariscope.

The double refraction is extremely weak, the retardation being probably of the order of 1/1000th of a wave. The structure cannot be advantageously examined with a polarising microscope as used by geologists, for the large number of lenses between the Nicols show enough double refraction to spoil the contrast between the dark and light parts. It is advisable to use a Nicol, and not a glass reflector, as polariser, and to dispense with lenses between the Nicols. A magnifier of 2 in. focus is placed above the analyser. An extremely bright light is necessary; I have used sunlight reflected straight into the apparatus, thus obtaining an intrinsic brightness comparable with that of the sun's disc. (No doubt an arc with a suitable condenser would do equally well.) The Nicols are to be accurately crossed so that the sun is invisible.

If a circular plate of fused silica of "ordinary" quality with polished faces is examined in this arrangement, it shows a striking mosaic of dark and bright parts without regular arrangement. The size of this structure is of the order of half a millimetre. It is seen superposed on the ordinary "dark cross" due to strain, which extends across the whole disc, 6 cm. in diameter.

A rectangular plate of the same class of material showed the dark parts elongated into bands set in a definite direction, and suggestive of a flow structure.

A circular disc of optical quality silica showed a spiral structure.

I have examined a large number of specimens of sheet- and bottle-glass without meeting with any trace of such a structure, which is evidently something quite peculiar to silica glass. It may be suggested tentatively that silica glass consists of a mass of "liquid crystals" comparable with those described by Lehmann in the case of certain organic substances.

It is intended to obtain photographs of these structures, and to study the effect of heat treatment on the silica until it becomes visibly devitrified.

Rayleigh.

Imperial College, South Kensington, October 20.

A Search for Fine Wool.

Mr. Lydekker in his monograph on "Wild Oxen, Sheep, and Goats," published in 1898, stated that the ancestral stock of sheep is not only extinct, "but totally unknown." But in a book on sheep published in 1912 Lydekker admitted that the mouflon and urial had probably contributed to the making of domestic breeds. As a matter of fact, it has been proved beyond doubt (1) that the first domesticated sheep in Europe (*i.e.* the sheep introduced by the Alpine race about 7000 B.C.) were derived from a urial (*Ovis vignei*) not unlike the one now inhabiting the Kapet-Dagh, and (2) that nearly pure descendants of the ancient Neolithic breed still survive on the small uninhabited island of Soay (Sheep Island) near St. Kilda. Further, it is now realised that rams of at least three varieties of *Ovis ammon* have long been used for maintaining the size and vigour of fat-rumped and other breeds of Central Asia. More important still, it has recently been ascertained that the wool forming the inner coat of several of the wild sheep of Asia is longer than in the Soay, and decidedly finer than and quite as white as superfine Australian merino, usually said to be the finest and whitest wool in the world. Crosses between Soay and Southdown sheep yield excellent mutton, and beautiful wool remarkable alike for its strength and quality.

It is hence possible that, with the help of the urial and other wild types, new fine-woolled, vigorous varieties of the merino might be introduced. In the meantime, I am anxious to examine the wool of crosses which include wild species amongst their recent ancestors. Sir Joseph Banks, president of the Royal Society when the attempt was made to establish the merino breed in England, was a keeper of sheep, and was "well informed on all points relating to the production and uses of wool." Some of the readers of Nature who, like Banks, are interested in sheep may be in a position to help in the new search for the Golden Fleece.

J. C. Ewart.

The University, Edinburgh.

Radiation Temperatures.

In a letter to Nature of October 9 (p. 113) Mr. Mallock points out the uncertainties attaching to records of "temperatures in the sun," due to the influence of the nature of the thermometer bulb on the readings. Similar uncertainties attach to readings of instruments exposed to a clear sky at night, and with even greater force, for there are two main radiation factors here, one of them being the cold ground—such thermometers being generally placed only four inches above the soil—and radiation to the ground is dependent to a very large extent on the nature and condition of the soil, or of the vegetation growing on it. It would appear that the so-called minimum earth radiation temperatures have very little value as meteorological data. Both these and readings of "temperatures in the sun" are affected by a source of error other than that noticed by Mr. Mallock, namely, the size of the thermometer bulb. With very large bulbs this may not obtain, but with bulbs of ordinary dimensions, say from 1·2 to 0·2 c.c., the difference caused by size is very noticeable, and is a curvilinear function of that size; with still smaller bulbs the function becomes rectilinear, the apparent radiation effect varying inversely with the linear dimensions of the bulb. Within the limits of bulb-size above mentioned, the differences observed may be 5 to 10 per cent. of the total radiation effect; and this, with readings "in the sun," might represent differences of 3° to 6° F. These figures apply to mercury thermometers; I have no observations yet with alcohol thermometers.

Differences of radiation temperatures due to the size of the object have an important bearing on subjects other than meteorological records. Thus, it will be impossible to cool a very small object by radiation to a temperature appreciably below that of the surrounding medium; hence the damage done to the pistils and stamens of flowers by frost cannot be due to radiation, but must be the result of the coldness of the air about them; therefore, methods of protection from frost dependent on preventing radiation by interposing a smoke cloud, or smudge, between the tree and the sky, will be ineffective, unless, indeed, the smoke cloud is sufficiently extensive to cover a large tract of country, and thus ensure a material reduction in the loss of heat from the ground by radiation, and a consequent reduction in the cooling of the air above it. Local and restricted smudging will not prevent the inflow of colder air from the surrounding land where radiation is active.

In England and on the Continent most of the recent suggestions for frost-fighting have been erroneously based on smoke production; but in Canada and the United States, although the reason of the inefficiency of smoke production does not seem to have been realised, the steps actually adopted for frost-fighting have taken the right direction, aiming at orchard heating—that is, actual heating by artificial means the air and the trees in the plantation. It is true that smudging is still used, but with a very different object, the smudge fires being lighted at dawn to prevent the sun's rays from heating too rapidly the frozen blossoms. It appears that the damage usually done by frost is not due to the freezing of the contents of the cells and the disruption of the cell-walls, but to the freezing of the intercellular liquid, the formation of ice here resulting in the abstraction of water from the cells; on thawing, this water is re-absorbed, but only very gradually; and, if the heating be too rapid, much evaporation occurs before the re-absorption is complete, and the cells remain permanently depleted of part of their water. The dehydrating action of freezing water in this case is analogous to that observed by the present writer in the case of clay and other highly hydrated substances, when the liquid in which they are suspended is frozen. But in those cases no re-absorption of the water occurs on thawing.

Spencer Pickering.

Time Relations in a Dream.

The following account of a dream which I had last night, and of which I took some notes, may be of interest. The dream commenced by my, as I thought, hearing a drop fall on the laboratory floor; after a time there was another drop. I then realised that mercury was dropping on the floor from a small split in some rubber tubing in a gas-analysis apparatus. As I became more wakeful and seemed to realise that I must get up to deal with the leak, the drops fell more rapidly until they were coming quite fast at the moment when I definitely awoke. I then realised that the dropping of mercury which I heard in my dream was in reality the ticking of the clock in my room.

The point which interested me, and may, I think, interest you, is that of the time relations of the dream. I went over my memory afterwards with a stop watch—and, of course, it is only one's memory of a dream that one ever has to go upon—with the following results:—

As I dreamed it, the interval between the first two drops seemed to be of the order of five seconds, and the drops seemed to quicken until they were at an estimated rate of about one drop per second.

Now the actual rate of ticking of the clock was one tick every quarter of a second. It is, of course, evident that one's judgment of time in a dream is quite erroneous in the sense that the occurrences as they take place in the dream seem to extend over a much longer time than the actual time of the dream.

On the assumption that each consecutive drop in my dream corresponded with one consecutive tick, it would appear that at the commencement of the dream the time interval between two consecutive ticks was exaggerated about twenty-fold in the dream, and that as I got more nearly awake the degree of exaggeration became reduced to something like four-fold. At a guess, I heard about thirty drops, in which case the dream would have lasted seven to eight seconds.

There is another possible interpretation, namely, that when I was most soundly asleep only one tick out of twenty came through to my consciousness, and that as I became more wakeful the number increased until one tick in four came through. On the latter theory the dream would have lasted considerably longer than on the former.

Whatever the interpretation, however, it occurred to me that the time records might be of interest, as a dream is rarely so simple or of such a kind as to admit of even the vague degree of measurement which I obtained.

Joseph Barcroft.

Physiological Laboratory, Cambridge, October 14.

International Relations in Science.

A circular letter has been addressed, within these last few days, to "Members of the Academies of the Allied Nations and of the United States" by their brethren of the learned societies of the neutral countries. It is an appeal for toleration, even for generosity, an earnest and eloquent protest against a policy which would seek to exclude the present generation of German scholars and men of science from all our scientific and scholarly intercourse.

I cannot say that I have always been on the side of tolerance and reconciliation; but already we have had some little time to think, and this all but cosmopolitan appeal is bound, as it seems to me, to become a factor in the case. It is signed by very many friendly and honoured names; we cannot shut our ears to it, we cannot resolve upon isolation, lest it be isolation indeed.

This is not a matter to be decided for us by the votes of others, but by each man for himself—by all who claim liberty of action and freedom of thought. I am convinced that very many men feel, as I feel, that whatsoever overtures our German-speaking colleagues may make to us on matters scientific should be freely reciprocated. Need we ask what a man has thought or said, or even what he has done, in these last sad years? If he come in the universal name of science let that suffice; let it be granted that he means, now and henceforth, to follow the paths of learning and to walk in the way of peace.

St. Andrews. D'Arcy W. Thompson.

INTERNATIONAL ORGANISATION IN SCIENCE.

An appeal addressed "to the members of the Academies of the Allied Nations and of the United States of America" and signed by a number of scientific and literary men in neutral countries has been circulated and has already given rise to comments in the Press. It deals mainly with the formation, by the Allied academics, of new international scientific associations which neutral countries are now invited to join. Stripped of its rhetorical clothing, the document is an appeal to let bygones be bygones and to allow science to become again "the great conciliator and benefactor of mankind."

There will be much sympathy with the arguments used, the regrets expressed, and the hopes foreshadowed by our neutral friends, but they have left untouched, and to a great extent misunderstood, the principal considerations which have driven the allied academies to the policy they have adopted. It is only that part of our scientific activity which involves a regular personal and intimate relationship between men of different nationalities that is affected by the action of these academies. The question, therefore, simply resolves itself into this. Is it possible that an international scientific meeting in which the belligerent countries sit side by side can, at the present moment, lead to any satisfactory results, or tend towards that reconciliation which the neutral countries very naturally and legitimately hope for? There can be but few who will answer that question in the affirmative, and it is doubtful whether those few would include anyone who has had experience of international meetings before the war. The questions discussed at these meetings frequently touch national interests or national ambitions, be it only a discussion whether units adopted in one country shall be universally accepted. It often requires tactful leadership and a conciliatory disposition on the part of everyone present to steer an international meeting to a successful issue.

The matter is, to a great extent, decided for us by Article 282 of the Treaty of Peace which Germany has ratified. According to that article, "treaties, conventions, and agreements of an economic and technical character" not included in a specified list cease to be operative. That this article was intended to cover conventions on scientific matters appears from the list of exceptions, in which the Metric Convention and the Agricultural Institute at Rome are included.

In view of the strong feelings of resentment which still exist between the belligerent nations, feelings shared by the great majority of their members, the alternatives possible to the allied academies were either to discontinue international unions or to proceed as they have done. The former course, not perhaps very harmful in some branches of science, would have been fatal in others, and in coming to a decision they have had to give the foremost consideration to the interests of science. It is intelligible that, both in the review of the past and in the outlook of the future, neutral opinion should differ from ours; but we may be confident that the academies of the nations to which the signatories of the appeal belong will, in considering the invitations which are to be sent to them, be guided in their response by the same interest for the future of scientific progress which lies at the heart of the allied academies.

EVOLUTION OF OSTRICH PLUMES.

PROF. J. E. DUERDEN has published (Bulletin No. 7, 1918, Department of Agriculture, Union of South Africa, pp. 39, 12 figs.) a fourth report on his breeding experiments with ostriches at the Grootfontein School of Agriculture. His work is full of interest, both theoretically and practically. Birds brought from Nigeria have 33–39 first-row feathers on each wing, with an arithmetical mean of 36·54. If these imported birds represent a pure line, the likelihood is that the numerical variations are fluctuating somatic modifications, and that no amount of selection will increase the average number of plumes beyond that given. If the imported birds represent a mixed population of several pure lines, only appearing pure as a whole because of their small differences, it should be possible to obtain higher averages by always selecting as breeders the birds giving the highest number of plumes.

It turns out that Cape birds have the same number of plumes as the wild Nigerian birds, and it appears, therefore, that during the fifty years of ostrich farming in South Africa no advance whatever has been made on the number of plumes originally present on the wild bird. For farmers have always bred for quality; quantity has never been taken into account. As regards the number of plumes, ostrich-breeding has been carried on altogether indiscriminately, and no advance has been made.

Among the Cape birds in the Grootfontein flock there have been two cases of 42 plumes to the first row. One of these met with a fatal accident; the other bred true. The 42-plumed bird might be regarded as a novel mutation, but there is a more plausible view. Recent studies on the ostrich afford strong evidence that the wings of its ancestors were much better covered with feathers than is the case to-day. There has been retrogression, and it is still continuing. The 42-plumed wing is a survival of an ancestral condition. Very interesting facts are communicated in regard to the retrogressive or degenerative processes which are still going on in the ostrich's wing. The retrogression proceeds in one part of the wing quite independently of the other parts. Thus, apart from the plumes altogether, the third finger shows retrogression. It is almost buried in the flesh, and the claw which some books describe has never been found on the hundreds of birds coming under Prof. Duerden's observation. But a study of the plumes lends no countenance to the common view that degeneration takes place by slow, continuous stages. There may be the full presence of particular plumes in one individual, and their total absence in others; but there is not a gradual passage from full expression to the vanishing-point. The degeneracy of an organ may stop at any stage according to the number of constituent factors which happen to be lost. We are apt to think of the degeneracy as a somatic affair, whereas it is germinal.

As to the possibilities of the 42-plumed survival, no chicks have yet been produced from the 42-plumed cock mated with a hen with the same number of plumes, for no hen has been forthcoming. But a score or so of chicks have been reared from the 42-plumed cock crossed with different 36-plumed hens, and these showed an interesting series of numbers from 37 to 43. It seems probable, therefore, that if the 42-plumed cock had been mated with a 42-plumed hen there would have been a full 42-plumed progeny. If similar 42-plumed survivals occur, it should be possible for farmers to increase by as much as 25 per cent. the crop of feathers from the same number of birds, or, a more desirable outcome, to procure the same quantity of plumes from three-quarters of their present number of birds. Prof. Duerden is to be congratulated on reaching conclusions at once of high theoretical interest and great practical utility.

EDUCATION IN INDIA.[1]

THIS is the second quinquennial review compiled by Mr. Sharp, Educational Commissioner with the Government of India. Shortage of paper and other conditions bred of a period of war have compelled him to curtail his report and, not without advantage, to diminish his statistics. What remains is full of interest and significance, especially, of course, to those who have some first-hand knowledge of Indian education. There is the inevitable, and in some respects useful, comparison with the educational statistics of various European countries and Japan. Of this it is necessary to repeat that the comparison is obviously unfair, even in the case of Japan. British India is a continent rather than a country, and is far more varied in culture and civilisation than Europe or Japan. It is the great towns, such as Calcutta or Bombay, that should be compared with European countries, since there alone are conditions sensibly similar to those of Western nations.

We should have welcomed, too, a fuller account of the attempts to impart instruction in the local languages. So long as British rule exists it will be as necessary for Indians to learn English as for educated Englishmen to learn French and German. But English as a medium of instruction is open to obvious objection. We continue to hear complaints of superficial thought, parrot learning of cram text-books, absence of originality, and so forth. Surely this is largely due to making lads, many of whom are not gifted linguists, learn difficult subjects, such as science and mathematics, in a language in which they cannot think. Were it not that many Indians have attained to a surprising proficiency in English, the system would have been condemned long ago. In the chapter on Oriental teaching Mr. Sharp confines his remarks to education in the Indian classics, and has little or nothing to say of the attempts now being made to gain for the modern languages of India the same facilities that English universities are now supplying for European living speeches, their philology, phonology, and literature.

From the point of view of education in India, war and the economies it involved came at an unfortunate moment, since it was necessary to suspend a great part of the reforms projected in Lord Hardinge's resolution of 1913. Even in that circumstance, however, we may ultimately find comfort, since what India chiefly needs is not official encouragement and the vicarious liberality of Government so much as public appreciation of what good and solid education is and by what means it can be supplied to the people at large. One of the most important steps in this direction (less neglected than official reports seem to show) is to make the greater Indian languages fit vehicles for supplying instruction to immature minds. In many Indian provinces non-official committees and societies have carefully compiled vocabularies of scientific terms. Some of these seem pedantic and clumsy enough to those who study Indian languages merely with a view to the enjoyment of literature or the understanding of local life and character. But we must not forget that our own scientific nomenclature is chiefly borrowed from dead, inflected languages, and presents difficulties which, to an Indian mind, would not occur in the use of similar phrases borrowed from Sanskrit in the case of Hindu languages or from Arabic for Mohammedan learners of science.

On the whole, in spite of war and other lets and hindrances, some permanent, some, we hope, temporary, Mr. Sharp's admirably arranged and very valuable report tells us a tale of substantial progress. *E pur si muove!* Public expenditure on education has increased by one-half in the five years under review. There is a steady improvement in the number of boys and girls under instruction. Teachers are better paid, though it is probable that much of their increased salaries has been swallowed up by rising prices. The huge, too huge, examining universities are gradually being supplemented by smaller residential and teaching colleges. This change implies some recognition, on the part of Government and parents alike, of the fact that education comprises a moulding of character and will as well as the training of memory, intelligence, and interest.

It is perhaps a little surprising that Government reports on education do not deal with the significant results of school and university teaching as these appear in vernacular literature and journalism. Most of us in Europe have heard of Rabindranath Tagore and one or two other contemporary Indian authors. There are others, locally held in equal, or almost equal, esteem. A system of education which produces really fine literature, much of it entailing solid research and thought in history, in philosophy, and, to a growing extent, in science, is probably more full of hope and promise than can well be shown in an official summary of the educational doings of some 200 millions of human beings of extraordinarily various degrees of social, religious, and scientific progress. This, of course, will be sufficiently apparent to any careful and disinterested reader of Mr. Sharp's admirable report.

[1] "Seventh Quinquennial Review of the Progress of Education in India." By H. Sharp. (Bureau of Education, India.) Price 5s. 6d. net.

NOTES.

The Board of Agriculture and Fisheries has taken a step long overdue, and now the one competent entomologist on its permanent staff can look forward to assistance in doing the work which twenty competent entomologists might, perhaps, be expected to perform. An entomological laboratory has been established and placed at Rothamsted, where a chief entomologist and two research assistants are to devote their whole time to investigation. The further proposal to appoint twelve advisory entomologists for the twelve agricultural divisions of England is one the advantages of which are doubted in a leading article in the *Times* of October 10. It would be better, our contemporary thinks, "were the research staff at Rothamsted to be increased, and arrangements made for the investigators to visit, now Cornwall, now Northumberland, wherever a local problem became urgent, returning to their headquarters to pool their experience and their results." Research is needed, very much needed, and probably nowhere else in England could greater facilities for investigations of the kind required be found than those at Rothamsted. But if the practical value of entomological research is to be brought home to the farmer, the fruit grower, or the breeder of stock, he must have his eyes opened for him and be given instruction on the spot; it can never be attained simply by the distribution of pamphlets or journals, no matter how well prepared or how valuable the advice they may give. The divisional entomologists should do something more than give advice when called upon; they might make periodical inspections, and have a look out for incipient stages in the diseases of crops in their divisions, as well as for critical stages, so that means could be taken in time to prevent the spread of the disease. It should also be their duty, rather than directly that of the farmer, to keep in touch with what was going on at headquarters, and to become acquainted with all the latest discoveries brought about by research. Even in research they themselves need not be idle, if they have been properly trained, and are qualified, as they should be, to carry it on.

The annual exhibition of the Royal Photographic Society is again held at 35 Russell Square, as, owing to the requirements of the Government, none of the larger galleries are available. But the scientific section suffers nothing on this account, as the society in its own house has greater facilities for displaying the exhibits. This section fully maintains its reputation. There are forty-three colour transparencies on autochrome plates out of a total of forty-six, but this kind of work is now so well established and so perfect that the interest has passed to the subject rather than to the process. Photomicrography is well represented by entomological and botanical series. A photomicrograph that stands alone must have something very remarkable indeed about it to justify its exhibition. The radiographs of surgical and medical interest are as numerous and valuable as ever, and the application of Röntgen rays to the detection of hidden defects in metal castings and in aeroplane parts is strikingly and beautifully illustrated. Concerning novelties in scientific methods and apparatus, the splendid exhibit of grainless and filmless photography by the Messrs. Rheinberg richly deserves the medal awarded to it. It includes scales on glass for apparently every conceivable purpose, from micrometer scales to scales 30 cm. long. Messrs. Adam Hilger show a spectrograph on an improved Schumann plate which records lines from wave-lengths 21 to 67, and photographs that illustrate the use of the interferometer for testing camera-lenses. The exhibition closes at the end of November.

The subject of the declining birth-rate was raised at the Church Congress on October 15 in two papers. The Bishop of Birmingham held that restriction of births was due in most cases to prudential motives and to a sense of responsibility, and noted as a curious fact that statistics showed that doctors and clergy, who used to be very prolific, now had smaller families on the average than other people. The nation wants more children, but wants them of the best quality. There must be cases where some kind of control should be exercised, and that must be before conception is known to have taken place. Dr. Amand Routh directed attention to parental syphilis and alcoholism as causes of ante-natal and neo-natal disease and death. He condemned the circulation of so-called "prophylactic packets" as likely to increase rather than to diminish venereal disease. He stated that in the six months ended March 31 last deaths in England and Wales exceeded births by 126,445—for the first time in our statistical history. Dr. Stevenson, Superintendent of Statistics, attributed this to a decline in fertility. Dr. Letitia Fairfield stated that venereal diseases had not only spread during the war, but had rapidly increased since the armistice, and urged an addition to the number of clinics. The Archbishop of Canterbury considered that the use of prophylactics would be perilous as smoothing the way towards vice, but approved the efforts of the National Committee for the Prevention of Venereal Diseases.

It is with sincere pleasure that we learn that M. Emmanuel de Margerie has been appointed Director of the new Geological Survey of Alsace and Lorraine. M. de Margerie brings to his official duties the knowledge gained by years of cultured conference with geologists throughout the world, and we are indebted to his wide reading and his personal acquaintance with the face of the earth for the French edition of Suess's "Antlitz der Erde." This, far from being a mere translation, is the form in which the book will live as a monument to Austrian powers of collation and construction and to French lucidity of exposition. M. de Margerie's published work has been geographical as well as geological, and it is pleasant to picture him as looking out from the heights of the Vosges on river-profiles once more associated with France. Many questions of economic geology, and therefore of national welfare, will come before him in the recovered provinces. While his sympathetic spirit will find no barrier in the Rhine, his vindication of the attitude of the Entente Powers, addressed during the war to Prof. Heim of Zürich, proves him to be the right man for the task of reconstruction on the frontier.

Mr. Francis Jeffrey Bell, who has just retired from the Natural History Museum under the age-limit, entered the service of the trustees on August 12, 1878, when the Zoological Department was still at Bloomsbury and Prof. Owen the superintendent. He took an active part in the removal of the collections to South Kensington in 1882–83, and concerned himself with various divisions of the marine invertebrata, giving especial care to the exhibition of selected types. Mr. Bell is emeritus professor of comparative anatomy in King's College, London, and he served for many years as one of the secretaries of the Royal Microscopical Society, the Journal of which he also edited. In 1898 he acted as general secretary of the International Congress of Zoology, and for many years was a constant attendant at the council of the Marine Biological Association. Mr. Bell is part editor of the Museum report on the collections of the

Southern Cross, and he has seen all six volumes of the *Discovery* Antarctic report through the press.

WE learn from *Science* that Mr. John D. Rockefeller has given to the General Education Board, founded by him in 1902, twenty million dollars, the income of which is to be currently used and the entire principal to be distributed within fifty years for the improvement of medical education in the United States. The working capital previous to this accretion amounted to between 35,000,000 and 40,000,000 dollars. Since the present sum is to be devoted exclusively to medical education, whereas the board's previous resources, under the terms of the charter granted to it by Congress, have been devoted to "promoting education within the United States, without distinction of race, creed, or sex," the activities of the organisation with respect to medical teaching will be greatly increased.

ACCORDING to the *Morning Post*, the Norwegian traveller, Dr. O. Olsen, proposes to conduct a small anthropological and botanical expedition to Siberia next spring. Dr. Olsen has had previous experience in Siberia when in 1914 he studied the Soyot tribes in southern Transbaikalia, near the Kitoisk Mountains. His present project is to go to the Yenisei valley north of Krasnoyarsk, and to push thence into the less known regions immediately to the east, with the object of studying several little-known tribes. These include the Dolgans, a Yakut tribe living between the Yenisei and the Khatanga; certain races of Samoyedes; and certain tribes of Tungus. The expedition also proposes to bring back with it, about January, 1921, seeds of Siberian conifers suitable for planting in Norway.

WE have received a copy of the "Annuaire de l'observatoire royal de Belgique" for 1920, edited by M. G. Lecointe. We are glad to note that the publication of this useful little annual was continued throughout the years of the German occupation of Belgium. The observatory at Uccle was held by the Germans, but its scientific work continued. There was no interruption in its publications, and even research did not completely cease. Needless to say, the Belgian staff was responsible for this continuous activity, M. Stroobant replacing for the time M. Lecointe, who was with the Belgian Army.

THE assistant secretary of the British Association, Mr. O. J. R. Howarth, has been charged with the collection of materials for a history of the association. The records available in the office, especially those referring to the foundation of the association, are far from exhaustive, and the loan of any letters or other documents bearing upon the history of the association will be gratefully welcomed by Mr. Howarth at the office of the association, Burlington House, W.1, and they will be duly returned after use.

THE Secretary of the Department of Scientific and Industrial Research informs us that the following research associations have been formed in accordance with the Government scheme for the encouragement of industrial research:—British Rubber and Tyre Manufacturers' Research Association (c/o Messrs. W. B. Peat and Co., 11 Ironmonger Lane, E.C.2) and the Linen Industry Research Association (secretary, Miss M. K. E. Allen, 3 Bedford Street, Belfast).

THE council of the Chemical Society has arranged for the delivery of three lectures during the coming session dealing with the work accomplished by chemists during the war. The first of these will be delivered at Burlington House on December 18 at 8 p.m. by Prof. James Walker, who will lecture on "War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes."

THE council of the Ray Society has appointed Dr. W. T. Calman, of the Zoological Department, British Museum (Natural History), to be secretary in succession to the late Mr. John Hopkinson.

THE annual report for 1918 on the Forest Administration of Nigeria shows the number of forest reserves to be gradually increasing. Their total area now amounts approximately to 1462 square miles in the Southern Provinces and to 3965 square miles in the Northern Provinces. Plantations continue to be made, in spite of the greatly depleted European staff and the disorganisation caused by the influenza epidemic. Apart from mahogany and *Albizzia lebbek*, the species that have proved most successful are *Cassia siamea*, *Dalbergia sissoo*, *Grevillia robusta*, and *Melaleuca leucodendron*, all of them exotics. In fact, it is very probable that, as experienced in South Africa, the planting difficulty in the Northern Provinces will be solved only by the introduction of suitable exotics. Hence these operations must, for some years to come, be of an experimental nature.

A NUMBER of papers dealing with marine biological and fishery subjects have recently been published. The Danish series, "Meddelelser fra Kommissionen for Havundersogelser," contains articles on purely fishery, hydrographic, and biological investigations. A very useful account of the North Atlantic halibut fishery, including work on the biology of the species, as well as on its exploitation by fishing vessels, is given by P. Jespersen in Bd. v. (No. 5) of the Fishery Series, and a very interesting paper by A. C. Johansen in the same series deals with the biometrics of the spring-spawning herrings that form the bulk of the fish caught during the great spring and summer fisheries. There is also an account of fish-marking experiments carried out on the Faröese fishing grounds. This is local in its scope, but it is interesting to see, from the results, to what an extent this region must have been exploited by British trawlers in the years immediately preceding the war.

IN Report No. 4 of the Industrial Fatigue Research Board Mr. Major Greenwood discusses "The Incidence of Industrial Accidents upon Individuals, with Special Reference to Multiple Accidents." As a result of an elaborate mathematical analysis of a large mass of statistical data, Mr. Greenwood comes to the conclusion that the distribution of accidents among the employees at a factory is by no means a matter of chance, but that certain individuals are much more liable to accidents than others. This susceptibility to accidents is not due to the workers being quicker at their job than their fellows, nor do they differ from them appreciably in general health. It seems to be a matter of personality, and not determined by any obvious extrinsic factor. As Mr. Greenwood points out, the weeding-out of these specially susceptible individuals would lower the average accident-rate of a factory considerably, and it might, in certain instances, have a more important effect than this. In some industries, such as certain of the explosive-supply trades, an accident may lead to frightful disaster, and it might be well worth while to track down these unsafe people by a study of the ambulance-room records and get them transferred to a less risky industry.

THE limitation of human settlement in South Africa through deficient water-supply has moved Prof. E. H. L. Schwarz to undertake a journey to Ovamboland, a little-known district north-west of the Kalahari region, which seems threatened by the desiccation that has overtaken the country to the south. In a paper entitled "The Kalahari Lake Scheme" (*S. African Mining and Engineering Journal*—the complete reference is not given on the separate copy sent us), Prof. Schwarz proposes to save Ovamboland and its native population by damming the Cunene River at the cataracts and diverting the water that now flows into the Atlantic back into a depression known as the Etosha Pan. Hence irrigation could be arranged northwards and eastwards. A "Makarikari Lake" is also proposed as a development of the Soa Pan, west of Bulawayo, and from this irrigation might be possible in the eastern Kalahari down the channels of streams flowing to the Orange River. The scheme is already exciting discussion in the States of the Union.

IN a recently published memoir of the Carnegie Institution of Washington (No. 285), Prof. T. H. Morgan gives an account of his experiments relating to the secondary sexual characters of poultry, and discusses at some length the genetic and operative evidence with regard to secondary sexual characters in general. In some breeds of poultry, notably Sebright bantams, the cocks are feathered like the hens, lacking the long, silky hackles of the neck and saddle, and the curved sickle feathers in the tail that distinguish the cocks of normal breeds. Prof. Morgan demonstrates by crossing experiments with game bantams—a breed with the normal sexual differences of feathering in the cock—that the hen-feathered condition is dominant. His figures suggest that two factors are concerned, but the experiments are not sufficiently extensive to render this certain. Castration experiments were performed on the Sebright cocks and some of their hen-feathered progeny, and the interesting fact was disclosed that removal of the testes results in the male assuming a type of plumage characteristic of the cocks of normal breeds. The fact is of great interest in connection with the recent work of Goodale, who showed that removal of the ovary from the hen leads to the assumption of the male plumage. A further point of interest lay in the demonstration of luteal cells in the testes of hen-feathered cocks, similar to those which are known to occur in the ovary of normal hens. Cells of this type are stated to be absent from the testes of normal cocks. The greater part of the memoir is taken up with a discussion of secondary sexual characters in animals generally, in relation both to Darwin's hypothesis of sexual selection, and to the many other views which have been put forward at various times since. A brief review is also given of the heredity of the colour of the plumage in domestic fowls. The memoir contains an ample and useful bibliography, and is well illustrated with coloured and other plates.

THE economic value of the forests of New Zealand is discussed by Mr. D. E. Hutchins in the Transactions of the Royal Scottish Arboricultural Society (vol. xxxiii., part 2, July, 1919). The forests are of great value, and admittedly the best soft-wood forests in the southern hemisphere. In quality New Zealand timbers come before those of Europe and Australia and after those of North America. The valuable kauri-pine (*Agathis australis*) is the largest timber-producing tree in the world, owing to its massive bole having little or no taper. At one time there were about three million acres of kauri forest in New Zealand, now reduced to about half a million, in the extreme north. The next most valuable timber is supplied by another conifer, Totara (*Podocarpus totara*); it is very durable and of a fine colour. This tree is generally distributed through the North and South Islands. A third conifer, Rimu (*Dacrydium cupressinum*), also abundant throughout the islands, is the common house-building timber, a deep red, strong, hard, and heavy wood. White pine (*Podocarpus dacrydioides*), one of the tallest trees in the colony (the writer records one of 210 ft.), has white, easily worked timber suitable for inside work. Honeysuckle (*Knightia excelsa*), a tall, handsome tree with beautifully variegated wood, has never been exported. There is a large class of so-called secondary timbers in New Zealand forests which have never been utilised. The writer deplores the destruction of forests without any attempt to discriminate between land best suited for farming and land best suited for forestry. In 1886 the forest area of New Zealand was estimated at 21,000,000 acres, which by 1909 had become reduced to about 17,000,000 acres. The forests even in their present reduced and neglected condition are worth more than all the known mineral wealth of New Zealand, and they still offer more employment than any other industry. Compared with sheep-farming, the New Zealand forest, if worked as are forests in Europe, would afford about ten times the employment.

IN the *Indian Forester* for July last, Mr. H. H. Haines gives an elaborate description, with figures, of the various shrubs belonging to the genus Carissa, the bark and leaves of which are an important source of tannin. Thirteen species have been described by various authors, but these are reduced by Mr. Haines to five distinct species with several varieties.

MR. ALEX. L. HOWARD wrote some time ago in the *Timber Trades Journal* a series of short articles giving a popular description of the most important woods that are imported into London from India, with notes upon their properties and uses in this country. These articles are now issued by Messrs. W. Rider and Son in pamphlet form, entitled "The Timbers of India" (pp. 16, quarto, price 2*s.* 6*d.*).

IN the description which appeared in NATURE of October 9 of the aurora of October 1, and the simultaneous magnetic storm, several observations were recorded, but unfortunately the time reckoning is not the same throughout. The observations described in the first and last paragraphs were received from the Meteorological Office, and the times mentioned in them were all referred to the civil day, which runs from midnight to midnight, whereas in the other paragraphs describing observations at Bristol and in the Isle of Man the astronomical "day" seems to have been used. When the change of time reckoning to which astronomers have agreed comes into force, the risk of similar accidents will be obviated.

SIR ROBERT HADFIELD has just issued copies of a Foreword which he prepared on the occasion of the Prime Minister's recent visit to Messrs. Hadfield's works at Sheffield. Sir Robert has some timely remarks on the labour situation in the country and the extreme necessity for joint intelligent effort on the part of capital and labour, without which understanding the burden of debt arising from the war cannot be wiped out. During the present year many hundreds of valuable working hours have been lost as the result of trade disputes; but it is really hard to see what can be done without increased enlightenment of the working classes, whose destinies may be said largely to rest with themselves. Sir Robert pleads for the revision of the existing patent laws in this country, so that all classes, without distinction, may benefit from the fruit of their discoveries.

Some space is devoted to the importance of inventions and research in connection with war munitions, and it is interesting to note that Sir Robert's firm is now in a position to manufacture a heavy calibre naval shell which, for range and piercing power, will far outstrip anything previously accomplished. Invention should be stimulated and every effort made to discover fresh inventors, and, once they are discovered, to encourage them to give their ideas to the world so that everyone may benefit from them.

CONSIDERABLE interest is attached to the description in *Engineering* for October 10 of the geared turbines supplied by the De Laval Steam Turbine Co. to the Swedish destroyers *Wrangel* and *Wachtmeister*. The high- and low-pressure turbines occupy separate casings, and drive pinions engaging on opposite sides of the main gear wheel. The high-pressure turbine casing accommodates a cruising element, and the low-pressure turbine an astern turbine. The wheels of both high- and low-pressure turbines are designed to make 3600 revs. per min. at full power, and the maximum peripheral speed is 180 metres per second. The cruising element consists of one velocity-compounded wheel, followed by a simple impulse wheel. The main turbine has four wheels. The astern turbine has one velocity-compounded wheel with two rows of blading, followed by a simple impulse wheel. The aggregate shaft horse-power at full power is 11,000, with the propellers running at 450; the astern shaft horse-power is 4400, with propellers running at 250. With steam 97 per cent. dry, the turbines were guaranteed to consume not more than 5·2 kg. of steam per shaft horse-power hour at full load. Double helical gear wheels are used for speed reduction, and the pinions are rigidly mounted. The pitch line speed at full power is 35 metres per second. Michel thrust-blocks have been fitted, and their remarkable qualities confirmed by the tests.

OUR ASTRONOMICAL COLUMN.

NOVÆ.—Yet another nova has been found on the Harvard plates, this time by Miss Woods (Harvard Bulletin 693). Position for 1875: R.A. 18h. 24m. 6·2s., S. declination 29° 28·9′. Its former magnitude was 14, but it rose temporarily to 11 in 1901. On April 24, 1919, it rose to 7, and has now sunk again to 12, its image appearing nebulous. The magnitudes are photographic.

Pubs. Ast. Soc. Pac., August, 1919, contains a paper by Dr. Shapley on a nova of another kind that was discovered by Prof. Wolf two years ago, and independently by Prof. Barnard in the present year. Its place for 1917·0 is R.A. 17h. 35m. 13·45s., S. declination 11° 53′ 57·6″; its photographic magnitude is 11 (Harvard scale); spectral type, FO; radial velocity large and positive. All plates exposed before 1909 fail to show it; all since 1910 show it. Three interpretations are suggested:—(1) That it is really just beginning its stellar career, in which case it is of unique interest; (2) that it is a long-period or irregular variable, somewhat like η Argûs; and (3) that it has just emerged from behind an obscuring nebula. To test this last suggestion, Dr. Shapley took a long exposure with the 60-in. reflector and studied the distribution of faint stars. The results, given in the paper, while not inconsistent with the hypothesis, give no decisive evidence in its favour; there is no distinct line of demarcation of stellar density, as in some of Prof. Barnard's dark nebular regions. However, a much smaller cloud than these would suffice in this case.

Mr. Joy has made an estimate of the star's distance by the Adams spectroscopic method, finding 500 parsecs. A Harvard plate of 1909 July 9 shows it of magnitude 14·4; 1910 March 21, 11·3. Since 1915 it has been 11.

Both Mr. C. P. Olivier (*Ast. Journ.*, No. 757) and Messrs. Van Maanen and Sanford (Pubs. Ast. Soc. Pac., August, 1919) publish preliminary values of the parallax of Nova Aquilæ 1918. Their values (absolute parallax) are 0·060″ and 0·009″. The latter, which implies a distance of 362 light-years, is close to the values found for Nova Persei, both by direct measures and by the expanding nebular illumination. All the observers contemplate further measures when the brightness of the nova has sunk nearly to that of the comparison stars.

THE SUN-SPOT CURVE.—Mr. Seth B. Nicholson gives an interesting curve of sun-spot activity in Pubs. Ast. Soc. Pac., August, 1919. It is constructed simply from the number of spots, regardless of area. Mr. Nicholson places the late maximum in September, 1917, and the curve since then shows a notable decline. The previous maximum is placed in May, 1905, and is both flatter and lower than the recent one. The minimum is shown in June, 1913. There are also curves of the mean latitude of spots, which show that the fall in latitude since the last minimum has been much steeper than in the preceding cycle.

Mr. Nicholson directs attention once more to the resemblance of the spot-activity curve with the light-curve of Cepheid variables. The sun's surface is certainly not pulsating, as those of the Cepheids are believed to be; if the resemblance of curve means anything, it suggests that there may still be remnants of pulsation in the sun's interior.

SOLAR RADIATION.—Mr. C. G. Abbot (Proc. Nat. Acad. Sci., U.S.A., September, 1919) gives an account of the simultaneous measures of solar radiation made in 1918 at Mount Wilson and Calama, Chile. The results give still stronger support to the hypothesis that the short-period variations in the radiation are in the sun itself than did those at Mount Wilson and Algeria in 1911–12. Mr. Abbot states that the Calama results are telegraphed to Argentina, and successful predictions of temperature are based upon them. He suggests additional radiation stations at various cloudless regions, which he anticipates would be of great utility in weather prediction.

NEW SOURCES OF ALUMINIUM IN NORWAY.

DURING the war neutral as well as belligerent countries had to search within their own borders for those raw materials which formerly they were content to import; new occurrences of well-known ores have been discovered, and new methods devised for winning important products from rocks which hitherto have possessed no commercial value. Norway was particularly hard hit by the curtailment of international trade, and, amongst other problems, that of finding a home source of aluminium presented itself, and seems to have received a promising solution.

The metal aluminium can be obtained by electrolytic means from its oxide, and nearly all the suggested methods of manufacture depend upon this as a final stage, the main difficulty being the preparation of a sufficiently pure oxide, free from iron and silica. The ore commonly used is bauxite, after a rather costly preliminary purification by the Baeyer process. At the outbreak of war the Central Powers utilised their available bauxite, including the small deposits of poor quality in Germany; but the necessity of finding a more widespread source was felt, and a process was discovered and successfully put into operation by Dr. Buchner, of Heidelberg, for winning the metal from kaolin and kaolin-rich clays. Clay is extracted with sulphuric acid, and, after removal of the iron, the alumina is precipitated from the solution with ammonia, four tons of a clay with an alumina content of 30 per cent. yielding one ton of the oxide. This process seems to have a considerable future before it, and plans are laid for its introduction on a large scale into Sweden.

There is no bauxite in Norway, and it was first proposed to work the clays after the Buchner and other suggested methods. This, however, has for the most part proved impracticable owing to the unfavourable character of the clays, which are relatively unweathered glacial deposits, not only poor in alumina, 16–20 per cent., but with part of it bound in alkali felspar, and therefore unavailable. In 1917 Prof. V. M. Goldschmidt, of the Mineralogical Institute, Kristiania, conceived the idea of using labrador-stone as a source of aluminium.[1] Labrador-stone is a white rock extensively developed in south-western Norway, and especially in the inner Sognefjord district, where it builds the huge laccolitic mountain masses so familiar to tourists, by whom it is commonly mistaken for marble. The main constituent of this rock is a plagioclase felspar of the labrador group, the more felspathic varieties containing only a very small amount of iron-bearing pyroxenes, and with an alumina content of 30 per cent. Prof. Goldschmidt has found that the felspar is surprisingly soluble in dilute acids, so that it can be dissolved out, leaving a residue of insoluble ferro-magnesian minerals and silica. The calcium and sodium oxides of the felspar, 13 per cent. and 5 per cent. in amount respectively, go into solution with the alumina, and, using sulphuric acid, there is thus a considerable loss in the form of a useless by-product. This method is rejected for the manufacture of alumina, although it is used in the preparation of sufficient quantities of aluminium sulphate to satisfy Norwegian needs. By using nitric acid as a solvent, not only is a waste of acid avoided, but the precipitation with ammonia can be dispensed with—a valuable consideration in Norway, where ammonia cannot be obtained cheaply in quantity.

The main features of the process, which has been worked out by Prof. H. Goldschmidt, are as follows:—The labrador-stone is extracted with dilute nitric acid, the 30 per cent. acid, first raw product of the electrical air-industry, serving for this purpose. The silica and greater proportion of the iron minerals remain insoluble, aluminium, calcium, and sodium going into solution together with a little iron. After removal of this iron the solution is evaporated down and the residue heated to a certain temperature at which the aluminium salt alone is decomposed, the nitric acid driven off being collected as a valuable concentrate. By washing with water the nitrates of calcium and sodium are removed, to be recovered and used in agriculture, the alumina remaining.

This process seems to be full of promise for Norway—a country with such abundant water-power, a flourishing nitric acid industry, and an unlimited quantity of a raw material which few other countries possess; and hopes are entertained that a product will be obtained which will not only suffice for local needs, but also win a footing in the world's rapidly expanding aluminium market. L. Hawkes.

[1] "Om Aluminiumfremstilling av Norske Raastoffer." By V. M. Goldschmidt. Særtryk av Tidsskrift. for Kemi, No. 2, 1919.

HYDRO-ELECTRIC DEVELOPMENT WORKS.[1]

An extremely able and informative paper has recently been contributed to the Institution of Electrical Engineers by Mr. J. W. Meares, chief engineer of the Hydroelectric Service of India, dealing with the general principles of the development and storage of water for electrical purposes—a subject which is of the greatest interest at the present time from an industrial and economic point of view. Mr. Meares's paper is a general survey of the various problems connected with the inception of hydro-electric installations; it outlines the conditions essential to the satisfactory development of any scheme of water-power, for it must, of course, be borne in mind that it is quite possible for a country to have considerable water resources, say, in the form of rivers, which are incapable of economical development. The paper treats of all the preliminary considerations relating to the gathering of supplies, flow and storage, the lay-out and efficiency of hydro-electric plant, and the principles underlying the design of headworks, canals, and delivery mains.

Supplies of water at different heads entail distinct methods of treatment. The heads may be broadly grouped as high, medium, and low, in which, without too rigidly defining the boundary lines, high heads are taken at from 300 ft. or 400 ft. to a possible 5000 ft., low heads from 3 ft. as a minimum to, say, 80 ft. or 100 ft., with medium heads between these limits. A high head is associated with small volumetric flow, and a low head with a large flow; the former is adapted to jet-impulse wheels of the Pelton type, and the latter to pressure, or reaction, turbines.

In areas dependent on the collection of rainfall for supplies, the amount of fall and the run-off are important considerations. The following empirical table devised by Mr. G. T. Barlow, formerly Chief Engineer of the United Provinces, India, gives a working hypothesis for preliminary calculations which, while perhaps inapplicable to many parts of Europe or America, affords a clear indication of the nature of the variations to be met with in a particular locality:—

	Percentage run-off				
	A	B	C	D	E
Light falls, say under $1\frac{1}{2}''$ in 24 hours	1	3	5	10	15
Medium falls, say from $1\frac{1}{2}''$ to $3''$ in 24 hours	10	15	20	25	33
Heavy falls, say above $3''$ ...	20	33	40	55	70

A is flat, cultivated and black cotton soil catchment.
B is flat, partly cultivated and stiff soils.
C is average catchment.
D is hills and plains, with little cultivation.
E is very hilly, steep, and rocky, with very little cultivation.

The paper also contains a table giving the over-all commercial efficiency of hydro-electric plant as follows:—

For 500 kilowatts	74 per cent.
,, 1000 ,, ...	76 ,, ,,
,, 1500 ,, ...	78 ,, ,,
,, 2000 ,, ...	80 ,, ,,
,, 3000 ,, and over ...	82 ,, ,,

As a rough approximation, the capacity of plant in kilowatts may be obtained by dividing by 15 the product of the quantity of water in cubic feet per

[1] "The General Principles of the Development and Storage of Water for Electrical Purposes." By J. W. Meares.

second into the head in feet; the b.h.p. of the turbine will be given by one-eleventh of the same product.

The ground covered by the paper is too extensive to admit of adequate notice in the space at disposal. From the foregoing extracts the paper will be seen to be replete with useful information.

BRYSSON CUNNINGHAM.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION F.

ECONOMIC SCIENCE AND STATISTICS.

OPENING ADDRESS (ABRIDGED) BY SIR HUGH BELL, BART., D.L., J.P., PRESIDENT OF THE SECTION.

THE cessation of hostilities did not carry with it the cessation of expenditure. The figures given each week in the *Economist* show the daily disbursements of the kingdom to have amounted to 6,500,000*l.* for the twenty-one weeks from November 16 to April 12. Our expenditure from August 24 to November 9 amounted to 585,500,000*l.* From November 23 to July 8 we expended 564,000,000*l.*, a reduction of only 21,500,000*l.*, or about 250,000*l.* a day. The debt with which the war burdened us continued to augment long after the cause of it had ceased to operate. We are still vastly exceeding our income. Even if we take into account the interest on the war debt, which amounts to about 1,000,000*l.* a day, it is clear that the various obligations undertaken by the Government during the war continue to impose on us a huge expenditure which is largely in excess of our revenue.

New claims are made on the national purse and are accepted with the same apparent light-heartedness and disregard of consequences which mark so many previous acts of those responsible for our expenditure both during the war and before it.

The call made on the men and women of the nation for services differing from those to which they had been accustomed involves great changes in the conditions of those affected. Some compensation for these sudden changes was, no doubt, inevitable. The disorganisation of the whole industrial machine made it difficult, if not impossible, to turn these different classes adrift into a world in the chaotic condition into which the war had thrown it. But it does not follow that this compensation should have been given in a way actually to encourage unemployment. There are only too many indications of a general tendency to extravagant expenditure which must be checked before the course of our economic existence can return to normal lines. To enable us to do this we must consider what has happened to the world economically since August, 1914.

The first and perhaps most striking change to be noticed is that in these five years an immense quantity of wealth has been destroyed.

There must be many hundred thousand acres of cultivated land, with the apparatus required for its cultivation, which has been reduced to a state of complete desolation. It is difficult to see how it can be brought again into use at an early date. The mere clearing away of the wire entanglements must be a costly operation. Great quantities of shell abandoned by the Germans in their hasty retreat still cumbered the ground they had occupied. These must be carefully removed—not a very simple operation, and one which must be carried out under skilled direction.

Can anyone doubt the huge destruction of wealth which has occurred? But it is really worse than it appears, for the very process of destruction was even more costly than the damage which was done. Millions of tons of steel in the form of guns and their projectiles—millions of lives had gone to produce this untoward result. For fifty months all the energies of the most active and energetic people on the globe had been turned from beneficial enterprise to work of which the result was the annihilation of vast masses of wealth.

When all these things are considered it is not surprising to find our estimate of the cost of the war reaches a total the mind cannot grasp. When you begin to speak of pounds by thousands of millions, the difference between twenty-five and forty is scarcely noticeable. But be the sum larger or smaller, the all-important fact to be borne in mind is that the wealth which it represents has passed out of being.

So much confusion exists on this subject that it is worth while dwelling on it for a moment. Some contend that there has been a mere change of wealth from one ownership to another. Into whose possession, may we ask, has passed the wealth which used to exist in the towns and villages and cultivated land of the battle area? It is true that the steel which went to effect this destruction has been paid for, but from what source has that payment come? Let us think what might have happened but for the war. The steel might have made rails and been laid on a railway to bring the produce of Central Africa to lands ready to pay for it and desiring to consume it for useful purposes. For all time there would have arisen in the process an income which would have gone to support in comfort those receiving it, and its surplus after this had been effected would have served to add yet more miles of railway and to bring yet more tons of useful produce. All this energy has been dissipated in the manner indicated, and all that remains is the obligation of the "State" for all time to pay interest on a debt which has been created.

There is, as it seems to me, but one way to escape from the situation we have created. No measure of confiscation, however disguised, will remove the burden under which we lie. It may be decided to alter the incidence of the burden from one set of shoulders to another. Any proposal of the kind must have very careful and earnest consideration.

If a really sound and equitable scheme of taxation could be devised, each taxable unit would contribute to the common fund raised for the purpose of the Government an amount which would be arrived at after due allowance was made for his services to the community and his ability to pay. A bachelor, with no claim on him but to support himself without State aid, who had done nothing to provide for a citizen to take his place in the fullness of time, might be called upon to pay more than a man under obligation to maintain a family, and supply, by his children, the means of carrying on the torch of progress.

One of the chief objections of graduation seems to be the danger of gradually increasing the steepness of the scale until the higher incomes would be taxed out of existence and the revenue they produced disappear. This would, no doubt, bring its own remedy. The State needs a certain annual revenue to provide the services demanded by the community. If the result of taking much the greater part of incomes over a certain amount ends by extinguishing these, the State will cease to derive the revenue on which it counts. It must then either reduce the tax on them until a point is reached at which they will continue to exist, or it must increase the tax on all or some of the other incomes. Unless it means to rush headlong into bankruptcy, it must find the point of equilibrium at which its scheme of graduated taxation continues to produce the revenue required, not in any one year, but in all future years. Such a scheme, could it be discovered, would meet entirely that very important desideratum of a tax, namely, that it should be based on ability to pay.

Two other points must be kept in view. A tax must be equitable in its incidence and reasonably continuous in its imposition. Given these three conditions, the economic burden of the impost will quickly fall on the right shoulders. We may dismiss the argument which asks for a levy on capital, and defends it against the accusation of being confiscatory on the ground that it is no more confiscatory than any other means of raising money by the State. No juggling with the balance-sheets of the nations of the world will get rid of the fact that many thousands of millions of wealth slowly accumulated in the generations which lived before August, 1914, have been dissipated.

[After a brief examination of the changes in the amount of the National Debt for the past century and its gradual reduction since 1814, the address proceeds:—]

In the last five years all this has been changed. From August, 1914, to March, 1915, 450,000,000*l*. were added. The next year added more than 1,000,000,000*l*. By March, 1917, it stood at 3,906,000,000*l*., and now it has nearly doubled, and is more than ten times what it was at the outbreak of the war.

It is true we have something to set against this vast sum. We have acted as the financial agents of our Allies. The sums we have found for them amount to close on 2,000,000,000*l*. On the other hand, we have ourselves contracted debts abroad to the extent of well on to 1,500,000,000*l*. On balance, therefore, we have interest to receive on about 400,000,000*l*. to 500,000,000*l*. But to enable the inhabitants of this country to find money for our Government, we have sold fully as large an amount of our holdings in foreign securities. It may be contended that we are little worse off. I fear on closer examination this view will not be found good.

Let us admit that our Allies will find no difficulty in paying the 100,000,000*l*. a year or thereabouts due for the interest on their debt to us. We must recognise that this will make a serious draft on their resources. Very different were the securities held by individuals in this country with which they parted to take up each successive issue of Government Bonds at the urgent insistence of successive Chancellors of the Exchequer. The securities sold were usually first-class industrial or public utility issues. What have we got now? A charge on a heavily burdened country of which, it may be, many thousand acres have passed out of cultivation for years to come.

Put at the highest, not many of our millions of pounds will find their own interest. All the balance must come out of the product of the other and real industries of the debtor country, and to this branch of the subject we must now turn.

At the present moment it is of more vital importance than ever that we should come to a clear and unprejudiced understanding on this subject. To judge by appearances, the vaguest opinions exist as to the capacity of the community to meet the various claims which are preferred for a share of the wealth from which alone these claims can be satisfied. Many people seem to think that no demand is too exorbitant. We are asked to provide houses by the hundred thousand, undeterred by the consideration that they will cost two-, three-, or even four-fold the amount at which they could have been built before the war. They are, moreover, to afford accommodation of a much better character than was thought sufficient a very short time ago. Houses built so recently as twenty years ago are no longer good enough for the social reformers of to-day. It is forgotten that something like 80,000 houses are needed each year to accommodate the growth of the population. There are to-day something more than eight million inhabited houses in Great Britain. Not more than half of these are above fifty years old. During the war housebuilding had almost ceased, but before 1914 the building of houses had been checked by two causes. The various Acts of Parliament dealing with matters affecting the building of houses had so enhanced their cost that there was the greatest uncertainty whether houses could be built to return a reasonable interest on their cost.

But the second cause was of as great, or possibly even greater, significance. The trade unions connected with the building trades had gradually succeeded in imposing conditions which had added enormously to the cost of building. It would not be difficult to show why this had been possible, but it would take us too far to follow this line of thought. The fact will not be denied by anyone conversant with the circumstances. The result of all this is a serious shortage of houses, and this it is proposed to make up by grants from the public purse. If this were the only demand of the kind we might face it with more equanimity than is in fact the case. But when we look elsewhere we see other claims comparable in their effects on the public purse, but differing in kind.

The railway enterprise in this country may serve as typical of what is meant. Prior to the war the railways were carrying on their duties in a manner which enabled the country to get through its business in a profitable and, on the whole, fairly satisfactory way. They earned sufficient revenue to pay a fair return to the shareholders. It is true the prospect was not reassuring. The railway management was meeting the usual contradictory claims preferred against almost every industry. It was asserted that they were rendering services which were not nearly so great as were demanded by their customers, and they were charging for them rates which were regarded as quite out of proportion to the value of the services. On the other hand, they were paying wages which the recipients thought entirely inadequate, for much longer hours of service than their workmen were disposed to give. Negotiations between the parties had obtained certain concessions as to hours of work, and also as to rates of pay; but these were not accepted as sufficient, and Parliament was called upon to intervene, with the result that statutory hours were imposed.

The very essential difference between hours of work or rates of pay resulting from convention between the parties interested and the same imposed by statute is often overlooked. The convention can be varied to meet the varying circumstances. The statute provides a hard-and-fast rule, from which it is impossible to depart without incurring penalties.

When the railway companies pointed out the serious effect which these statutory obligations imposed on them had on their revenue-earning capacity, and sought power to increase the rates, their customers were up in arms. The very men who, in Parliament and elsewhere, were applauding the decision to give relief to the railway servants, resolutely refused to pay the extra cost thus incurred. With difficulty was Parliament induced to give the companies leave to add to their charges something towards meeting this cost. The companies found still greater difficulty in obtaining a settlement with their customers as to the amount which should be so added. The question was still awaiting a final settlement at the outbreak of war.

[The position of the railways is examined; the small yield to the shareholders is set out; the need of the expenditure of fresh capital to enable the companies to cope with the growing traffic is stated; and the address proceeds :—]

There has been a persistent demand by labour throughout the country for better pay, and an equally persistent demand for more leisure. To these demands no objection can be taken. On the contrary, rightly understood, they must meet with approval by all who desire to see the country, as a whole, happy and prosperous. But we must consider how they can be satisfied.

The only source from which satisfaction can be derived is the sum-total of the product of the industry of the country, and indeed of the world, in the period under consideration. It must be noted that in many cases the product may not be realised within that period, as, for example, when a manufacturer holds large stocks of goods which he has not yet marketed, but on which much the greater part of the cost has been paid. It must also be noted that a very considerable part of the industry of the country does not add to the total product which is the subject of division, but is, in fact, a charge on that product. The whole burden is borne by those engaged in providing commodities or services necessary for the members. We touch at this point a very difficult problem, the proper solution of which may possibly show us how all our economic troubles may be ended. I can do no more than state it as briefly as may be.

There can be no question that a very great part of human activities is spent, and the resulting product used, in providing things which cannot be called necessaries of existence. The simplest food, clothing, and shelter may be said to cover all that comes under this head. But life that gives us nothing but the indispensable minimum of these essentials would be so dull and monotonous as to be scarcely worth the exertion needed to procure them. We must have more than these if we are to get enjoyment as well as mere life. How much more can we claim—perhaps we might say, extort—from our environment? And how shall this extra tribute be shared among us?

If we made a complete analysis of the division of the product of industry we should be astonished to find how large is the amount which remains after the essential demands have been satisfied. If we sought to classify our expenditure we might come to some such division as this :—

On essential needs.

On things making for the irreproachable amenities of life.

On luxuries which add to and aid our reasonable enjoyment.

On those which subserve mere pleasures.

On extravagant expenditure for which no justification can be offered.

It is difficult to draw any clear line between the heads of this very rough division. Each class passes imperceptibly into the next. Fortunately for our present purpose, we do not require to do this. It is enough that we should admit that not all activities are well directed, and that we consume a great many things we could do without. No class is exempt from this blame, if blame it be. Each is disposed to look askance at what is called the extravagance of some other. When people talk of waste, they often mean expenditure on things for which they themselves do not care. But the question is: How can we check this extravagance and provide more fully for the more essential needs of the whole people?

If rich men did not drive motor-cars or drink costly wines, would the people who produce these luxuries be better off? Or if, instead of making these things, they made articles needed for the mass of the people, could these buy the result if they had no more means than they now possess? Do we not come back at the end to the proposition that men can have more only if they have more to offer in exchange?

It may be contended that men have obtained more or less completely what they wanted most urgently. They wanted shorter hours. In many trades they have got them, and might have had them in more had they gone about it in the right way. They were not sufficiently desirous of having better houses, and they failed to procure what their well-wishers desired for them.

A relatively small part of the population does unquestionably get a very large share of the total income produced by the whole community. Can we do anything by which this share may be reduced without bringing about greater evils than those we seek to overcome? The history of the sumptuary laws does not encourage much hope that attempts to prevent expenditure in particular directions will have much success. My own studies had brought me, many years ago, to the conclusion that in every industry examined there is no way of giving to those engaged shares greatly differing from what has been afforded in the past. The margins on which manufacture in general is conducted are too small to make it possible to give the larger contributors to the ultimate result any considerable addition to what they have been accustomed to receive. This impression was confirmed by the elaborate general survey of the industry of the kingdom carried out by the Census of Production of 1907.

No doubt labour (which is much the most important item of cost) has obtained a gradually increasing payment, though not necessarily any larger proportionate share. A steady improvement in the methods in which the labour of men is applied has resulted in enabling a larger product to be obtained. Each new implement, each fresh application of energy of various kinds, as, for example, steam and electricity, has meant that the individual man produced more in his day's work, and he got, in fact, a larger return for what he did. But at the same time the capital engaged was increased, and consequently the proportion of the product to be allotted to rewarding capital also increased. It is neither possible nor desirable to attempt to alter this state of things.

The whole question has been treated in a very masterly way by Prof. Bowley in a book published some months ago, entitled "The Division of the Product of Industry." Mr. Herbert G. Williams's pamphlet, entitled "The Nation's Income," also deals with the same subject with much care and skill. In it he makes a critical examination of Sir Leo Chiozza Money's book entitled "Riches and Poverty."

The conclusion reached in these publications is practically the same. It may be stated, in the cautious words with which Mr. Bowley ends his book :—

"This analysis has failed in part of its purpose if it has not shown that the problem of securing the wages, which people rather optimistically believe to be immediately and permanently possible, is to a great extent independent of the question of national and individual ownership unless it is seriously believed that production would increase greatly if the State were sole employer. The wealth of the country, however divided, was insufficient before the war for a general high standard; there is nothing as yet to show that it will be greater in the future. Hence the most important task—more important immediately than the improvement of the division of the product—incumbent on employers and workmen alike, is to increase the national product, and that without sacrificing leisure and the amenities of life."

I shall have failed in my object if I have left my hearers under the impression that I am wedded to or pleading for any particular division of the wealth of the country. We hear much talk about abstractions called "capital" and "labour." The terms are convenient enough if we do not let ourselves be deluded with the idea that they mean more than the sum of those who own the capital or supply the labour. Labour itself is a somewhat ambiguous term. Until comparatively recently the members of the "labouring classes" so called thought it was synonymous with the man who laboured with his hands. The Labour Party itself has been fain to enlarge its definition so as to include all those who "labour by hand or brain." Not one of us is independent of capital. The most poverty-stricken member of the community relies as implicitly on it as the richest among us. To talk of the "abolition of capital" is to use a form of words which is absolutely meaningless. What most people who use them really mean is one or other of two things, sometimes both at the same time—either that the capital is in the wrong hands and that it should not be held in the way or to the amount which is at present the case, or that the division of the joint product of capital and industry is defective and should be altered.

I see great difficulty in saying no man's fortune shall exceed some given sum, and even in saying no man shall bequeath to his survivors more than some very moderate amount. In either case I should fear endangering that building up of capital which, however it may be divided, is essential to our national progress.

When we come to the division of the joint product of industry and capital other considerations become apparent. The question at once arises whether any other division would have been possible in the past, or could be accomplished in the future, without great changes in the way in which the product arises. Reference has already been made to my own examination of this matter, which leaves me in no doubt that any considerable increase of the part of labour would have left the share of capital so small as to have stifled enterprise.

This does not mean that large fortunes may not have been made by those whose skill and industry and enterprise enabled them to seize the advantages presented to them.

Those who cry out against capital overlook the fact that in modern industries no man can be set to work except by means of a capital sum first found for the purpose. In the industries I know best something above 200*l*. is needed to put a man to work. The population of this country increases at the rate of about 1 per cent. per annum. This means that for every 1000 men to whom employment is being given, about ten youths are ready to be set to work each year, and something above 2000*l*. must be found year by year to give them employment.

One further point must be made. Men see some great enterprise (and the railways will serve very well as an example), and look upon it as a capitalist organisation. But when the circumstances are examined it is found that it consists of a multitude of small holdings, and comparatively few of large amount. In the North-Eastern Railway something like 60,000 shareholders hold the 83,000,000*l*. of capital of various denominations—say, on the average, some 1400*l*. each. Consider the widespread distress which would be caused if the income from the sum were to cease.

I have made a similar calculation for a large colliery undertaking in which I am interested, with the following result. The capital in shares and debentures is about 1,300,000*l*. There are a little more than 1800 shareholders. We employ 5500 men. Each shareholder therefore provides employment for about three men, and holds on the average 725*l*. Before long we shall require further capital. We see our way to enlarge our operations and so to provide employment near to their homes for the fifty to sixty youths who, each year, grow to manhood, and need productive employment if they are not to become burdens on the community. We hope our 1800 shareholders will have laid by enough to provide the 12,000*l*. a year which is necessary for this purpose. We are assuming they or someone will provide it, for we are using our resources (reserves and depreciation funds) in this way, and shortly it will be incumbent on us to fund this obligation and add it to our capital.

We are thus brought to the last subject which I desire to consider with you—the widespread tendency towards what is somewhat vaguely called Nationalisation. It may be questioned whether any large number of people have very clear ideas what is meant by the term.

Let us assume for the present purpose that it signifies that the State shall become the owner of any enterprise which is nationalised—as it owns the business of the Post Office, the Telegraphs, and the Telephones. Let us ask what advantage will be gained by the assumption of ownership. A centralised management, even of so simple a business as that of collecting and distributing letters and parcels, has not been an unqualified success. Where the business is more complicated, as in the other examples, the success has been even less conspicuous. What reason have we to hope, then, in such intricate matters as the railways or the mines, better results will follow?

The incentive of individual gain will have disappeared, and with it the readiness to accept such risks as those to which reference has already been made. We may easily find that the developments needed to find employment for our young people are not forthcoming, for without such risks being run no growth of employment will take place. Unless I am much mistaken, a great temptation will be put before politicians to make concessions to the huge army of voters who will be in the direct employment of the Government.

The experience of these five years has failed to teach the lesson that you cannot touch one branch of labour without affecting all others. An advance of wages given to one section will inevitably be demanded by all others. The result will be prejudicial to the whole community. As regards international trade, we may find ourselves shut out of foreign markets because our wages are made artificially high, just as we should be excluded if, for example, the shipowners could compel us to pay inordinate freights on some indispensable raw material like cotton.

A cure will speedily come, but it may come after great suffering has been inflicted on the whole community. Parliament can easily impose on the employer, whether a private individual or the State, the payment of a certain wage if a man is employed, but one thing it cannot do, and that is compel the employment of the man at a wage which the price of the article he produces will not suffice to pay. The man will remain unemployed. That is the drastic remedy which economic law imposes. We may escape it by making up from some other source the deficiency if we insist on having the article and refuse to pay the cost. But this remedy is applicable only to some small part of our total product. When we come to such industries as those now talked of it is impossible. We must make the industry self-contained.

But it may be said that those most concerned are not striving alone, or even chiefly, for higher wages, but desire to participate in the management and to bear their part in deciding the questions of policy which up to now have been in the hands of the employers. To this no fundamental objection can be raised. The more completely the men engaged in any enterprise understand it, the better it will probably be for the whole. But large questions of policy require knowledge and appreciation of circumstances which can with difficulty be acquired by persons whose life is necessarily passed in quite other surroundings. That the fullest information should be given to the persons in question cannot be denied. The claim to deal with matters of management lying quite beyond their competence cannot be conceded. The final impulse comes from one mind which cannot divest itself of its responsibility or exercise it under such conditions as those suggested would impose.

A universal unrest pervades the world. This had indeed already become apparent before 1914. The war has exacerbated the symptoms which were already sufficiently menacing. Remedies by legislation had been applied here and elsewhere without success. In the nineteenth century the political emancipation of the inhabitants of this country was gradually effected. By the end of it freedom had been practically won. The great changes which occurred in the political condition of the country as it was before 1832 and as it became by the end of the century had been brought about with relatively little trouble. It is not surprising that this should have led to the conclusion that economic changes could be effected with equal ease. Perhaps the confusion which we continually observe between a "law" imposed by the will of a legislature and a "law of Nature," so called, is responsible for this conclusion.

Having gained political freedom comparatively easily, people seem to have thought economic freedom could be got with equal facility. We have had numerous instances of this on which it is unnecessary to dwell. Concessions have been made by which, apparently, life was made much easier for certain people. But the fund out of which these concessions were to come has not been increased. Many of them, though not so intended, had the effect of positively lessening that total. In a perfect world it ought not to have had this effect, but, human nature being what it is, it was easy to foresee the result. It could have been foretold that a minimum wage established by law would sooner or later reduce the output of the man paid by piece. It had that effect on the coal-miners at a very early date after its enactment.

The demand for higher wages without a corresponding increased output was causing anxiety before the outbreak of war. The inordinate expenditure which the war brought with it seemed to justify the contention of the workmen that the claims they had put forward could easily have been met in the past, and must be conceded when things became normal again. It was forgotten that all thought of economic production had ceased. We were living, not on the earnings of the year, but on credit raised on our expectations of the future. In the past this course was also pursued, but (as has already been pointed out) in very different circumstances, for the capital thus created was calculated to yield an adequate return to the persons interested.

None of the remedies proposed touches the difficulty. We must obtain a larger product if we are to have more to divide. Restrictions in output, whether produced by the act of the Legislature, the will of the worker, or (let us add) the hindrance of a tariff, will fail to effect this. None of the short cuts now proposed will lead us to our goal. Can we convince those most deeply interested of the truth of this? The task is not an easy one, for promises without end are made to accomplish what is desired without pursuing the patient and laborious course which alone can lead to a happy solution. For my part, I rely on the common sense of my fellow-countrymen. The speedy abolition of all artificial prices by which we shall get to know the real cost of what we buy will be a great help. We may hope that on this will follow an earnest desire on the part of all to do their best for the commonweal—convinced that on this intelligent altruism we are best serving our own ends. A better division of industry would ensue. The net result would be a happy and contented nation, in which the efforts of each would be more guided by the common welfare than by the selfish desire for the advantage of the individual.

None of these things can be accomplished by Acts of Parliament. Statutory prices and statutory hours offer no solution—rather increase the evil than lessen it. There is no royal road by which we can travel to a solution. We must, by patience and mutual forbearance, seek to alter the present hostile attitude. We may frankly accept Prof. Cannan's opinion that "the economic organisation of the nineteenth and early twentieth centuries will not endure for ever, but will be gradually replaced by something else more suitable for its own day and generation."[1]

Let all parties in the State bend themselves to this change, in which, again to quote Prof. Cannan, "free associations of free men able to go out and come in as each pleased would voluntarily give service for service, irrespective of domicile and nationality." This is a change which we may agree with him in thinking more "desirable than any restoration of the feudal system basing economic organisation on the territory of the lord, even if the personal lord of the Middle Ages is replaced by a Parliament elected by universal suffrage and proportional representation."[2]

FORTHCOMING BOOKS OF SCIENCE.

SINCE the appearance of the article on "Forthcoming Books of Science" in NATURE of October 16, some further lists of books likely to appear in the near future have reached us. *The Cambridge University Press* is to publish "The Transmutation of Bacteria," Dr. S. Gurney-Dixon, and "Notes on Magnetism," C. G. Lamb. *Messrs. C. Griffin and Co., Ltd.*, announce "The Flow and Measurement of Air and Gas," A. B. Eason; "The Practical Design of Plate Girder Bridges," H. Bird, illustrated; "Marine Diesel Engines: Maintenance and Running," J. Lamb, illustrated; "Laboratory Aids in Practical Mechanics," G. S. Bowling; "Airman's International Dictionary, English–French–Italian–German," Lieut. M. M. Dander; "A Treatise on Surveying and Levelling," S. Threlfall, illustrated; "Modern Mine Valuation," D. Penman, illustrated; "Peat Reference Book," F. T. Gissing; "Coke-Oven and By-Products Works Chemistry," T. B. Smith, illustrated; "Coal Economy: The Reduction of National Coal Consumption by 50 Million Tons a Year," W. H. Casmey; "Analytical Chemistry as a Profession for Women," Emily A. L. Forster; "Text-book of Inorganic Chemistry,"

[1] "Coal Nationalisation," p. 25. [2] *Ibid.*

vol. ix., Cobalt, Nickel, and the Elements of the Platinum Group, Dr. J. Newton Friend, and Iron, Dr. J. Newton Friend and J. Bentley; and new editions of "A Treatise on Petroleum," Sir Boverton Redwood, Bart., in 4 vols.; "Electrical Practice in Collieries," Prof. D. Burns; "The Problem of Flight: A Text-book of Aerial Engineering," H. Chatley; "The Mineralogy of the Rarer Metals," E. Cahen and W. O. Wootton; "Elementary Agricultural Chemistry," H. Ingle; "Dairy Chemistry," H. D. Richmond; "Paper Technology," R. W. Sindall; "Modern Road Construction," F. Wood; "The Physico-Chemical Properties of Steel," Dr. C. A. Edwards; "General Foundry Practice," A. McWilliam and P. Longmuir; "A Medical Handbook." Dr. R. S. Aitchison; "Introduction to the Study of Midwifery," by Dr. A. Donald, illustrated; "A Manual of Elementary Seamanship," D. Wilson-Barker; and "Elementary Coal-Mining," G. L. Kerr. The new list of the *J. B. Lippincott Co.* includes "The Harvey Lectures, Delivered under the Auspices of the Harvey Society of New York, 1917–1919"; "Training of a Pharmacist," D. C. O'Connor, illustrated; "Airplane Photography," Major H. E. Ives, illustrated; "Training for the Electric Railway Business," C. B. Fairchild, illustrated; and "Applied Economic Botany," Prof. M. T. Cook, illustrated. They have also a number of volumes in preparation for appearance in the series of "Monographs on Experimental Biology and General Physiology." *Mr. John Murray* promises "Science and Life: Aberdeen Addresses," Prof. F. Soddy; "Springtime and Other Essays," Sir Francis Darwin; "The Life of Sir William White, K.C.B., F.R.S.," F. Manning, illustrated; "The Shibboleths of Tuberculosis," Dr. M. Paterson; "Theodore Roosevelt's Letters to his Children," edited by J. B. Bishop; "Wild Life in Canada," Capt. A. Buchanan, illustrated; "Homing with the Birds," Gene Stratton-Porter; "Strategic Camouflage: The Probing of a German Secret," S. A. Solomon, illustrated; and a new and enlarged edition of "Microscopy: The Construction, Theory, and Use of the Microscope," E. J. Spitta, illustrated. We notice that Dr. E. A. Wallis Budge's long-expected new book is to be entitled "By Nile and Tigris: A Narrative of Journeys in Egypt and Mesopotamia on Behalf of the British Museum between the Years 1886–1913." It will be in two volumes and illustrated.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—A new chair of physical chemistry has been established in the University on the endowment of Lord Leverhulme. Capt. J. W. McBain, lecturer in physical chemistry in the University since its foundation, has been appointed to the chair.

OXFORD.—We understand that Prof. S. H. Vines is retiring from the Sherardian professorship of botany in the University at the end of the current year.

SHEFFIELD.—On Friday, October 17, the Prime Minister received an honorary degree at the University, and took the opportunity of speaking on the place which the university, especially the modern university, can fill in the general field of education. He spoke with great cordiality on the function in the educational world of the modern universities, illustrating particularly by the influence which the University of Wales has exercised throughout the entire Principality. He congratulated Sheffield on the progress that it had made, and paid a warm tribute of appreciation to the work of Mr. H. A. L. Fisher, both as Vice-Chancellor of the University and as President of the Board of Education. In particular he spoke of the work done by the applied science department during the whole history of the University, and especially in relation to the supply of munitions for the British Army. "The contribution of Sheffield," the Prime Minister said, "was not merely a contribution drawn from the ranks of its students and its staff on the fighting side. It made a real contribution on the side of the provision of materials—an essential part of the winning of the war." At the same time he pointed out that the work of a modern university was not by any means comprised in the service which it rendered to material needs or to local industries, important as these were; it should be, in addition, the intellectual centre of the whole district in which it was situated. "It leads," he said, "the population which surrounds it to a higher culture; that is the great task of all these young universities; and I am glad to know that Sheffield is thoroughly realising the importance of this aspect of its work, as well as the more and immediately practical part of the enterprise."

THE Salters' Institute of Industrial Chemistry has awarded grants in aid to thirty young persons occupied in chemical factories in or near London to assist them in improving their knowledge of chemistry.

THE estate left by the late Gen. Horace W. Carpentier is valued, says *Science*, at 721,200*l*. The principal beneficiaries are Columbia University and Barnard College, each of which receives 284,000*l*., and the University of California receives 20,000*l*. From the same source we learn that by the will of the late Mr. Charles W. Lenney, of New York, 10,000*l*. is left to Boston University.

THE Rev. S. Graham Brade-Birks has been appointed lecturer in zoology at the South-Eastern Agricultural College, Wye. Mr. Brade-Birks is an honours graduate of the Victoria University of Manchester, and since his ordination in 1914 has spent much of his leisure researching with his wife (Dr. Brade-Birks) on the English millipedes and centipedes. Last session (1918–19) he acted as demonstrator in the zoological laboratories at the University of Manchester.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 22.—M. Léon Guignard in the chair.—The president announced the death of Gustaf Retzius, correspondant for the section of anatomy and zoology.—N. E. **Nörlund**: The polynomials of Bernoulli.—L. B. **Robinson**: A symmetrical system of polynomials.—J. **Chazy**: Solutions of the problem of three bodies where the three bodies form an isosceles triangle.—G. **Sagnac**: The æther and absolute mechanics of waves.—L. **Bruninghaus**: The conditions of production of fluorescence.—J. **Guyot** and L. J. **Simon**: The action of hydrates, oxides, and carbonates of the alkaline earths on dimethyl sulphate. Quicklime and caustic baryta are almost without action upon methyl sulphate; baryta-water and lime-water give barium and calcium methyl sulphates in theoretical quantities. Crystallised barium hydrate or slaked lime with methyl sulphate gives methyl ether and the sulphate of the metal.—M. **Delpech**: Flameless powders. An account of experiments on the effect of adding charcoal, vaseline, and other substances to propellant explosive from the point of view of producing a flameless explosion at the gun. Vaseline and heavy petroleum oil proved to be the most effective, provided that suitable additions to the weight of the charge were made to make up for the addition of the non-explosive material.—M. **Bourgeat**: The discovery of coal-bearing schists on the borders of the Serre.—E. **Chaput**: Remarks on the origins and classification of Desmoceras.—F. **Morvillez**: The leaf-conductor apparatus in the Hamamelidaceæ and neighbouring forms.—J. **Dufrénoy**: Experimental bacterial tumours in pines. This disease is due to a coccus, and is transmissible from tree to tree. The tumour is caused by a deposit of resin at the infected part.—G. **Bazile**: New methods for the destruction of Acridians. The experiments were carried out in Algeria on columns of *Schistocerca tatarica*. Of the methods tried, the use of flame-projectors proved to be the best.—P. **Godin**: Difference of progression of the index of growth in the male and female sexes.

SYDNEY.

Royal Society of New South Wales, September 3.—Prof. C. E. Fawsitt, president, in the chair.—J. H. **Maiden**: Two new Western Australian species of Eucalyptus. The two species have hitherto been wrongly included in *Eucalyptus Oldfieldii* One is a mallee that was originally collected by the Elder Exploring Expedition in 1891 both in South Australia and in Western Australia. It is now recorded from the Murchison River. It attains a height of about 20 ft., and has a singular, striate bark. The other species grows in damp, sandy land between the Darling Range, south of Perth, and the sea. It is a white gum, and has for many years been confused with the wandoo.—E. **Cheel**: Three new species of Leptospermum. One of the species from North Queensland, collected by Dr. E. Mjoberg during the Swedish Scientific Expedition to the Commonwealth in 1913, has been named *Leptospermum Mjobergi* in honour of the discoverer. The other two species are found chiefly along the south coast of this State, and include a species which somewhat resembles some of our native Epacris. This has been named *Leptospermum epacridioideum*, and the other *L. odoratum* on account of the fragrant oil contained in the leaves.

BOOKS RECEIVED.

Stereochemistry. By Prof. A. W. Stewart. Second edition. Pp. xvi+277. (London: Longmans and Co.) 12*s*. 6*d*. net.

Immunity in Health: The Function of the Tonsils and other Subepithelial Lymphatic Glands in the Bodily Economy. By Prof. K. H. Digby. Pp. viii+130. (London: Henry Frowde and Hodder and Stoughton.) 8*s*. 6*d*. net.

Human Vitality and Efficiency under Prolonged Restricted Diet. By F. G. Benedict, W. R. Miles, P. Roth, and H. M. Smith. Pp. xi+701. (Washington: Carnegie Institution of Washington.)

A Biometric Study of Basal Metabolism in Man. By J. A. Harris and F. G. Benedict. Pp. vi+266. (Washington: Carnegie Institution of Washington.)

The Ecological Relations of Roots. By Prof. J. E. Weaver. Pp. vii+128+30. (Washington: Carnegie Institution of Washington.)

The Carbohydrate Economy of Cacti. By H. A. Spoehr. Pp. 79. (Washington: Carnegie Institution of Washington.)

Orthogenetic Evolution in Pigeons. Posthumous Works of Prof. C. Otis Whitman. Vol. i. Edited by O. Riddle. Pp. x+194+88 plates. (Washington: Carnegie Institution of Washington.)

Inheritance, Fertility, and the Dominance of Sex and Color in Hybrids of Wild Species of Pigeons. Posthumous Works of Prof. C. Otis Whitman. Vol. ii. Edited by O. Riddle. Pp. x+224+39 plates (Washington: Carnegie Institution of Washington.)

The Behavior of Pigeons. Posthumous Works of Prof. C. Otis Whitman. Vol. iii. Edited by Prof. H. A. Carr. Pp. xi+161. (Washington: Carnegie Institution of Washington.)

Theorie de Strahlung und der Quanten. By Dr. A. March. Pp. vii+182. (Leipzig: J. A. Barth.) 12 marks.

Studies of Heredity in Rabbits, Rats, and Mi–. By W. E. Castle. Pp. iii+56+iii plates. (Washington: Carnegie Institution of Washington.)

A Manual of Physics. By Dr. J. A. Crowther. Pp. xx+537. (London: Henry Frowde and Hodder and Stoughton.) 16*s*. net.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 24.

PHYSICAL SOCIETY, at 5.—Dr. N. W. McLachlan: The Effect of Pressure and Temperature on a Meter for Measuring the Rate of Flow of a Gas.—J. H. Shaxby: A Cheap and Simple Micro-balance.—J. W. T. Walsh: The Resolution of a Curve into a Number of Exponentials.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. E. Hopkinson: Presidential Address.

TUESDAY, OCTOBER 28.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—General Meeting.

WEDNESDAY, OCTOBER 29.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Sir Horace Darwin: The Static Head Turn Indicator for Aeroplanes.

CONTENTS

PAGE
Facts and Factors of Evolution. By J. A. T. . . . 149
American Universities. By C. E. M. 151
Our Bookshelf 152
Letters to the Editor:—
The Doubly Refracting Structure of Silica Glass.—Right Hon. Lord Rayleigh, F.R.S. . 153
A Search for Fine Wool.—Prof. J. C. Ewart, F.R.S. 153
Radiation Temperatures. — Spencer Pickering, F.R.S. 153
Time Relations in a Dream.—Joseph Barcroft, C.B.E., F.R.S. 154
International Relations in Science —Prof. D'Arcy W. Thompson, C.B., F.R.S. 154
International Organisation in Science 154
Evolution of Ostrich Plumes 155
Education in India 156
Notes 157
Our Astronomical Column:—
Novæ 160
The Sun-spot Curve 160
Solar Radiation 160
New Sources of Aluminium in Norway. By L. Hawkes 160
Hydro-electric Development Works. By Dr. Brysson Cunningham 161
The British Association at Bournemouth:—
Section F—Economic Science and Statistics—Opening Address (Abridged) by Sir Hugh Bell, Bart., D.L., J.P., President of the Section 162
Forthcoming Books of Science 166
University and Educational Intelligence 167
Societies and Academies 167
Books Received 168
Diary of Societies 168

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THURSDAY, OCTOBER 30, 1919.

EDUCATION AND LIFE.

Education for the Needs of Life: A Text-book in the Principles of Education. By Dr. I. E. Miller. (Home and School Series.) Pp. vii+353. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 7s. net.

BOOKS on education may be roughly divided into two classes—those to be read and those to be avoided. There need be no hesitation in placing Dr. Miller's work in the former class. It is designed chiefly as a text-book, but may be studied with profit by those who have long passed student days. It is a fresh and attractive re-statement of the educational problem and its suggested solution. Education is conceived of as an integral phase of the life process; its task is to ascertain the child's vital needs and satisfactions, and to prepare him for their discharge or enjoyment, as the case may be. The starting-point is the biological adjustment to an environment. But adjustment is not mere passive moulding; it includes also dynamic response by the child. Nor does environment consist solely of the physical and material world; it embraces also mental, moral, social, æsthetic, and religious factors. The general treatment of the biological presuppositions occupies the first chapter, in the course of which it appears that the several elements involved are the aim of education, the child, the curriculum, methods, and the teacher. These, therefore, are the titles of the other five chapters.

Dr. Miller is a trained and sane psychologist, and his chapter on the child is an admirable epitome of our present knowledge of the stages of development up to adolescence, with hints for guidance in their treatment. Education must be functional; it must follow the child; it must wait upon development; it must catch the seasons of opportunity. The curriculum and the method must alike be organic to the pupil's capacities and requirements, and the teacher must by character and training be a person who can adapt himself to the varying situations which continually confront him. No mere structural or mechanical view satisfies the conditions of the problem, for any education deserving of the name must be subjective, not simply superposed. While the author would probably hesitate to subscribe to Rousseau's doctrine that the child should learn no lesson of which he does not see the present need, yet his theory seems to suggest that the appeal must always be through the consciousness of a felt want. He does, indeed, distinctly recognise the remote end—the needs of life; but as "two points determine a straight line," the present needs of the child and the destination in life are sufficient, he thinks, for the teacher's guidance and the pupil's well-being. But surely education is, like human progress in general, not a straight line. The analogy is rather that of zigzagging in a mountain ascent, or tacking on a voyage, where the goal is reached by humouring the gale, availing of the currents, and, above all, avoiding the shoals. Or, like the billiard player, the teacher may have to effect a cannon through a series of carefully calculated reactions along numerous lines, and with ultimate dual or multiple aim.

The volume bears evidence all through of the influence of Profs. Dewey, James, and other American writers, but Dr. Miller is by no means a slavish copyist. Among points of special merit are the treatment of imagination, the fundamental conception of the curriculum in its relation to life, and the plea for generous æsthetic culture based on psychological no less than on practical considerations. Dr. Miller writes out of the fullness of knowledge, first-hand acquaintance with the problems he discusses, and a belief in the efficacy of education which is an indispensable qualification of all workers in the field. But one would welcome a modification of expressions like "to gushingly remark" (p. 29), "to continually reconstruct" (p. 242), "run way beyond" (p. 292), and the like.

MATHEMATICAL TEXT-BOOKS.

(1) *Introductory Mathematical Analysis.* By Dr. W. Paul Webber and Prof. Louis Clark Plant. Pp. xiii+304. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 9s. 6d. net.

(2) *Descriptive Geometry.* By H. W. Miller. Revised in 1917 by the Department of General Engineering Drawing. Fourth edition. Pp. v+176. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 7s. net.

(3) *Premiers Eléments d'une Théorie du Quadrilatère Complet.* By A. Oppermann. Pp. 76+1 plate. (Paris: Gauthier-Villars et Cie, 1919.) Price 4 fr.

(1) THIS book contains the elements of algebra, trigonometry, analytical geometry, and infinitesimal calculus; it is apparently intended for first-year students at a university. The reviewer does not feel able to recommend the book; the reason for his opinions will be gathered from the following notes, which may be of use to the authors in the event of their having to prepare another edition:—

P. 122. It is tacitly assumed that complex numbers obey the ordinary laws of algebra; the assumption is pointed out in a footnote on p. 240.

P. 199. The proofs of the formulæ for the derivates of irrational and imaginary powers appear to assume what they profess to prove. Incidentally, imaginary powers do not seem to be defined anywhere in the book.

P. 236. The exponential series is defined as the limit of $(1+x/n)^n$, and is denoted by e^x; on p. 237 it is taken for granted that e^x, so defined, obeys the laws of indices.

P. 241. The proof of Euler's exponential expressions for the sine and cosine is new to the reviewer, but he fails to see why the variable must be expressed in radians rather than in any other unit of angular measure. The fact that the authors tell us on three occasions (pp. 108, 147, 243) that angles must be given in radians scarcely seems an adequate reason.

We are told twice (pp. 22 and 29) that feet and inches are denoted by the symbols $'$ and $''$, but it is apparently considered superfluous to define a degree (until p. 106, though degrees are used on p. 41) or to give the details of sexagesimal measure, and the student is referred to the tables for the values of the trigonometrical functions of $30°$, $45°$, and $60°$.

P. 63. A definition of "variable" is given, but no definition of "constant."

P. 91, ex. 10. To solve $\sin(x-25°)=0{\cdot}6$ by using the addition theorem is a method which seems unnecessarily cumbrous.

P. 91, ex. 11. The equation $\operatorname{arc}\tan x = \operatorname{arc}\sec x - 45°$ seems to lead to a cubic equation. Methods for solving cubics are not given until p. 144.

P. 182. The student should not be asked to prove that, in the hyperbola, $F'P-FP=2a$, without being told that the equation is true for one branch only.

P. 269. In a book which does not define even hyperbolic functions, it is going rather far to ask the student to find the length of $y=\sin x$ from $x=0$ to $x=\pi$.

Chap. xvii. The notations $\int f(x)$ and $\int f(x)dx$ seem to be used indifferently. The object of the former notation is not apparent. The notation "cot" used hitherto is here replaced by "ctn" without explanation.

Misprints and other minor errors have been noted at p. 35, ex. 17; p. 50, ex. 17; p. 69, l. 9; p. 106, l. 7 up; p. 116, ex. 9; p. 120, l. 2 up; p. 123, l. 2 up; p. 136, l. 21; p. 173, ex. 12; p. 180, ex. 6; p. 232, ll. 3, 4; p. 243, ll. 5, 7, and 8; p. 253, ex. 22; p. 263, l. 1; p. 271, ex. 2; p. 274, exs. 14, 21; p. 275, ex. 25; and p. 277, ex. 15.

(2) This work, which was first published in 1911, has now been revised by the author, with the assistance of six of his colleagues. It forms an admirable introduction to the subject for the student, and deserves very high commendation. The mode of presentation has been carefully thought out, with the result that the style is clear and lucid, and any student of ordinary intelligence should be able to get from the book a sound knowledge of the subject without the aid of a teacher.

The first chapter contains a synopsis of the notations used in the book; then follow four chapters on the representations of points and lines by elevation and plan, and of planes by their traces; next there are four chapters on curved surfaces—mainly cones, cylinders, and spheres—a useful chapter on shadows, and a brief account of perspective. These chapters contain numerous practical problems, each worked out in full with enunciation, discussion, analysis, and construction. The book concludes with a collection of eight long papers of problems and a good index. The diagrams are clear and well-proportioned, though a few of them would have been improved by being made rather larger.

The reviewer would like to make a few minor suggestions for the improvement of future editions. In the first place, the student may be a little puzzled at finding that the "profile-plane" plays a subordinate part compared with the other two co-ordinate planes (*e.g.* it is not mentioned in § 19 on the "alphabet" of a point), and the explanation of this would be useful. Also, the terms "profile ground-line" (§ 13) for a line which is not horizontal, and "vertical of a plane" (§ 42) for a line which is not vertical, seem somewhat misleading.

Two omissions must be mentioned. The first is that no use is made of the method of changing the co-ordinate planes—a method which gives an elegant solution of such a problem as finding the true length of a line, by taking a new vertical plane parallel to the plan of the line. The second omission is of rather more importance to the student; he would find the subject much more interesting and concrete if some work (possibly in the form of examples) on solids with plane faces were included. The reviewer well remembers how fascinated he used to be by drawing cubes and pyramids in fantastic positions, particularly if a section of the solid had also to be drawn.

The book would have been enhanced in value to the student of crystallography if some account of isometric projection had been given, and the reviewer would have been glad to see some developments of the theory of perspective—*e.g.* the theorem that plane figures in perspective remain in perspective when rotated about their axis of collineation; but possibly the author considers that such additions would have unduly increased the size of the book.

(3) In this, an interesting and suggestive work, the author (an engineer) discusses the theory of the quadrilateral after the manner in which various modern geometers have discussed the triangle. The treatment is quite elementary, and the object of the author is not to give a complete discussion of the subject, but to encourage and facilitate research. The book, "publié au moment où la France vient de reconquérir les provinces qui lui ont été arrachées en 1871," is dedicated to the memory of Joseph Pruvost, professor of mathematics at Strasbourg until the annexation; it contains a useful bibliography—a feature hitherto somewhat rare in mathematical works published in France.

MINERAL RESOURCES OF GEORGIA.

Mineral Resources of Georgia and Caucasia: Manganese Industry of Georgia. By D. Ghambashidze. Pp. 182. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1919.) Price 8s. 6d. net.

THIS little book is interesting as being the outcome of the reorganisation of national boundaries after the war and as evidence of the political and economic independence of the new Republic of Georgia; this was an independent kingdom until it was forcibly annexed by Russia in 1801, and only recommenced its autonomous existence in 1917. The object of the work now published by Mr. Ghambashidze is to make British readers acquainted with the industrial importance of Georgia and Caucasia so far as the mineral wealth of this region is concerned. The author gives a long list of the various mineral substances of economic value known to occur therein, although relatively few have been worked on an industrial scale.

The oilfields of Caucasia have long been known, the principal field, that of Baku, having been for many years one of the world's great producers, with an annual (pre-war) output of about 7 million tons of petroleum. Next in importance comes that of Grozny, with a production of 1–1½ million tons, and there are also several smaller ones, the output from which is at present negligible; even the Maikop field, the first borings in which aroused so much excitement, has sunk to a quite unimportant factor in the general production. Of the other non-metallic minerals, bitumen is at present the most important, though the sulphur deposits in the province of Erivan, 30 miles from a railway line, may prove to be of value in the near future.

Of the metallic minerals, a few deposits of iron-ore are known, but none apparently of great importance. There are several known deposits of blende and galena, but only one, a mine at Sadon, is being worked at present; it is in the hands of a Russo-Belgian company, the Société Minière et Chimique Alagir. Copper is abundant and has been worked in many parts of Georgia and Caucasia. The best known of all is the Kedabek mine at Mis-Dag, which was an important producer up to about 1912, when the deposits began to show signs of exhaustion, so that the present output is barely 100 tons of copper per annum, whereas it was at one time up to 1750 tons. Altogether there were in 1914 some twenty-eight copper mines at work, fourteen of which had their own smelters; the total production of copper in 1914 was 8259 tons. The most important of the metalliferous minerals is manganese ore. In addition to a number of deposits in various parts of Georgia, which are not being worked at present, and are briefly referred to, the well-known deposits in the province of Kutais, which cover an area of 400 square miles and are estimated to contain 200 million tons of available ore, are described in some detail. The exports of this ore from Georgia had reached more than a million tons in 1913, but then fell off rapidly owing to the war. There appears to be no reason why this industry should not again recover its previous importance. The book contains a valuable amount of statistical information carefully tabulated, showing the mineral production of the districts treated of, and should be of use to all engaged in the mineral industry of the Near East.

H. L.

OUR BOOKSHELF.

A Simple and Rapid Method of Tide Prediction. (Including Diurnal Time and Height Inequalities.) By Sgt. M. E. J. Gheury. Pp. 53. (London: J. D. Potter, 1919.) Price 5s.

IN this little book the author explains the method which he developed for predicting the time and height of high and low water at Richborough, on the River Stour (Kent). From observations of these variables, extending over a fortnight only (in the first instance), it proved possible to deduce satisfactory predictions with but little trouble. The method has a rational basis, which is described in a preliminary account of the tide-producing forces and their variations. The work involved is partly graphical and partly tabular, but no harmonic analyses are required. The aim is to replace the unsatisfactory method by which a set of corrections is applied to the high- and low-water data for the nearest standard port, which at some stations may be as much as 200 miles away. In the present case the nearest standard port was only 20 miles away (Dover), but even in this instance Mr. Gheury's method, applied to deduce times of high water, gave better results than did the application of a correction to the elaborately derived Dover data. Richborough, being situated several miles up a narrow and sinuous tidal stream opening in a bay, presents some rather complex tidal features, including well-marked diurnal height and time inequalities; the success of the method, which can readily be applied to other similar or simpler stations, is therefore the more significant. The book is marred by some irritating misprints and grammatical errors, but the explanations are, on the whole, correct and lucid.

Fermat's Last Theorem: Three Proofs by Elementary Algebra. By M. Cashmore. Revised edition. Pp. 55. (London: G. Bell and Sons, Ltd., 1918.) Price 2s. 6d. net.

IT is unfortunate that F. P. Wolfkehl's legacy of a prize for settling the vexed question of "Fermat's Last Theorem" should have stimulated such a large erroneous mathematical literature. Most of the publications pretending to prove the theorem are deplorable for at least three reasons: first, because many of their authors have had insufficient mathematical training to enable them to decide whether a supposed proof is sound or not; secondly, because of the expense incurred by the authors in printing invalid proofs; and thirdly, because useless publications increase the burden of librarians and scholars. We are far from wishing to discourage genuine attempts to reproduce Fermat's line of thought. In view of the state of mathematical knowledge 250 years ago, Fermat's proof, assuming it to be correct—a point on which expert opinions differ—is as likely to be discovered by a clever schoolboy of seventeen as by a more highly trained mathematician.

Mr. Cashmore, in the tract before us, presents three distinct "proofs," all erroneous. In I. (p. 14) he states that when

$$ax^2+by^2=w^n, \text{ then } w=au^2+bv^2,$$

the letters denoting ordinary integers. A numerical example is enough to show that this is erroneous; thus

$$2^2+5\cdot1^2=3^2, \quad 11\cdot2^2+9^2=5^3;$$

but there are no integral solutions of

$$x^2+5y^2=3, \quad 11x^2+y^2=5.$$

The first of several fallacies in II. occurs on p. 26, and in III. (p. 43) Mr. Cashmore states that when $(p^n-q^n)y^{n-1}$ is divisible by pq, then y is divisible by pq, it being assumed that p and q are integers with no common factor It is seen that this deduction is erroneous by taking

$$p=9, q=4, y=6, n=3.$$

W. E. H. B.

Secrets of Animal Life. By Prof. J. Arthur Thomson. Pp. viii+324. (London: Andrew Melrose, Ltd., 1919.) Price 7s. 6d. net.

This is a collection of forty essays, contributed during recent years by Prof. Thomson to the *New Statesman*, and now collected in a handy and attractive volume. In his own clear and charming style the author seeks "to interest thoughtful readers in the multitudinous problems of animal life," and he wisely enforces the lesson that, in many cases, the solutions of these problems are "secrets" still. Such familiar subjects as the habits of rooks and cuckoos or the "Fall of the Year" are mixed with review-summaries of noteworthy recent zoological literature of general interest such as Watson and Lashley's observations on the "homing" of terns, Emery's researches on the habits of Amazon ants, or Petersen's surveys of the Zostera-beds off the coasts of Denmark. The problems of inheritance and evolution are prominent, as might be expected, and from such papers as "With Darwin Forwards" and "The Mendelian Clue," the "thoughtful reader" may gain a clear introductory view of the fields of biological inquiry, as well as guidance in the way of deeper study. Prof. Thomson never misleads those for whom he writes by implying that after reading him they have no more to learn; his treatment of "The Problem of Cave Blindness," for example, affords a needed corrective to widespread dogmatism on a subject that has appealed to popular imagination since the early days of evolutionary biology.

G. H. C.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

International Relations in Science.

I do not agree with the proposals made by Prof. D'Arcy Thompson in Nature of October 23. I think that the less our academies and societies move in this matter the better. For my own part I objected altogether to the proposal made during the war to strike off our records the names of distinguished men of enemy nationality who had been elected "foreign members" before the war. They had not been admitted to any power or rights in consequence of that election, and it was, in my judgment, futile and petty to endeavour to obliterate the record of the honour which had been justly accorded to them.

As to making overtures to, and the reception of overtures from, the academies of those hostile nationalities with which peace is not yet ratified, it seems to me that our own societies and academies should at present neither offer nor accept any such overtures. They are mere formalities and demonstrations without any real significance or value, and must be, and are often designed to be, misleading. On the other hand, I think every individual should act according to his own feeling and judgment, and not according to mass sentiment, in regard to entering into friendly relations with German men of science. At present I personally could not accept such relations. I wish to reserve all action in the matter until my memory of many things has faded. But I will never wittingly treat even those whom I most dislike with less than justice tempered by generosity.

E. Ray Lankester.

The Response of Plants to Wireless Stimulation.

A growing plant bends towards light; this is true, not only of the main stem, but also of its branches and attached leaves and leaflets. This movement in response is described as the tropic effect of light. Growth itself is modified by the action of light: two different effects depending on the intensity are produced; strong stimulus of light causes a diminution of rate of growth, but very feeble stimulus induces an acceleration of growth. The tropic effect is very strong in the ultra-violet region of the spectrum with its extremely short wave-length of light; but the effect declines practically to zero as we move towards the less refrangible rays, the yellow and the red, with their comparatively long wave-length. As we proceed further in the infra-red region we come across the vast range of electric radiation, the wave-lengths of which vary from the shortest wave I have been able to produce (0·6 cm.) to others which may be miles in length. There thus arises the very interesting question whether plants perceive and respond to the long æther-waves, including those employed in signalling through space.

At first sight this would appear to be very unlikely, for the most effective rays are in the ultra-violet region with wave-length as short as 20×10^{-6} cm.; but with electric waves used in wireless signalling we have to deal with waves 50,000,000 times as long. The perceptive power of our retina is confined within the very narrow range of a single octave, the wave-lengths of which lie between 70×10^{-6} cm. and 35×10^{-6} cm. It is difficult to imagine that plants could perceive radiations so widely separated from each other as the visible light and the invisible electric waves.

But the subject assumes a different aspect when we take into consideration the total effect of radiation on the plant. Light induces two different effects which may broadly be distinguished as external and internal. The former is visible as movement; the latter finds no outward manifestation, but consists of an "up" or assimilatory chemical change with concomitant increase of potential energy. Of the two reactions, then, one is dynamic, attended by dissimilatory "down" change; the other is potential, associated with the opposite "up" change. In reality, the two effects take place simultaneously; but one of them becomes predominant under definite conditions.

The modifying condition is the *quality* of light. With reference to this I quote the following from Pfeffer:—"So far as is at present known, the action of different rays of the spectrum gives similar curves in regard to heliotropic and phototactic movements, to protoplasmic streaming and movements of the chloroplastids, as well as the photonastic movements produced by growth or by changes of turgor. On the other hand, it is the less refrangible rays which are most active in photosynthesis."[1] The dynamic and potential manifestations are thus seen to be complementary to each other, the rays which induce photosynthesis being relatively ineffective for tropic reaction, and *vice versa*.

Returning to the action of electric waves, since they exert no photosynthetic action they might conceivably induce the complementary tropic effect. These considerations led me to the investigation of the subject fourteen years ago, and my results showed that very short electric waves induce a retardation of rate of growth; they also produce responsive movements of the leaf of Mimosa when the plant is in a highly sensitive condition.[2] The energy of the short electric waves is very feeble, and undergoes great diminution at a distance; hence the necessity for employment of a specimen of plant in a highly sensitive condition.

I resumed my investigations on the subject at the beginning of this year. I wished to find out whether plants in general perceived and responded to long æther-waves reaching them from a distance. The perception of the wireless stimulation was to be tested, not merely by the responsive movement of sensitive plants, but also by diverse modes of response given by all kinds of plants.

The Wireless System.

For sending wireless signals I had to improvise the following arrangement, more powerful means not being available. The secondary terminals of a moderate-sized Ruhmkorff's coil were connected with two cylinders of brass, each 20 cm. in length; the sparking took place between two small spheres of steel attached to the cylinders. One of the two cylinders was earthed and the other connected with the aerial 10 metres in height. The receiving aerial was also 10 metres in height, and its lower terminal led to the laboratory, and connected by means of a thin wire with the experimental plant growing in a pot; this latter was put in electric connection with the earth (Fig. 1). The distance between the transmitting and receiving aerial was about 200 metres, the maximum length permitted by the grounds of the institute.

I may state here that with the arrangement described above I obtained very definite mechanical and electric response to wireless impulse. For the former I employed the plant Mimosa; the latter effect was detected in all plants, sensitive and ordinary. Limitation of space will allow only a detailed description of the responsive modification of growth.[3]

[1] Pfeffer, "Physiology of Plants," vol. ii., p. 104.
[2] Bose, "Plant Response," p. 618. (1905.)
[3] A detailed account of the response of plants to wireless stimulation will be found in the Transactions of the Bose Institute, vol. ii., to be published in November, 1919.

Effect of Wireless Stimulation on Growth.

For the detection of variation of growth it was necessary to devise the extremely sensitive balanced crescograph. In this apparatus a compensating movement is given to the plant-holder by which the plant subsides exactly at the same rate as its growth-elongation, so that the tip of the plant remains at the same point. This perfect balance is attained by a variable regulator. The compound magnifying

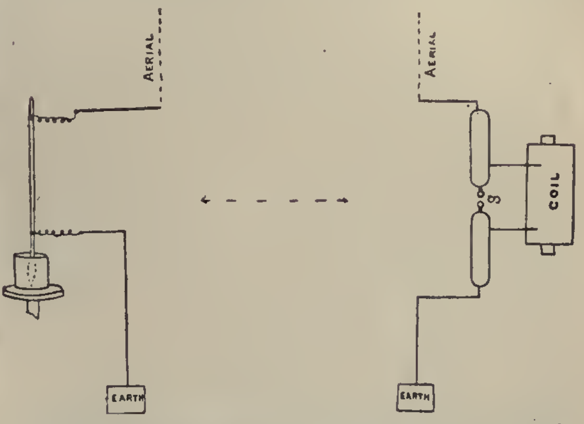

Fig. 1.—Diagrammatic representation of the method of wireless stimulation. On the right is seen the generating apparatus. The tip of the growing plant is connected with the receiving aerial, and the lower part or the flower-pot is earthed.

lever attached to the plant records the movement of growth. Under exact balance the record is horizontal. Any induced acceleration of growth would upset the balance, with a resulting down record; induced retardation, on the other hand, would cause an upset in the opposite direction and an up curve. The results given below show that growing plants not only perceive, but also respond to the stimulus of electric waves. These effects were found in all

Fig. 2.—Automatic records obtained with the balanced crescograph showing the effects of wireless stimulation on growth. (*a*) Feeble stimulus inducing acceleration; (*b*) strong stimulus inducing retardation of rate of growth; (*c*) series of growth responses by variation of growth due to uniform moderate stimulation. Up-curve represents retardation of growth and down-curve acceleration (seedling of wheat).

growing plants. The following records were obtained with the seedlings of wheat.

Effect of Feeble Stimulus.—Experiment 1: I first studied the effect of feeble stimulus. This was secured by decreasing the energy of sparks of the radiator. The response was an acceleration of rate of growth as seen in Fig. 2, (*a*). This is analogous to the accelerating effect of light stimulation of subminimal intensity.

Effect of Strong Stimulus.—Experiment 2: The maximum energy radiated by my transmitter, as stated before, was only moderate. In spite of this, its effect on plants was exhibited in a very striking manner. The balance was immediately upset, indicating a retardation of the rate of growth. The latent period, *i.e.* the interval between the incident wave and the response, was only a few seconds (Fig. 2, (*b*)). The record given in the figure was obtained with the moderate magnification of 2000 times only; but with my crescograph the magnification can easily be raised ten million times, and the perception of plant to the space-signalling can be exalted in the same proportion.

Under an intensity of stimulus slightly above the subminimal, the response exhibits retardation of growth followed by quick recovery, as seen in the series of records given in Fig. 2, (*c*). The perceptive range of the plant is inconceivably greater than ours; it not only perceives, but also responds to the different rays of the vast æthereal spectrum. J. C. BOSE.

Calcutta, August 16.

A New British Enchytræid Worm.

IN a collection of worms brought from Lapworth by Mr. Hillman on August 11, I found one which is new to this country, and of great interest on account of its unusual character and relationships. In 1877 Vejdovsky described his *Pachydrilus sphagnetorum.* Eleven years later Michaelsen added to it a variety named *glandulosus.* In course of time the name Pachydrilus was changed to Marionina, and the two worms above-named were placed as distinct species under this genus, forming a section by themselves on account of their aberrance. They both had the girdle thrown forward, the spermathecæ were free in the cœlom, the septal glands were more numerous than in the type, and there were other peculiarities. In Michaelsen's "Oligochæta," published in 1900, they appear as *Marionina sphagnetorum*, Vejd., and *M. glandulosa*, Mich.

In 1913 I described a new British Enchytræid (*Chamaedrilus chlorophilus*, Friend), which could not be fitted into any then known genus. Its relationships were discussed and its affinities with the two aberrant Marioninas pointed out. On finding *M. glandulosa,* I was for a time in doubt about its true name, as it so closely resembled Chamædrilus. Careful study, however, shows that the three worms are very nearly related, and must be referred to one and the same genus. In Marionina the blood is slightly coloured, in Chamædrilus it is quite colourless. In the former the spermathecæ are free, whereas in Chamædrilus they are attached to the intestine. In all other respects they agree. The forward position of the girdle, the shape and number of the setæ, absence of salivary glands, form of spermathecæ, size of cœlomic corpuscles and chloragogen cells, enlarged number of septal glands, incised brain, and other important characters, all point to one genus.

They are exceedingly slender worms, and Vejdovsky has pointed out a peculiarity in *M. sphagnetorum* which is of special interest. Like certain waterworms, it can multiply by subdivision. We have here, very clearly, a genus which links the Enchytræids with some of the other families of worms. Details cannot be discussed now, but it is evident that we shall for the present have to regard the genus Chamædrilus as consisting in this country of three species, viz. *Chamaedrilus sphagnetorum,* Vejd., *C. glandulosus*, Mich., and *C. chlorophilus*, Friend. The generic characters are roughly as follows:—

CHAMÆDRILUS.—Girdle advanced to segment 10, 9, or 8; nephridia begin in 8/9 or 9/10; spermathecæ with posterior outgrowth, either free or attached to the intestine; cœlomic corpuscles and chloragogen cells large; blood colourless or but slightly tinged with yellow or red; the dorsal vessel originating behind the girdle and possessing no anterior commissures (apparently). Salivary gland absent, brain deeply incised. Related to Stercutus and Bryodrilus.

HILDERIC FRIEND.

"Cathay," Solihull, September 24.

A Photoelectric Theory of Colour Vision.

IN view of the recent letters from Prof. Joly and Sir Oliver Lodge under the above heading, I may be allowed to point out that such a theory of colour vision was advanced by me in a lecture delivered before the Röntgen Society on January 7 last, and published in the Journal of the society for April. After referring to Prof. Joly's views as to the nature of the change taking place in the formation of the latent image and in radio-therapy, I said: "In my opinion, it is unnecessary to assume that a photochemical change is the cause of the visual sensation. It appears to me sufficient to suppose that photoelectric action takes place in the rods or cones, so that we have a separation of electrons resulting in electrification of the nerve-cells which set up the nervous impulse to the sensorium." A number of familiar facts were adduced in support of this view, and it was mentioned that the peaked curve which shows the relation between the sensitiveness of the eye for light of different wavelengths bears a very close resemblance to the curve which shows the variation of photoelectric activity with wave-length. H. STANLEY ALLEN.

Luminous Worms.

AROUND Nottingham forty-five years ago it was a common practice among anglers to search the meadows by aid of a lantern for "dew-worms and cockspurs," as they were locally known. After collection they were placed in damp moss in a dark shed for a few days until they were "scoured"; this brought them into condition, and rendered them more attractive as bait and fresher and redder in colour. After this treatment worms were phosphorescent for about one-fourth of the entire length of the body, while the light was most noticeable in the ventral region. H. E. ALDRIDGE.

40 Great Queen Street, Dartford.

RECONSTRUCTION.

IT has been a reproach, not without foundation, frequently cast at the British Empire that there has been hitherto a lack of reasonable and sufficient organisation. The circumstances arising out of a state of war have led necessarily to the institution of a number of new Departments which have been called into existence hastily and without adequate consideration. Some of these will, of course, disappear, and others will remain to be reconstituted. In view of these facts the Government did wisely in July, 1917, in appointing a Committee with the purpose of considering the changes which would become necessary after the war, and the report of one of its Sub-Committees, that on the Machinery of Government, under the chairmanship of Lord Haldane, is now before us. This Sub-Committee was appointed "to inquire into the responsibilities of various Departments of the Central Executive Government and to advise in what manner the exercise and distribution by the Government of its functions should be improved." It is obvious that here is a field of inquiry which is necessarily very extensive and very complicated, and the report fills eighty octavo pages. We have already (April 3) dealt with some aspects of the report, but the subject is so important that no excuse is necessary for considering others now. One of the most striking declarations by the Sub-Committee is to be found very early in the report in reference to the formulation of policy, for the conclusion is reached that "the duty of investigation and thought, as preliminary to action, might with great advantage be more definitely recognised." In elaborating its remarks on the importance of distinguishing the business of inquiry and research from that of administration, it refers especially to the desirability of giving special attention to the methods of recruiting the *personnel* to be employed in the Departments charged with the duty of inquiry, research, and reflection before policy is defined and put into operation.

This is one of the questions concerning which there is room for criticism of the methods generally pursued in the past. Attention has been repeatedly directed to the neglect of physical and natural science in the qualifications demanded of every member of the higher branches of the Civil Service in this country. The effect of this neglect has been that it frequently happens that when a new Department is to be called into existence the men appointed to take charge of the work are deficient in knowledge of the facts, principles, and methods which should be employed in carrying out their duties, inasmuch as it is still the custom generally to select for these appointments Civil Servants whose good general characters as active and intelligent men are their only qualification. In a few cases, far too infrequent, appointments of this kind have been offered to men outside the Civil Service with special qualifications for the work contemplated. Such a post as that of the Government Chemist has necessarily been filled by an eminent outsider, and the Board of Agriculture has in several cases selected for posts in that Department men who have an established reputation in connection with problems relating to agricultural practice.

The remarks of the Sub-Committee on the necessity for collaboration among Departments so that all information collected by any one Department may be accessible to all the rest whenever it is required without waste of energy or time in re-collection are very appropriate, and it may be hoped will be acted upon.

To the readers of Nature probably the contents of chap. iv. of the report, concerning research and information, will be found most interesting, and among the subjects dealt with in some detail is the work of the Medical Research Committee and of the Department of Scientific and Industrial Research. Both of these cover a wide field. The work of the former may be roughly divided into the study of questions connected with the National Health Insurance Acts on one hand, and general medical research on the other. Here, as in other directions, applications of science are subject to constant modification arising out of the discovery of new facts or principles. By way of illustration reference may be made to researches on food which are now being carried on. The discoveries which in very recent times have been made as to the existence in certain foodstuffs of the remarkable substances known as *vitamines* and their non-existence in others must lead to a modification of our views concerning the whole question of dietary and health. The exact nature of the vitamines is at present unknown, whether they consist of definite chemical, but hitherto unrecognised, substances, or whether they consist of mixtures of products of degradation of proteins. All that can be said is that the amount present in any case is minute. It is therefore not sufficient to determine roughly the composition of a given foodstuff and the proportion of fat, starch, or protein it may contain. Another line of work arises from the study of the question of the preservation of food by cold storage. It is now well known that the temperatures requisite in one case are not suitable in others; thus the cold required for meat and fish is not required for fruit, and even different kinds of fruit, such as plums and pears, cannot be shipped safely in the same chamber where slight differences of temperature may be found between the centre of the room and the walls.

The Department of Scientific and Industrial Research, the third annual report of which was noticed in Nature of October 17, 1918, comes in for a good deal of discussion in the report before us. It will be remembered that this is a Department for which the Lord President of the Council (then Lord Crewe) was responsible, and was created with funds at its disposal for instituting (1) specific researches, (2) scientific research in connection with industry, and (3) the award of studentships or fellowships to assist in research. The sum of 1,000,000*l.* was granted for use in applying over an agreed period a special stimulus to industry. This fund is applied in making grants to approved trade associations for research to supplement the resources of the associations. Some difficulties have occurred in determining to whom the results of research undertaken by the respective associations belong, and it seems doubtful whether procedure through the agency of trade associations is likely in the long run to prove the best avenue to progress in the way of applying discovery to industry. At any rate, the claims of the individual researcher will have to be considered and provided for in each case.

Funds are also provided by an annual vote for the general purposes of the Department, and from this source assistance is given to other bodies and other questions which may have only an indirect relation to particular industries or trades. The Fuel Research Board affords an example of the kind of work which may be undertaken with the aid of Government funds, and is now in active operation in connection with the South Metropolitan Gasworks. The inquiry is too costly and altogether beyond the means of such agencies as a British Association Committee or the private persons by whom the research was initiated.

But with regard to special scientific studies undertaken by individuals help is still urgently wanted, and the question arises whether such help can always be obtained from the Department so long as one of the conditions of a grant is that details of the research contemplated must be communicated to so large a number of persons as form an advisory council or board. Aids to research must be given in other ways. There seems to be some difference of opinion whether this would be best accomplished by increasing substantially the present grant of 4000*l.* per annum to the Royal Society, or by augmenting the annual grant to universities and other teaching institutions where teachers and students may co-operate in the work. The scientific worker is often shy of exposing his ideas in their early crude form to external criticism, and tentative preliminary inquiry should be provided for before the researcher is called on to expose the whole of his plan.

The whole scheme foreshadowed in this report shows and acknowledges in more than one passage the need for men. It has often been claimed for the Oxford classical system of education that it does select and equip with the necessary knowledge the young Englishmen whose destiny it is to become administrators. The Oxford of the future will doubtless furnish at least some of them with science and scientific ideas. But in the meantime there exists throughout the universities of the country a body of some hundreds of able men of science in the form of professors and lecturers to which recourse might, one would suppose, be had when occasion arises.

The report discusses at some length the momentous question as to the employment of women in the Civil Service. All the world has now profited by the experience derived from the war, and much prejudice on this subject has been cleared away. But while many women have distinguished themselves by patriotic fervour, physical energy, and administrative ability, the education of women has in general been more defective than that of men, and it will be necessary to wait for another generation before the question can be determined on satisfactory grounds whether sex will not always stand in the way of substituting women for men in many of the professions and callings necessary to the world.

Since the issue of the report—viz. on February 12, 1919—a lecture has been given to the Royal Society of Arts by Sir Frank Heath, Chief Secretary of the Department of Scientific and Industrial Research, on the work of that Department. The lecture is lucid and interesting, and shows that some definite results have already been attained. Lord Crewe, who was in the chair, remarked that this was "the only country in which a Government Department of Research existed." Such a statement can be accepted only with some reservations. Research stations in connection with agriculture have been instituted and supported by the State in many European countries during the last half century, and the United States Department of Agriculture at Washington maintains a scientific staff and issues a very valuable illustrated annual report. Moreover, the assistance given to the universities from national funds has always been in European countries far more liberal than has ever been the case in the United Kingdom, even at the present day, when the Government grants have been so considerably augmented.

THE FAUNA OF THE INLÉ LAKE.[1]

THE Inlé Lake, lying at a height of 3000 ft. in the great limestone zone of the Shan plateau, is of peculiar bionomical interest, since, although it belongs to the Salween river-basin, it has become sequestered, or at least obstructed in its biological commerce, by the behaviour both of its principal feeders and of its only effluent, which in considerable parts of their course flow deep underground. Another point of interest in a biological view is that it appears to be a relic of a former lake, or system of lakes, of great depth and extent. Two other remarkable features of the Inlé Lake are the extraordinary limpidity of its waters, through which its animal population can be watched as in an aquarium, and its girdle of floating marshland. This curious terraqueous fringe is capable of exuberant cultivation: the local genius cuts from it an island plot, tows it off where he lists, there turns it upside down and anchors it with stakes, then dredges and adds more clotted vegetable ooze to its surface, until it becomes solid enough for tillage, and perhaps firm enough to carry a sty for his pig, or a hut for himself. Such an islander, as he turns from spearing and trapping fish to tend with incessant care the homely market-garden trade, or strictly meditate the vocal pig, might well avouch the philosophy of Thales.

In this fine report, which includes twenty-eight first-class plates, and more than 200 large pages close packed with information both descriptive and ratiocinative, the fauna of the lake (exclusive of the plankton) is fully disclosed. Dr. Annandale, the editor, contributes an introduction mainly physiographical, a summary comprehensively biological, compendious treatises on the fishes and the aquatic mollusca, and minor papers on the sponges, hydrozoa, polyzoa, and amphibia. Among other contributions may be mentioned that by Mr. S. W. Kemp on the Decapod Crustacea, that by Mr. C. A. Paiva on the Aquatic Hymenoptera, and those by Mr. Baini Prashad on the Marsupium and Glochidium of

[1] Records of the Indian Museum, vol. xiv. (Calcutta, 1918).

Physunio, and on the anatomy of a Chironomid larva of the genus Polypedilum.

The most peculiar elements of the fauna are the fishes and mollusca. Of fishes there have been found thirty-one species, representing seventeen genera and seven families; among the many new forms is an extraordinary eel-like creature which Dr. Annandale regards as a type of a distinct family of Apodes. Common features of the fishes are a large eye and small development of tactile appendages—features thought perhaps to be directly correlated with the remarkable transparency of the water. Of aquatic mollusca thirty-seven species are mentioned—a large proportion being new—representing twelve genera and eight families; they are said to display extraordinary variability, and their evolutional plasticity is discussed with much learning and an equal wealth of illustration.

Altogether, this investigation of the fauna of the Inlé Lake is a refined piece of work, reflecting high credit on the new zoological survey of India and its versatile director. Moreover, although the report shows an intelligent appreciation of the economic perspective, as is seen in the full and critical description of the fisheries of the lake and all their apparatus, it is free from any taint of that meretricious stuff which so commonly in ponderous administrative circles of the British Empire lives and spreads aloft under the pseudonym of science.

NOTES.

THE first number of NATURE appeared on November 4, 1869, so that the jubilee of the journal will be attained next week. In celebration of this event the issue of November 6 will be devoted to articles upon scientific progress and developments of the past fifty years, contributed by eminent workers in different fields. Through the active co-operation of these authorities it has been possible to secure a comprehensive collection of articles of great interest, which we believe will be accepted as a worthy epitome of outstanding advances in the half-century during which NATURE has been published.

A MEETING of the International Electrotechnical Commission was held in London on October 20 and the three following days, under the presidency of M. Maurice Leblanc. Representatives of twenty nations were present, and the reports of the various committees were considered. Signor Semenza stated that national agreement had been obtained in Italy on the subject of symbols, both in those used in textbooks and in those used in engineering drawings. He pointed out the many advantages that would ensue if international agreement could be obtained. The British list of symbols, which is finished and will shortly be published, is very similar to the Italian list, and complete agreement could be easily obtained. Nearly all the committees on nomenclature have published lists of definitions, etc., and the next step to take is to compare them all closely and then to issue a standard list. The committee on the rating of electrical machinery has been very busy, and has held many meetings. This subject, however, proves to be very difficult, as trade considerations have to be taken into account. The commission has definitely taken up the question of preparing a specification for aluminium on the same lines that it adopted for specifying pure copper. The copper specification was most useful, and has been adopted by every country in the world. A special committee was appointed to consider the question of screw-lamp caps and holders. This country is almost the only one which retains bayonet-holders for electric lamps, although many electrical engineers think that the screw-lamp caps are the best. Sir Richard Glazebrook presided at the banquet, and the Right Hon. A. J. Balfour made a thoughtful speech on standardisation which was much appreciated by all the engineers present. He pointed out that if it did not entirely prevent waste, it at least diminished it.

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 27, the following office-bearers and members of council were elected:—*President:* Prof. F. O. Bower. *Vice-Presidents:* Prof. G. A. Gibson, Dr. R. Kidston, Prof. D. Noël Paton, Prof. A. Robinson, Sir George A. Berry, and Prof. W. Peddie. *General Secretary:* Dr. C. G. Knott. *Secretaries to Ordinary Meetings:* Prof. E. T. Whittaker and Dr. J. H. Ashworth. *Treasurer:* Dr. J. Currie. *Curator of Library and Museum:* Dr. A. Crichton Mitchell. *Councillors:* Prof. P. T. Herring, Prof. T. J. Jehu, Dr. A. Lauder, the Hon. Lord Guthrie, Prof. R. A. Sampson, Prof. J. Lorrain Smith, Dr. W. A. Tait, Surg.-Gen. W. B. Bannerman, Mr. H. M. Cadell, Prof. A. R. Cushny, Sir J. A. Ewing, and Mr. G. J. Lidstone.

MR. BRUCE FREDERIC CUMMINGS, who died on October 22, will probably be known to a wider public as "W. N. P. Barbellion," author of "The Journal of a Disappointed Man," noticed by us on July 10 last, but his few scientific papers will ensure for him a no less enduring, if a more limited, reputation. Born at Barnstaple in August, 1889, in spite of meagre circumstances and increasing ill-health he taught himself zoology to such good purpose as to gain an assistantship in the entomological department of the British Museum, which he entered in January, 1912. He had previously contributed notes on local natural history to the *Zoologist*, and had been offered in the Marine Biological Laboratory at Plymouth a post which the illness of his father prevented him from taking up. In his "Journal" he affected scorn for the entomological work to which he was set, but his studies of lice soon gave rise to important papers published by the Zoological Society and in the *Annals of Natural History*. Another paper of much interest was on a scent-organ in the caddis-fly, *Sericostoma personatum*. Failing health caused him to resign his appointment in July, 1917. Mr. Cummings might never "have revolutionised systematic zoology," but he gave something more than the promise of distinguished work.

IN a Memorandum by the Chancellor of the Exchequer on the future Exchequer balance-sheet (Cd. 376) an attempt is made to arrive at very tentative revised estimates of the national revenue and expenditure in a "normal" year. The estimated normal yearly expenditure is 808,000,000*l.*, and includes the following items:—Education, 45,900,000*l.*; upkeep of museums and galleries, 600,000*l.*; and scientific investigation and research, 400,000*l.* The year 1919–20 will not be a normal year, but as regards the above items of expenditure the only difference in the estimate is that the education is down for 41,000,000*l.* instead of 45,900,000*l.*

DR. K. E. LAMAN, leader of the Congo mission of the Swedish Missionary Union, has lately returned to Stockholm with a large collection of ethnographical material drawn from the Bakongo, Bateke, and Bakuta people, as well as from five races of Ngunu.

This will be distributed between the ethnographic department of the Swedish Riksmuseum, the Ethnographic Museum of Gothenburg, and the Missionary Union's museum. Dr. Laman has made six visits to the Congo since 1890, and has paid particular attention to the language. His collection includes gramophone records of native songs.

THE Swedish Academy of Science has reported favourably on a request by Prof. J. G. Andersson (formerly Director of the Swedish Geological Survey) for a Government grant of 90,000 kronor towards scientific researches and collections in China, where Dr. Andersson is now Geological Adviser to the Chinese Government. It is hoped that the Swedish Riksmuseum will thus receive rich collections in palæontology, prehistory, and zoology, but, to comply with conditions laid down by Profs. Andersson and Wiman, the fossil vertebrates will go to Upsala.

ON October 21 the Manchester Chemical Club (president, Mr. R. H. Clayton) was incorporated with the Manchester Literary and Philosophical Society. A new chemical section of the society has been formed, and Sir William J. Pope, professor of chemistry in the University of Cambridge, delivered an address on "The Photography of Coloured Objects" to a large audience at the opening meeting on October 24.

A COURSE of twelve Swiney lectures on "Geology and Mineral Resources of the British Possessions in Africa" will be given in the lecture-theatre of the Imperial College of Science and Technology (Royal College of Science, Old Building), Exhibition Road, S.W.7, by Dr. J. D. Falconer, on Mondays, Wednesdays, and Fridays, at 5.30, beginning on Monday, November 10. There will be no charge for admission.

A JOINT meeting of the Royal Society and the Royal Astronomical Society will be held at the Royal Society on Thursday, November 6, at 4.30 p.m., for the discussion of observations made during the total solar eclipse of May 29 last. Sir Frank Dyson will open the discussion, and will be followed by Prof. Eddington and other members of the eclipse expedition.

THE Aristotelian Society will open its forty-first session on November 3. The president, Prof. James Ward, will deliver the inaugural address on the subject "In the Beginning . . ." The congress which the society arranges annually will be held next year at Oxford in September, and the French Philosophical Society will take part.

THE opening meeting of the new session of the Institution of Electrical Engineers will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Thursday, November 13, at 6 p.m., when the president, Mr. Roger T. Smith, will deliver his inaugural address.

THE one hundred and first session of the Institution of Civil Engineers will be opened on Tuesday, November 4, at 5.30 p.m., when Sir John Purser Griffith, president, will deliver an address, and will present awards made by the council for papers dealt with during the past session.

SIR HENRY ALEXANDER MIERS, Vice-Chancellor of the University of Manchester, has been appointed by an Order of Council dated October 16 to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

THE first meeting of the session of the Royal Geographical Society will be held at 8.30 p.m. on Monday, November 3, at the Æolian Hall, New Bond Street, when Major Kenneth Mason will read a paper on Central Kurdistan.

MESSRS. HODGSON AND CO., 115 Chancery Lane, W.C.2, are to sell by auction on Thursday, November 13, and Friday, November 14, the library of the late Sir William Crookes. A catalogue is obtainable from the auctioneers upon application.

AN interesting series of fragments of prehistoric pottery was found early in the year in Eastern Macedonia near Drama and the plain of Philippi. The chief importance of the discovery lies in the relation with both the north and the south which is seen in the types of pottery found. Pottery similar to the so-called Dimini ware of Thessaly, and not hitherto found in Macedonia, occurred in large quantities. Fragments of a white-on-black ware of a date later than the Dimini ware and common in Thessaly were also found. A few fragments of this latter ware were found in Macedonia in 1916 near Salonica. Some remarkable fragments showed a combination of the white-on-black painted technique with incised white-filled patterns, thus showing that the two types of technique were contemporaneous. The wares of a northern type consisted for the most part of simple pottery decorated with large spiral or semi-spiral designs. Similar wares are common in the Upper Maritsa Valley near Philippopolis and generally in the Danubian area, and are essentially northern in type. A number of clay figurines of men, women, and domestic animals were also found. The human figures are for the most part steatopygous. The importance of these discoveries for the prehistoric study of Macedonia cannot be overestimated. The series will be published in the forthcoming Annual of the British School at Athens.

THE October issue of *British Birds* contains an extremely interesting account of the nesting habits of the sparrowhawk. The author, Mr. J. H. Owen, gives a vivid description of the bathing habits of this bird and of its playful feints at capturing prey. At one time a hen he had under observation stooped at a rabbit two or three times, yet made no serious attempt to seize it; at another it trifled in the same way with a brood of partridges. But perhaps the most important of Mr. Owen's notes are those concerning the efforts of the bird to protect her eggs from the sun, which she did at the cost of great distress to herself. The nestlings suffered no less from this cause; at times, indeed, they were on the verge of collapse. Some very beautiful illustrations add greatly to the value of these notes.

THE first number of the *Radio Review*, a monthly magazine devoted to scientific radio-telegraphy and radio-telephony, has been published. It contains short instalments of papers by André Blondel and Dr. Eccles on the functions applicable to directive aerials and on the internal action of a triode valve. In Blondel's paper the definitions are not very explicit, and so it is not easy to follow his reasoning. Dr. Eccles's paper is simpler, but in order to follow it the reader must have a knowledge of Child's and Langmuir's papers in the *Physical Review*. In a brief introduction the editor, Prof. Howe, states the policy and aims of the review. The remaining part of this issue consists of abstracts and reviews of books. Apparently the aim of the journal is to do for radio-telegraphy what the *Philosophical Magazine* does for physics. The amount of matter in the first number strikes us as rather meagre.

THE Institution of Electrical Engineers has issued an amended edition of its Wiring Rules. These rules have been universally adopted in this country, and they are annually amended so as to keep them abreast of the latest practice. The amendments this year are almost of revolutionary importance. As we foreshadowed some months ago, the electricians have now abandoned measuring the size of wires in terms of the standard wire gauge (S.W.G.). They have dropped gauges altogether. Instead of speaking of a No. 20 wire, they speak of a 0·036 wire—that is, one having a diameter of 0·036 of an inch. Similarly, instead of writing 3/20 for a cable consisting of three strands of No. 20 wire, they write 3/0·036″. Formerly they had a choice of fifty-seven cables for use in electric wiring, but now there are only twenty-four sizes. Careful consideration has shown that this number is sufficient. Naturally this will be a great boon to the cable manufacturers. The British Engineering Standards Association (the B.E.S.A.) is to be congratulated on having initiated this important reform.

For more than forty years the Institution of Civil Engineers has printed in its Proceedings short abstracts of papers on engineering subjects which have appeared in periodicals and in the Transactions of scientific and technical societies. The institution now proposes to issue them separately in quarterly numbers, the first of which appears this month. Although its length is affected by the difficulty of obtaining periodicals from abroad, the first number gives ninety-nine abstracts, which cover seventy pages. Subject- and name-indexes are provided, and it is much to be desired that these should be made more useful by co-ordination in annual or two-yearly indexes. The abstracts are grouped under two heads:—Materials, Measurements, etc., and Engineering Practice. As the latter term is interpreted generously, there is some overlapping with abstracts issued by other bodies, and some system of interchange of abstracts will have to be evolved to prevent several abstracts of the same paper being written.

At University College, London, on October 21, a public lecture was given by Prof. J. A. Fleming entitled "Speaking Across the Atlantic by Wireless Telephony." Prof. Fleming opened by giving a general review of the physical facts leading up to ordinary telephony, and the application of Fourier's theorem to wave-forms, with their consequent resolution into harmonics, and the distortion produced in ordinary speech, due to the different velocities and damping of the various harmonics. Since the electromagnetic waves employed in wireless telegraphy have a velocity which is independent of the wave-length, and a falling-off of intensity with distance which is the same for all frequencies, there is no distortion of the sound in wireless telephony similar to that which occurs in long-distance telephony of the ordinary kind. Speech transmitted by wireless is particularly clear and distinct. The three typical modes of producing electromagnetic waves were explained and illustrated by lantern-slides—the high-frequency alternator, the Poulsen arc, and the three-electrode thermionic valve used as generator. Prof. Fleming explained the mode of action of the Fleming valve as a rectifier, and the development of the three-electrode valve from this. The Marconi Co. now uses seven such valves in cascade for amplifying in receiving the feeble trans-Atlantic speech, since the amplification increases geometrically with the number of valves used. By a series of trials the Marconi Co. has demonstrated the possibility of speech over 1800 miles across the Atlantic, and, moreover, the trials were carried out at an unfavourable time of day, 10 a.m. to 1 p.m. The audience was large and appreciative, one of the larger lecture-theatres of the college being required. A course of six lectures on "Thermionic Valves" is to follow on succeeding Wednesdays at 5 p.m.

Messrs. Chapman and Hall, Ltd., announce:—"Aeronautical Engines," Major A. G. Clark; "Theory and Practice of Aeroplane Design," S. T. G. Andrews and S. F. Benson; "Geometry for Architects and Builders," J. E. Paynter; "Mathematics for Engineers," W. N. Rose, vol. ii.; and "Metric System for Engineers," C. B. Clapham. *Mr. W. Heinemann* is to publish this autumn Sir Ernest Shackleton's new book. It will be entitled "South: The Story of Shackleton's Last Expedition, 1914–1917." *Messrs. G. Routledge and Sons, Ltd.*, promise "Bakery Machinery," A. W. Mathys; "The Utilisation of Natural Powers," E. L. Burne; "Engineering Instruments and Meters," E. A. Griffiths; "Direct-current Dynamos and Motors," Prof. W. B. Griffith; and "Manufacture and Installation of Electric Cables," C. J. Beaver (in the Industrial Supremacy Books Series). In their Efficiency Books they will publish "Bibliography of Industrial Efficiency and Factory Management," H. G. T. Cannons, and a new edition of "Lectures on Industrial Psychology," B. Muscio. *Messrs. H. Sotheran and Co.* will shortly issue an Illustrated Library edition of their "Bibliotheca Chemico-Mathematica." It will contain many full-page plates, reproductions of title-pages, textual passages from rare or historically important works, and an analytical subject-index.

The special catalogues of Messrs. H. Sotheran and Co. (140 Strand, W.C.2) are models of what catalogues of second-hand books should be, for they furnish in an interesting manner much out-of-the-way information respecting many of the volumes offered for sale, and are carefully classified. Messrs. Sotheran's latest catalogue (No. 773, 2*s*. 6*d*. net) deals with rare books on exact and applied science, and includes the library of the late Prof. Henrici and a portion of that of Prof. G. Govi, of the University of Naples. Its 3336 items are classified under the headings: General and Collected Works; Mathematics; Astronomy and Geodesy; Dialling and Horology; Physics; The Microscope and Microscopy; Meteorology and Physical Geography; Chemistry; Crystallography; Chemical Technology, including Photography; Mining and Metallurgy; Engineering; Seamanship, Airmanship, and Naval Architecture; and sets of Learned Societies' Publications and other scientific journals. The catalogue will be very useful for reference.

OUR ASTRONOMICAL COLUMN.

Large Meteors.—On October 21, at 8h. 35m. G.M.T., a meteor brighter than Jupiter was observed by Mrs. Wilson at Totteridge, by Mr. C. P. Adamson at Wimborne, and by Mr. H. G. Baker at Wangford. It was directed from a radiant near α Cephei, and moved slowly at an average height in the atmosphere. On October 22 at 7h. 42m. G.M.T. a bright meteor was seen from Bristol, Stowmarket, Wimborne, and Plumstead, S.E. It had a very long horizontal flight of about three hundred and thirty-five miles at a velocity of thirty-three miles per second, and passed from over a point twenty miles north-east of York to thirty miles south-west of St. Valery, France. Its height was about seventy-four miles, and its radiant at $156^\circ+39^\circ$. It is very suggestive that the radiant point of meteors from the comet of 1739, as computed by Prof. A. S. Herschel, was at $157^\circ+39^\circ$ for October 22; meteor speed = 39 miles per second. The comet passed about 7,500,000 miles outside the earth's orbit.

COMET 1919*b* (BRORSEN-METCALF).—Messrs. Braae and Fischer-Petersen have redetermined the orbit of this comet from observations on August 21 and September 7 and 27. They first assumed the period as seventy-two years, and found that on this assumption there were residuals of $+1{\cdot}61'$, $-1{\cdot}47'$ in longitude (great circle) and latitude in the middle observation. They then left the period to be determined by the observations, and obtained the following orbit (*Ast. Nach.*, No. 5015):—

$$T = 1919 \text{ Oct. } 17{\cdot}156 \text{ G.M.T.} \qquad \log q = 9{\cdot}68695$$
$$\left.\begin{array}{l}\omega = 129^\circ\ 53{\cdot}10' \\ \Omega = 310^\circ\ 28\ 56' \\ i = 18^\circ\ 53{\cdot}02'\end{array}\right\} 1919{\cdot}0 \qquad \begin{array}{l}\log e = 9{\cdot}98229 \\ \text{Period} = 42{\cdot}465 \text{ years}\end{array}$$

The residuals are now $-0{\cdot}21'$, $-0{\cdot}12'$, and, as it appears that a further reduction of the period would make them smaller, it is concluded that the comet has made two revolutions since 1847. The observations in that year were not very numerous, and the periods then deduced were liable to much uncertainty.

If the 36-year period is right, the comet belongs to the family of Uranus, not to that of Neptune as formerly supposed.

It is now more than ever desirable that the comet should be observed for as long a period as possible. The following ephemeris, for Greenwich midnight, has been corrected approximately for the change in the orbit:—

	R.A. h. m. s.	S. Decl. ° ′	Log *r*	Log Δ
Nov. 2 ...	12 33 8	4 39	9·7962	0·0932
6 ...	12 43 31	7 23		
10 ...	12 53 44	9 59	9·8750	0·1424
14 ...	13 3 36	12 18		
18 ...	13 13 8	14 25	9·9464	0·1808
22 ...	13 22 20	16 22		
26 ...	13 31 8	18 10	0·0090	0·2111

THE NEW LABORATORIES AT ROTHAMSTED.

ON Monday, October 20, the new laboratories at Rothamsted were opened by Sir Arthur Griffith-Boscawen, Parliamentary Secretary of the Board of Agriculture and Fisheries, in the unavoidable absence of the Right Hon. Lord Lee of Fareham, President of the Board of Agriculture, who had intended to be present himself. There was a distinguished gathering of men and women interested in the practice of agriculture and in the sciences underlying it, which included Sir Horace Plunkett, the Hon. Rupert and Lady Gwendolen Guinness, Sir David Prain, Sir Francis Watts, Mr. Otto Beit, Prof. V. H. Blackman, Dr. M. O. Forster, Prof. MacBride, Sir Robert and Lady Robertson, Mr. Arthur Sutton, Mr. M. R. Pryor, Dr. M. C. Rayner, Dr. T. A. Henry, Dr. J. A. Voelcker, and others.

The chair was taken by Prof. H. E. Armstrong, vice-chairman of the Lawes Agricultural Committee, who said that Rothamsted had long been known throughout the world as the chief centre of scientific inquiry into the problems of agricultural practice. It was now the Mecca of agricultural pilgrims. Its sphere had been further widened by the recent action of the Board of Agriculture in establishing there an institute for the study of plant pathology, where entomological and mycological investigations could be carried on. The demands of modern scientific workers were very considerable, but no pains had been spared to make the equipment and laboratories as efficient as possible. The total cost of these improvements had been 26,000*l.*; of this sum no less than 10,000*l.* was collected in public subscriptions from farmers and their friends. The Board of Agriculture gave generous assistance, and granted an equal sum—10,000*l.*—from its Development Fund. The remaining 6000*l.* had been given by private donors and obtained in other ways. Fortunately, the work was completed before the recent rise in prices, and at a conservative estimate could not be done now for less than 60,000*l*.

Sir Arthur Griffith-Boscawen said that for many years agriculture had been neglected by the State, but its national importance was discovered during the war, and he knew it was the intention of the Government, and of the Prime Minister in particular, that agriculture should not be neglected in the future as it had been in the past. It was possible that some of the methods proposed might lead to controversy, but he was sure that on one point there would be complete agreement, and that was the necessity of adequate provision for research in agricultural science. It was a fortunate, and perhaps significant, coincidence that the opening of the new Rothamsted laboratories was almost simultaneous with the Prime Minister's speech, which might announce an important agricultural policy. Sir Arthur expressed his faith in the system of demonstration farms, at which farmers could see new methods in operation. But behind and above all such farms must be the research stations, where facts and principles could be ascertained in a truly scientific manner and with truly scientific precision. The Board of Agriculture realised that reduced expenditure on agricultural research would be false economy; it was essential that agricultural production should be increased and that the best possible advice should be available for the farmer. The Board of Agriculture was conscious of the splendid work that was being done at Rothamsted, and he wished every success to that admirable institution.

The Hon. Rupert Guinness, in thanking Sir Arthur Griffith-Boscawen for having, at only an hour's notice, taken Lord Lee's place, emphasised the need for increased facilities for investigations in agricultural science as one of the surest means of progress, and expressed his satisfaction with the work done at Rothamsted.

Sir Horace Plunkett, in seconding the vote of thanks, referred to the simplicity of language in which the results of the Rothamsted inquiries were expressed, thereby making them intelligible to the ordinary farmer.

The door of the building was then opened by Sir Arthur Griffith-Boscawen, and the company proceeded to the inspection of the various laboratories and of the interesting series of exhibits which had been arranged by the staff.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. J. E. PETAVEL, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

DURING the last five years every resource of the Empire, moral, intellectual, and material, has been concentrated on one great task, now successfully achieved; and the present period marks the end of a gigantic military struggle and the beginning of a new social era

I.—*Engineering and Science during the War.*

To summarise adequately the part played by engineering in the war would constitute a task far beyond the power of the writer or the scope of the present address. Now, as in the past, the fate of nations in war or peace is primarily determined by moral, intellectual, and physical attributes; but, under modern conditions, these forces can find efficient application only through the agency of science and engineering.

A large army depends for its subsistence and equipment on the combined effort of every branch of human activity; and every productive industry, when organised on a large scale, is in turn dependent upon the engineer.

Before the end of the war this country had become transformed into one vast factory, every department of which required the services of trained engineers. Every member of this section has contributed his own share to the task, and our programme includes papers giving detailed accounts of several branches of the work.

It is fitting, therefore, that I should restrict myself to a mere outline of some of the more outstanding facts.

The urgent necessity for an output of munitions vastly in excess of any previous production made centralisation and standardisation essential, and involved a complete revolution in workshop practice. The Ministry of Munitions was responsible for the formation of the required organisations and guided the transformation of industrial conditions, and, when the dilution of skilled labour became inevitable, the technical engineer designed the machinery and devised the methods which made efficient work possible.

Credit is due to the unions for the concessions made; greater credit to the women for their enthusiastic response to the call and the steady output they maintained.

Munitions.—The Ministry of Munitions was created in May, 1915, its early efforts being concentrated on the production of guns and shells. A year later the Ministry was in a position to meet the ever-increasing demands of the Army, and by 1918 a large reserve of munitions had been established, the expenditure being limited only by difficulties of transport at the Front. The maximum expenditure of ammunition was reached one day in October in that year, when 900,000 shells, weighing 40,000 tons, were fired. The total number of guns manufactured during the war was 20,000, and more than 200,000 machine-guns had been delivered by November, 1918.

The Ministry of Munitions took charge also of the production of aircraft, which were ultimately turned out at the rate of 4000 per month; later, the provision of motor transport was in addition placed under its control. Finally, our production of "poison gas," for which this Ministry was responsible, rose during the last few months of war to several thousand tons a month, sufficient to make the Germans rue the day on which they had introduced this weapon into warfare.

Among the inventions which have had an influence on military operations I will mention only three as typical of three distinct classes:—

Tanks were first used in 1916, and the results produced were greatly enhanced by the surprise created, and consequent moral effect, but the idea of an armoured chariot is as old as organised warfare. The problem of constructing a vehicle which could travel across the trackless and shell-pitted district which extended between the two armies remained to be solved. In the light of the experience gained with various types of tractors it was, however, clearly not insoluble, and credit is due to the man who had the courage to hazard a novel and important experiment. The resulting tank was the product of careful design and experiment, and the outcome of the co-operation of several engineers with special knowledge. Sound-ranging introduced the complex methods and delicate instruments of physical research into the trenches, and, against all precedents, proved them to be trustworthy and practical under the most adverse conditions. The Stokes gun, on the other hand, superseded all other trench-mortars by simplicity of design of manufacture and convenience in handling; 20,000 of these guns were used during the war.

Transport.—On August 4, 1914, the Government assumed control of the railway systems in this country, but the working and management were left in the hands of the railway officials, and to them is due the smooth working of the lines during a long period of exceptional difficulty. British engineers, civil or military, have been responsible for the transport through France, and during the last two years of the war large numbers of engines were sent across the Channel and miles of track were taken up in England and relaid in France. Road transport was organised on an unprecedented scale, and 100,000 new vehicles were delivered. A network of narrow-gauge railways was carried right up to the trenches, and numerous new roads, railway lines, and bridges constructed. Railway construction formed an important factor in connection with the advances in Mesopotamia and Palestine; in the latter case the entire water-supply had for a long period to be drawn from the Egyptian base through a specially laid pipe-line.

In France and elsewhere the armies were primarily dependent upon sea transport for their food and equipment. This service, organised by the Navy, culminated in the unique effort which brought American troops at the rate of 300,000 per month, and thus overbore the balance which for four years had been oscillating between defeat and victory.

Among the notable new departures the cross-Channel train ferry and the portable steel bridges, principally of the Inglis type, should be specially mentioned.

Navy.—At the outbreak of war the Navy was ill-prepared with regard to anti-submarine defence and mining. The influence of the submarine on naval warfare had been under-estimated, and mines were regarded as a somewhat discreditable means of destruction; but during 1915 the depth-charge and the paravane were developed by the Naval Experimental Department at Portsmouth, and later thousands of these were brought into use. In principle the depth-charge consists of a canister containing a large charge of explosive and a pistol actuated by a hydrostatic valve. The merit of the invention resides in the simplicity, safety, and trustworthiness of the mechanism. In designing the paravane the body was borrowed from a torpedo, and wings, rudder, and elevator from an aeroplane. The secret of the device lies in the stabilising mechanism, which enables it to keep its position when the ship is running at high speeds. The paravane enabled most ships to pass unscathed through a minefield, and in a slightly modified form it served to seek out and destroy submarines under the water.

Sound-location proved to be one of the most valuable inventions developed by the Board of Invention and Research. By its means the position of a submarine explosion off the coast of Belgium could be found within a few hundred yards by observers on the English coast; passing ships or submarines could also be identified and located. Sound-locators were also used on board anti-submarine craft, but at the time of the armistice were for this purpose being superseded by other methods.

Mine construction, laying, and sweeping formed the object of many successive improvements. Mines of special construction, which cannot be swept by ordinary means and explode without actual contact, were used in large numbers in 1918, and were particularly effective against submarines. Various new types of oscillating mines were also developed.

Many of the newer fighting units of the Navy were designed for speeds far in excess of anything that had been previously contemplated; the attainment of the required horse-power was rendered possible by improvements in boiler construction, by the development of oil-firing, and by the invention of the geared turbine. At the present time the horse-power of some of the fastest destroyers equals that of any pre-war Dreadnoughts.

Numbers of strange craft were designed for special purposes. The monitor was used as a floating fortress, and ships without funnels or masts formed cruising aerodromes. The torpedo-net was known to be ineffective as well as inconvenient, but some years elapsed before ships were rendered immune from torpedo attacks by a wide outer sheath of resilient construction. Some protection was first given to minesweepers by fitting the vessels with a false prow; the newer minesweepers were rendered nearly unsinkable by the provision of numerous bulkheads. The submarine was developed with regard to size, range, and speed. The latest, and perhaps the strangest, craft was the submarine fitted with a heavy calibre gun which could be fired when all but the muzzle was submerged.

Aircraft.—The rapid progress and expansion of aeronautical science and construction are perhaps the most remarkable achievements of engineering during the war.

In 1909 Blériot flew the Channel. In 1910 Cody won the British Michelin Cup by a flight of 185 miles. The Royal Flying Corps was formed in 1912, and it was decided that the equipment should consist of seventy-two aeroplanes and two airships. The number of aeroplanes available in 1914 was less than 200; the number ultimately required proved to be more than 3000 a month. The aeroplanes which were sent out with the Expeditionary Force in 1914 had a maximum speed of some 80 miles an hour, a rate of climb at ground-level of 300 ft. or 400 ft. a minute; they were equipped with engines of 60 h.p. to 100 h.p. In 1918 the fast machine had a maximum speed of 140 miles an hour, a rate of climb at ground-level of 2000 ft. a minute; single-seaters were fitted with engines of 200 h.p to 300 h.p., and the largest machines were equipped with a power plant developing more than 1300 h.p. The maximum height attainable had increased from 5000 ft. to 25,000 ft.

The Atlantic flight has given the measure of the success achieved in the design of long-range bombing machines. Two types were evolved: the fast day bomber, capable of carrying a useful load of about 3000 lb. at a speed of 130 miles an hour, and the night bomber with a larger load and slower speed. The largest aeroplane manufactured in numbers was the Handley Page V/1500, with a weight of 11 tons and a power plant of 1300 h.p. Three days before the armistice two of these machines stood fully equipped waiting for the order to start for Berlin. The largest bombs in use weighed more than a ton, and during the war 8000 tons of explosives were dropped on the enemy. The experience which they had gained in the construction of the high-powered engines required for airship work proved to be a valuable asset for the Germans. Initially also their rate of production, both of aeroplanes and engines, was far superior to ours, and, faced with the menace of otherwise being for a period deprived of machines, we were bound to continue the use of a certain standardised types longer than was desirable.

The labour difficulty was overcome by the introduction of a large proportion of female labour, which proved to be very suitable for aeroplane manufacture, and especially for wing construction. The bulk production of aero-engines presented grave difficulties. Every part had to be made to close limits so as to be interchangeable, and it was necessary to maintain the highest quality with the minimum amount of skilled labour. For a period the supply of magnetos was both inadequate and unsatisfactory. The Germans had acquired practically a monopoly in this direction, and it became essential for us to build up a new industry on the results of careful research and experiment. The fact that in these circumstances a total of 8,000,000 h.p. was produced during the last twelve months of the war represents one of the greatest achievements of engineering organisation.

Synchronised gun-firing through the propeller was first brought into use by the enemy, and the success of the Fokker was due, not to superior design, but to this characteristic armament and to the relatively high engine power. On the other hand, throughout the war the only stable machines were British. For observation work, night flying, and flight in fog and cloud the advantages of a stable machine are obvious. Instability, inasmuch as it favours rapid and unexpected manœuvres, was for a time regarded as an advantage in aerial fighting, but later experience proved that a well-designed aeroplane could be made stable and yet remain quick and light on the controls.

Seaworthiness, no less than airworthiness, is required of the seaplane, and this implies a machine of considerable size and weight. Most of the best seaplanes in use in 1918 had a total weight of four or five tons each, a speed of nearly 100 miles, and engines of about 700 h.p.

The machines used by the special aeroplane-ships were principally small fast scouts, but one type was of sufficient size to carry an 18-in. torpedo. In 1918 seventy aeroplanes were carried by the Fleet as part of the regular equipment.

Airships proved to be of great importance in connection with naval work. The smaller non-rigids were used for patrol duty along the coast and convoy service, and by their means a submarine could be detected and attacked while still at a considerable distance below the surface. The success achieved was extensive, and ships convoyed by airships were practically immune from submarine attack. The larger non-rigids served as scouts in naval operations.

The SSZ had a speed of 50 miles and a gross lift of about two tons; the North Sea type a lift of 11 tons and a speed of 60 miles.

Compared with the achievements in other directions the record of British work in connection with the development of rigid airships is not entirely satisfactory. In this field, where consistent policy and firmness of purpose were essential, the Admiralty vacillated strangely. The *May-fly*, constructed at Barrow in 1910, was admittedly an experiment, and although an accident ended her career after the first few mooring tests, she had already served her purpose in providing the experience and data necessary for a more perfect construction. Nothing further was done, however, until after the war had started.

In Germany, on the other hand, painstaking plodding had built up success on the ruins of a dozen failures.

Improvements in the rate of climb of aeroplanes and the invention of the incendiary bullet brought an end to the effectiveness of the Zeppelin as a bomber, but as a scout in long-range naval operations its influence remained considerable, and the recent successful journey of R 34 indicates the possibilities of the rigid airship in times of peace. The useful load increases rapidly with size, and a ship 15 per cent. larger than R 34 in linear dimensions could have carried 100 people to America.

What is popularly known as an invention, or an idea of revolutionary importance emanating from one person, has played relatively little part in the recent development of aeronautics. Success has been due to systematic investigation and the combined effort of many scientific workers, trained designers, and practical constructors. With some exceptions the same holds true in the case of engine construction. Inventions there have been (8000 are duly recorded in the files of the Air Inventions Committee), but equipment and armament and accessories appear to have offered most scope for brilliant new departures.

Several inventions notably influenced the course of the war. The successful manufacture of incendiary bullets put an end to the Zeppelin raids, tracer bullets increased the accuracy of aim, and synchronising gear made it possible to fire through the propeller at the rate of nearly 1000 rounds per minute. A satisfactory self-sealing petrol tank was manufactured after many unsuccessful attempts, and greatly diminished the risk of fire. Much ingenuity was displayed in connection with bomb-sighting and navigational instruments. Wireless telephone and directional wireless were introduced. A trustworthy turn-indicator and improved compass made accurate navigation through clouds possible. Armoured aeroplanes were constructed; special machines were also designed for carrying 37-mm. quick-firing guns for use at the Front and against submarines; these guns fired a 1½-lb. high-explosive shell.

The increased efficiency of the anti-aircraft artillery and the high rate of climb of the defending machines put a check on daylight aeroplane raids, while at night and in mist both searchlights and guns could be trained on the enemy, even if invisible, by means of sound-directors. A screen of kite-balloons supporting nets formed part of the night defences of London, and justified its existence by the moral effect produced on the enemy pilots.

The use of airships near the fighting zone or within reach of enemy aeroplanes was impossible owing to the inflammable nature of the gas they contained, and, in spite of all precautions, the loss in kite-balloons was serious. The proposal to replace the hydrogen by helium came from a member of the Board of Invention and Research, and in 1915 experiments were started with a view to the ultimate production of several million cubic feet per month. The boldness of the idea is best emphasised by the fact that at that time it took weeks to obtain the few cubic inches of gas required for the preliminary permeability tests. Progress was accelerated when America came into the war, and at the time of the armistice a supply of 350,000 cubic ft. per week was ensured.

The above outline of engineering activities during the war is both incomplete and imperfect. It may, however, serve to emphasise and illustrate the two features which characterised the period and made victory possible.

The first is: Large production, obtained by organisation, standardisation, and co-operation.

The second is: Rapid progress resulting from the stimulus to research and invention and the immediate application of the results obtained.

The required organisation did not arise as a natural development of the pre-war industrial activity: it was called into being by dire necessity and applied with grim determination. Before the war the British nation was anti-militarist, non-scientific, and strongly individualistic. To achieve victory the nation accepted universal conscription, and submitted to the mixture of Socialism and tyranny which necessity dictated. Under extreme pressure scientific knowledge, technical skill, industrial ability, military and naval experience welded into a homogeneous and efficient organisation.

It is easy to disparage the effort or to point to defects, large or small, which tarnish the record, but the fact remains that, whereas in 1914 we were inferior to the enemy in every military asset except moral courage, in 1918 victory came as the result of mastery in practically all the thousand factors on which modern warfare depends.

The organisation involved the direct control of food, every essential raw material, shipping, and transport; further, under the cloak of various euphemisms, it involved the indirect control of all available capital and labour. The capitalist was granted the privilege of receiving and paying the interest on the money required. High wages and the Military Conscription Act ensured an adequate supply of labour in the factories. And these things came to pass, not by the tyrannical order of an all-powerful Government, but by the force of a great idea working within the nation.

II.—*Industrial and Economic Reconstruction.*

The peace declaration is the opening of a new act in the world's greatest drama, and the events of the next few years will decide the fate of many generations. The future is always the logical sequence of the past; it is the present which gives direction to the forces which are acting in virtue of the ideals which are operative. The world is emerging from a furnace, and the rigid constitution of civilisation, for a moment plastic, will harden in the mould we form. It is, therefore, the duty of each one of us to attempt to understand the transformation which is going on, and influence it in the right direction.

The principal feature of the day is the insistent craving for better and easier conditions of life; in popular language, this is quite inaccurately expressed by a demand for higher wages and less work. The two aims are far from identical; in fact, a little consideration will show that in some respects they are contradictory.

The total remuneration received by a nation is measured by its production, and this law cannot be altered or affected by legislation or revolution. On the other hand, the share received by a class or an individual is capable of adjustment within certain limits. Thus any class may increase its remuneration either by increasing the total production or by decreasing the remuneration received by the other classes. The capitalist who corners wheat, and the miner who corners coal, are examples of the latter method. No such limitations exist, however, with regard to the face-value of the wages paid; by Act of Parliament all wages might be increased arbitrarily twentyfold, but as a result the cost of living would rise to a similar ratio.

Incalculable harm has been done by ignorance and wilful misrepresentation. During a generation the working classes have been told, and have firmly believed, that they receive but a tithe of the value of their work, and that the bulk goes to swell the fortune of the capitalistic class. The actual facts so far as engineering is concerned will be found in the address of my predecessor in this chair. On an average in pre-war days the share of the capitalist was one-ninth that of the workman. The actual position with regard to coal is now known to all. For each ton raised 19*s.* 5½*d.* goes for labour, and a total of 2*s.* is paid as royalties, owners' profits, and owners' compensation. It is obvious that the 13*s.* rise in the miner's wages cannot be paid out of profits and royalties amounting to a total of 2*s.*, but the miner, who has been brought up to believe in the fabulous profits of the wicked duke, is quite ready to strike against the owners, the Government, and the laws of arithmetic.

These facts, though clearly established, are not easily credited by the working man; he may have received a penny for what he considers is the manufacture of an article, and sees it selling for a shilling in a shop. He forgets that the price must include, not only his wage, but that of the men in the mine, the smelting works, and the rolling mill, who provided the material in the shape required, the wages of the men who built the factory in which he works and made the machine he uses, the wages of transport workers, packers, shop assistants, advertising agents, printer, papermakers, etc., and that, finally, some minute fraction of a farthing might with justice be allotted to the engineer who designed the machine or invented the process. The general position, though similar, cannot, unfortunately, be followed so closely; the limitations, however, are clear. The income of the United Kingdom per head of the population was before the war about 50*l.* If, therefore, the State were run on completely communistic lines, and if under these conditions there were no reduction either in the working hours or the output, our wages would average a sovereign a week each, and we could buy our goods at pre-war prices.[1]

The above considerations indicate that a real improvement in material welfare is necessarily associated with increased production. The needs of mankind are many, its desires are unlimited, and for this reason general over-production need never arise. Many circumstances may, however, lead to uneven balance, and, unfortunately, when this occurs, the producers of the commodity which is in excess are penalised, and those responsible for a deficiency are rewarded. The instability is fostered and increased by speculation, and, although it forms the most powerful check on national prosperity, no serious effort has yet been made to apply a remedy.

I am inclined to think that two of the most important problems of our time relate to economic balance and increased production. The solution in the former case is dependent on the statesman, the economist, and the business man, in the latter on the combined efforts of various branches of applied science, and more especially on engineering.

At one time production was directly dependent on muscular effort; it is now mainly influenced by equipment, organisation, and skill. Increased production does not necessarily imply harder work or longer hours; it can be secured by improvements in method and machinery, but only with the willing co-operation of all concerned.

Before the war the Americans were far ahead of us in stardardisation and specialised machinery. The American clock and the Ford car are two well-known examples. During the war we adopted and developed these methods. As a result, although the cost of all materials increased considerably, although the wages more than doubled and the profits were more than adequate, the cost was in many cases reduced. Thus the eighteen-pounder shell fell from 22*s.* to 12*s.*, the Lewis gun from 165*l.* to 62*l.* The importance of standardisation has been fully realised by the manufacturers of this country, and as a result we may hope to see a general reduction in cost.

The economic value of an individual depends exclusively on the nature, quality, and quantity of

[1] This statement is optimistic in so far as it does not take account of war losses.

his output, and his remuneration should correspond with his economic value. The rule is simple, its application would solve most of the problems which vex the present generation, but no scheme has yet been evolved to make its application possible.

There can be no doubt that in this respect our present system is a complete failure. It has been built up casually in the course of the industrial warfare of the last twenty years, and each side, regardless of consequences, has entrenched itself in any position won. The result is a system nearly perfect from the point of view of offence and defence, well arranged for mutual destruction, but, like the trenches in France, unsuitable for use in time of peace.

The minimum wage is beneficial in so far as it prevents sweating, but in two other respects its consequences are most unfortunate. Under the operation of this rule the man whose value is a fraction below the minimum is unemployed and economically unemployable. Further, the minimum wage becomes the standard wage, and the better men are inadequately paid. Both causes lead to decreased production. The weaker or less skilful men drift into enforced idleness, and become a charge to the community under the heading of charity, poor-law, or some newly invented euphemism The better men, finding extra effort uncompensated, drop to an ever-decreasing minimum. Small output is in most cases the result of inadequate incentive rather than active restriction. Promotion by seniority is an example of a similar cause, producing similar effects in other classes of the community.

Among the professional and business classes the remuneration is proportional to the skill and to the effort; a barrister, an engineer, or a merchant has neither minimum wage nor fixed maximum output, and, the vagaries of chance excepted, generally speaking gets what he is worth. At the two extremes stand riches and starvation, and the economic world can offer no stronger motive forces than the allurements of the one, the fear of the other. There is no absolute reason why the working man should not be offered the same incentives to hard work and progress, but up to the present most efforts have tended in the opposite direction. Any form of payment by result is viewed with indifference or distrust by the unions, and past experience with piece-work explains that attitude. There has been a disposition for employers to make large individual earnings an excuse for cutting rates. Errors in rate-fixing may easily arise, and in certain cases special investigation might be necessary, but the advantages of high individual production are so great to both employer and employed that in all cases of doubt the higher rate should be maintained. In this connection the method of time-study first developed by Taylor in America and the various systems of payment by results which have been successfully applied deserve careful consideration.

Another important but difficult subject is the distinction drawn between skilled and unskilled labour. The experience gained during the war has proved that many operations scheduled as skilled work could be effectively performed by women who had received only a few weeks' special instruction. The oft-repeated demand for equal opportunity for all becomes a senseless parrot cry if it does not imply that an individual has the right to undertake better-remunerated work if qualified to do so. It is a misconception which leads the skilled worker to believe that such a concession would reduce his earnings. Just as it is clear that if labourers and skilled men were grouped together at a uniform wage, that wage would necessarily be lower than the present minimum for skilled work, so also the separation of tasks which require but a nominal period of training would increase the rate of remuneration available for the really skilled man.

I have directed attention to some of the difficulties which must be solved if the country is to emerge from the present crisis prosperous or even solvent. There is little doubt that an elucidation is possible, but it can only be evolved by the honest and intelligent collaboration of all parties concerned, a task rendered difficult or impossible by mutual distrust and class hatred. Class differences there are, and always will be; they exist as the result of breeding, education, and environment, but they do not extend to the fundamental characteristics of humanity. Many dukes and many miners are lazy; most capitalists and most trade unionists are greedy; all men, with a few exceptions, are selfish. The war has shown that lazy, greedy, and selfish men will die, or even work, for their country in a great exigency, but there is a limit to, and a reaction after, any profound emotional stimulus, and the present unrest and dissatisfaction are but normal symptoms. A satisfactory economic system can be based only on natural human impulses, and of these the most fundamental is self-preservation, or, more generally, self-interest. Increased production is at the present moment the most pressing national need, but it will become effective only when for every man increased production becomes the talisman by which *his* paper-wages can be turned to gold.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

London.—A massive bronze medal has been received from the University of Paris in commemoration of the manifold services rendered during the war by the universities of the Allied nations and "in token of a friendship henceforth indestructible." It bears in relief on the obverse the figure of "Scientia Instrumentum Justitiæ—Libro—Ense—MCMXIV–MCMXVIII," and on the reverse the old courtyard of the Sorbonne, with the inscription "Fidelissimæ Sorori Universitas Parisiensis dicavit."

The thanks of the Senate have been accorded to the Worshipful Company of Drapers for renewing for a further period of two years their pre-war grant of 500*l.* a year to the biometric laboratory of the Department of Applied Statistics and Eugenics at University College; and to the London County Council for a grant of 6000*l.* for the erection of temporary buildings for the Department of Engineering at King's College.

The following doctorates have been conferred:—*D.Sc. in Chemistry:* Mr. E. K. Rideal, an internal student of University College, for a thesis entitled "The Synthesis and Thermocatalytic Combustion of Ammonia." *D.Sc. in Botany:* Mr. H. Wormald, an external student, for a thesis entitled "Researches into the Biology, Morphology, and Mode of Parasitism of the Species of Monilia Occurring on Fruit Trees," and other papers.

A course of advanced lectures on (*a*) "The Energy Balance of the Human Body," (*b*) "Electrical Signs of Emotive Phenomena," is being given by Prof. A. D. Waller, professor of physiology in the University, at 5 p.m. on Wednesdays, November 5, 12, 19, and 26, and December 3, in the physiological laboratory of the University, South Kensington, S.W.7. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

OXFORD.—The entry of freshmen at the beginning of the present term is probably the largest on record. Nearly all the colleges have admitted members far in excess of their usual numbers, and very great difficulty has been met with in finding accommodation for undergraduates both within the colleges and in the town outside. In some cases quarters have been provided by the erection of Army huts. The science laboratories are overcrowded with students.

Prof. Vines has resigned the chair of botany as from December 31, 1919. Candidates for the professorship are requested to send in their applications to the Registrar of the University by November 22 next. Applications for the chair of geometry, vacated by the death of Prof. Esson, should be sent in to the Registrar by the same date. Particulars of these two professorships may be seen in the *Oxford University Gazette* of October 22.

Mr. R. S. Troup, Assistant Inspector-General of Forests, India, has been elected professor of forestry.

A Treasury grant of 15,000*l.* has been received for the University under the condition of an inquiry into the financial resources of the University and colleges.

Counsel's opinion has been taken on the question of the powers of the University in the matter of the admission of women to matriculation and degrees. Counsel advise that the University has the power, proceeding by statute, to provide for this object; but they also recommend application to Parliament for an expressly enabling Act. A decree will therefore be proposed on November 4 requesting the burgesses of the University to take steps with the view of securing the requisite legislative sanction.

MAJOR G. THORP has been appointed chief instructor in electricity at the School of Military Engineering, Chatham.

MAJOR RUPERT STANLEY has been appointed principal of the Belfast Municipal Technical Institute, and director of technical instruction for Belfast, in succession to the late Mr. F. C. Forth.

MR. E. DE BARRY BARNETT has been appointed to the post of lecturer in organic chemistry, and Mr. R. H. Humphry to that of lecturer in physics, at the Sir John Cass Technical Institute, Jewry Street, Aldgate.

DR. W. M. McDOUGALL, Wilde reader in mental philosophy in the University of Oxford, has been appointed to the chair of psychology in Harvard University, in succession to the late Dr. Hugo Münsterberg.

MR. B. MOUAT JONES, assistant professor of chemistry in the Imperial College of Science and Technology, has been elected to the chair of chemistry in the University College of Wales, Aberystwyth, in succession to Prof. Alex. Findlay.

THE council of the Institution of Naval Architects has awarded the Cammell Laird scholarship in naval architecture (150*l.* per annum for three years) to Mr. H. J. R. Biles, of the Fairfield Shipbuilding and Engineering Co., Ltd.; and the Parsons scholarship in marine engineering (150*l.* per annum for three years) to Mr. W. G. Simmonds, of Chatham Dockyard.

THE President of the Board of Education has appointed a Departmental Committee to inquire into the working of the existing arrangements (*a*) for the award by local education authorities of scholarships tenable at secondary schools or institutions of higher education other than universities or institutions for the training of teachers; (*b*) for the provision of free places in secondary schools under the Regulations of the Board of Education; and to make recommendations with the view of improving such arrangements, and thereby rendering facilities for higher education more generally accessible and advantageous to all classes of the population, regard being had (*inter alia*) to the migration of pupils from one school or area to another. The members of the Committee are:—Lt.-Comdr. E. Hilton Young, M.P. (chairman), Mr. E. K. Chambers, Mr. R. F. Cholmeley, Sir Mark Collet, Bart., Miss E. R. Conway, Miss Philippa Fawcett, Mr. F. W. Goldstone, Mr. H. J. Hallam, Mr. R. T. Jones, Mr. J. Murray, M.P., Major the Hon. W. G. A. Ormsby-Gore, M.P., Mr. C. J. Phillips, Mr. T. J. Rees, Mr. R. Richardson, M.P., Miss B. M. Sparks, and Mr. H. E. Mann (secretary). All communications should be addressed to Mr. Mann at the office of the Board of Education, Victoria and Albert Museum, South Kensington, S.W.7.

EARLY this year an account was given in these columns (January 23, p. 418) of a conference of representatives of scientific and educational associations interested in both the production and the distribution of knowledge, held to consider proposals for the publication of a monthly journal which should present in popular form the most recent results of research in all the chief subjects of knowledge. This conference appointed a committee to frame a scheme, and the report of the committee was presented and adopted at the adjourned meeting of the conference held on October 24. The meeting approved the title *Discovery* for the new journal, consent having been given to the use of this title by Sir Richard Gregory and by Messrs. Macmillan and Co., Ltd., the publishers of his book so named. Mr. John Murray will publish the journal, and Capt. A. S. Russell, recently of the R.G.A., now of the University, Sheffield, and reader-elect in chemistry at Christ Church, Oxford, will be editor. The first number will be issued on January 15, 1920, at the price of sixpence. It is understood that the journal will at first contain about twenty-four pages of matter, and will undertake in the course of the year to represent in interesting form, though it will make no attempt to describe in full, the progress of knowledge in all its chief branches. Canon Temple has been appointed by the trustees to be the first chairman of the managing committee, of which Dr. Armitage-Smith is the treasurer and Prof. R. S. Conway, of Manchester, the hon. secretary.

IT will be recalled that in July–August last a joint committee of the Empire Cotton-growing Committee of the Board of Trade and of the British Cotton Industry Research Association offered five botanical research studentships to graduates and others recommended as likely to prove successful research workers, for the prosecution of research bearing upon any of the numerous technical problems affecting the cotton industry. The studentships were of the value of 150*l.* per annum (or in certain circumstances 200*l.* per annum), and in the first instance were available for one year. Considerable freedom was allowed in the choice of the line of research, the joint committee recognising that the economic results hoped for can be obtained only by increasing the volume of purely scientific inquiry now being conducted into the physiology and genetics of plants. We are now officially informed that, although advertisement was given to the scheme and the heads of the botanical departments of the universities were approached in the matter, the response on the part of graduates has been disappointing. The committee hopes that it will be possible to offer similar studentships next year, and desires to give the scheme early publicity in order that senior students may be able to consider the offer when planning their post-graduate work. For the present the studentships are limited to men, though with the development of the scheme it is hoped that it will cover fields open to research workers of both sexes. The studentships appear to offer considerable attractions to young economic botanists, but the joint committee will no doubt consult the heads of the botanical schools as to the probable cause of the poor response to its first offer, with the object of mitigating any drawbacks which may have become apparent in the scheme. We venture to suggest also the desirability of indicating a selection of typical problems with which the cotton industry is confronted.

SOCIETIES AND ACADEMIES.

Manchester.

Literary and Philosophical Society, October 21.—Mr. William Thomson, vice-president, in the chair.—Prof. W. L. **Bragg**: Sound-ranging. A sound spreads from the point where it originates as a spherical cone moving with constant velocity. If it is intercepted by three or more stations the positions of which are accurately known, and if the time-intervals elapsing between its arrival at the stations are measured, a simple construction gives the position of the sources of the sound. Soon after the commencement of hostilities it became clear that the struggle was going to take the form of trench warfare. This gave rise to the idea of locating the enemy guns by sound in the way described. The French made experiments with sound-ranging in October, 1914, and showed that it was feasible, and the British Army was encouraged by their success to send an experimental sound-ranging section to the Front. This section started operations in October, 1915, taking up its position opposite Wytschaete. The first results obtained were poor, but they improved with experience and better apparatus. The original section became a training school for officers and men, and sufficient sections were formed to cover the whole of our Front. Each section had six microphones spaced along a base opposite the German front line. The microphones were connected to a chronographic instrument at a central headquarters, and when the sound reached each microphone it sent an electric signal recorded by the instrument. In front of the base there were two observation posts so placed that the sound reached them a few seconds before it reached the microphones, which gave time for an observer at the post to press a key which started the recording apparatus at headquarters. By studying the record the time-intervals could be measured and the position of the gun plotted on the map and telephoned to the artillery. There were between thirty and forty sections along the Front. They could locate batteries between 10,000 and 15,000 yards away with a mean error of about fifty yards. Each section sent in about one thousand results in the year.

Paris.

Academy of Sciences, September 29.—M. Léon Guignard in the chair.—A. **Rateau**: Speech given at the James Watt centenary dinner, September 17, 1919, at Birmingham.—MM. **Blondel** and **Touly**: New arrangements of universal potentiometer amplifiers.—**Albert, Prince of Monaco**: Stray mines in the North Atlantic. In December, 1918, the author gave a chart showing the probable course of floating mines in the North Atlantic, with the view of minimising the danger to navigation. Since then thirty-three mines have been located, the positions of which are shown on an accompanying map. The conclusions of the first note are confirmed.—J. **Wolff**: Series of holomorphic functions.—M. **Foch**: The period of water-mains furnished with an air-cushion.—M. **Grard**: Thermal treatment of aluminium alloys. The alloys studied contained 3·5–4 per cent. of copper, about 0·5 per cent. of magnesium, and from 0·5–1 per cent. of manganese, and were of the duralumin type. The treatment giving the alloy the maximum malleability was found to be heating to 450° C., with a cooling velocity of 100° C. per hour. Heating to 475° C., followed by immersion in water at 20° C., gave the highest elastic limit and breaking strain.—A. **Riccò**: Heliographic latitudes of the solar protuberances (1880–1918). The observations are summarised both in tabular and graphical form, the general conclusions being more clearly shown by the latter.—C. **Benedicks**: The thermo-electricity of liquid mercury demonstrated by means of the galvanometer. In an earlier paper the author has shown that thermo-electric currents of the first species can be proved in a column of liquid mercury asymmetrically heated. These results have been called in question, and confirmation by a different method is now given.—M. **Delpech**: The flashes produced by the fire of artillery, and a general method for the extinction of these flashes. For small-bore cannon (47 mm.) a simple lubrication of the projectile with vaseline suffices to prevent the flash; for larger bores the addition of vaseline to the powder serves the same end.—P. **Thiéry**: Some new observations on the *klippes* of the Alais Plain.—Mlle. M. **Goldsmith**: The behaviour of *Convoluta roscoffensis* in presence of the rhythm of the tides.—F. **Ladreyt**: Physiological dedifferentiation and cellular reinvigoration in intestinal epithelium.

Calcutta.

Asiatic Society of Bengal, September 3.—**Hashmat Rai** and H. B. **Dunnicliff**: The purification of Indian sesame ("til") oil. The following conclusions were arrived at:—(1) Of all the filtering materials used, bone charcoal and French chalk are the best decolorising agents; all of them are ineffective as deodorisers. (2) Exposure to sunlight alone gives progressive improvement in colour, but the odour still persists. (3) Treatment with air alone improves the colour, but the odour is not removed. (4) Exposure to both air and sunlight combined has a very marked effect on the colour. The odour, though not absent, is not unpleasant. (5) Sulphuric acid reduces the colour very slightly, but the odour practically disappears. (6) Caustic soda acts both as a very good decolorising and a deodorising agent. (7) In all the bleached samples the colour more or less comes back on standing for a long period. (8) On heating all the deodorised samples the odour becomes perceptible. On cooling, however, it disappears.—**Hashmat Rai**: Note on nitrogen. A new method of preparation. Nitrogen gas may be readily prepared by passing an electric current through an ammonium chloride solution with platinum foil electrodes, the anode and the cathode chambers being separated by a porous diaphragm. Air is excluded from the electrolytic cell and the connecting tubes. The anodic gas is practically pure nitrogen, containing less than 0·2 per cent. of oxygen. It should, however, be collected over caustic soda solution so as to absorb any chlorine gas that may possibly be mixed with it. This affords a ready method for the preparation of a continuous supply of pure nitrogen.—N. N. **Chatterjee**: The rationalisation of algebraic equations. An earlier paper on the subject by the author was referred to in a paper by Prof. Mahendra Nath De, "The Rationalisation of Algebraic Equations" (J.A.S.B., July, 1908), in which objection was taken that the method does not always lead to an equation of the lowest degree. The present paper aims at meeting this objection by employing the method of indeterminate coefficients, which, although applied to various other problems, has not, it is believed, been previously applied to the particular class of problems in hand.—E. G. **Barter**: Radiation pressure. This paper is a criticism of Sir Joseph Larmor's method of deducing the pressure of radiant energy, and directs attention to certain obscure points in the train of arguments used by him.

BOOKS RECEIVED.

The Genetic and the Operative Evidence Relating to Secondary Sexual Characters. By T. H. Morgan. Pp. 285. (Washington: Carnegie Institution of Washington.)

Die Leitgedanken. By E. Mach. Zwei Aufsatze. Pp. 31. (Leipzig: J. A. Barth.) 2 marks.

The Cambridge Pocket Diary, 1919–1920. Pp. xv+267. (Cambridge: At the University Press.) 2*s*. 6*d*. net.

The Thermionic Valve and its Developments in Radiotelegraphy and Telephony. By Prof. J. A. Fleming. Pp. xv+279. (London: The Wireless Press, Ltd.) 15*s*. net.

The Book of a Naturalist. By W. H. Hudson. Pp. viii+360. (London: Hodder and Stoughton.) 12*s*. net.

Birds in Town and Village. By W. H. Hudson. Pp. ix+274. (London: J. M. Dent and Sons, Ltd.) 10*s*. 6*d*. net.

A Popular Guide to the Wild Flowers of New South Wales. By F. Sulman. Vol. ii. Pp. xxxi+249+72 plates. (Sydney: Angus and Robertson, Ltd.) 6*s*. net.

Australian Wild Flowers. Photographed by A. E. Sulman. Second series. Pp. ii+61. (Sydney: Angus and Robertson, Ltd.) 1*s*. net.

Some Familiar Wild Flowers. Photographed by A. E. Sulman. Pp. ii+66. (Sydney: Angus and Robertson, Ltd.) 1*s*. net.

Das Erleben. By A. Koelsch. Pp. xi+389. (Berlin: S. Fischer.)

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, and Papers in Elementary Engineering for Naval Cadetships, March to July. Edited by R. M. Milne. Pp. ii+40. (London: Macmillan and Co., Ltd.) 1*s*. 9*d*. net.

Science and Fruit Growing: Being an Account of the Results Obtained at the Woburn Experimental Fruit Farm since its Formation in 1894. By the Duke of Bedford and S. Pickering. Pp. xxii+351. (London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

Revision Arithmetic, Logarithms, Slide Rule, Mensuration, Specific Gravity and Density. By T. Thomas. Second edition. Pp. 62. (London: Crosby Lockwood and Son.) 2*s*. 6*d*.

DIARY OF SOCIETIES.

MONDAY, NOVEMBER 3.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—W. Brown: Sewer Ventilation and Health.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street, W.1), at 8.—Prof. J. Ward (President's Inaugural Address): In the Beginning . . .

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—C. A. Mitchell: Black Lead Pencils and their Pigments in Writing.—Capt. E. T. Sterne: Shawiningan Chemical Industries.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major K. Mason: Central Kurdistan.

TUESDAY, NOVEMBER 4.

ROYAL HORTICULTURAL SOCIETY (at London Scottish Drill Hall), at 3.—J. Snell: The Ormskirk Potato Trials.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—E. Heron Allen: Exhibition of Skiagraphs of Vermiculina from examples grown in a Hypertonic Tank.—Dr. G. Marshall: The Species of Balaninus occurring in Borneo (Coleoptera, Curculionidæ).—Miss J. B. Proctor: The Variation in the Number of Dorsal Scale-rows in our British Snakes.—G. A. Boulenger. Some New Fishes from near the West Coast of Lake Tanganyika.—The Hon. Paul Methuen: Description of a New Snake from the Transvaal together with a New Diagnosis and Key of the Genus Xenocalmus, and of some Batrachia from Madagascar.

MINERALOGICAL SOCIETY (Anniversary Meeting, at Geological Society), at 5.30.—Dr. W. R. Schoeller and A. R. Powell: Villamaninite, a New Mineral.—A. Russell: The Occurrence of Phenasite and Scheelite at Wheal Cock, St. Just, Cornwall.—L. J. Spencer: New Crystal-forms on Pyrites, Calcite, and Epidote.—Dr. G. F. H. Smith: A Curious Crystal from the Binnenthal.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Sir John Purser Griffith: Presidential Address.

RÖNTGEN SOCIETY (at the Medical Society of London), at 8.15.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—J. W. Simpson: Presidential Address.

WEDNESDAY, NOVEMBER 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—H. H. Thomas: Some Features in the Topography and Geological History of Palestine, Illustrated by Aeroplane Photographs taken during the War.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—Dr. L. Aitchison: Valve Failures and Valve Steels in Internal Combustion Engines.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. R. Thompson: Egyptian Bricks.—A. R. Powell and Dr. W. R. Schoeller: The Analysis of Brazilian Zirconium Ore.—Ethel M. Taylor: The Halogen Absorption of Turpentine.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—*Probable Papers*: Dr. T. A. Chapman: (1) Contributions to the Life-history of *Lycaena euphemus*, Hb.; (2) Notes on *Lycaena arcon*, F.—Dr. G. D. H. Carpenter: Notes on Species of Pseudacræa from Uganda.

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY (jointly with the ROYAL ASTRONOMICAL SOCIETY), at 4.30.—Sir Frank Dyson, Prof Eddington, and Others: Discussion on the Results of the Observations obtained at the Total Solar Eclipse on May 29, 1919.

LINNEAN SOCIETY, at 5.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. P. Beddard: Some Remarks on Chronic Arthritis (Bradshaw Lecture).

CHEMICAL SOCIETY, at 8.

FRIDAY, NOVEMBER 7.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Committee), at 5.—Col. Sir S. G. Burrard, Prof. A. E. H. Love, and Others: Discussion on Isostasy.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—Prof. Baly: The Spectroscope in the Science of To-day.

CONTENTS.

	PAGE
Education and Life	169
Mathematical Text-books	169
Mineral Resources of Georgia. By H. L.	171
Our Bookshelf	171
Letters to the Editor:—	
International Relations in Science.—Sir E. Ray Lankester, K.C.B., F.R.S.	172
The Response of Plants to Wireless Stimulation. (*Illustrated.*)—Sir J. C. Bose	172
A New British Enchytræid Worm.—Rev. Hilderic Friend	174
A Photoelectric Theory of Colour Vision.—Dr. H. Stanley Allen	174
Luminous Worms.—H. E. Aldridge	174
Reconstruction	174
The Fauna of the Inlé Lake	176
Notes	177
Our Astronomical Column:—	
Large Meteors	179
Comet 1919*b* (Brorsen-Metcalf)	180
The New Laboratories at Rothamsted. (*Illustrated.*)	180
The British Association at Bournemouth:—	
Section G—Engineering—Opening Address by Prof. J. E. Petavel, D.Sc., F.R.S., President of the Section	181
University and Educational Intelligence	185
Societies and Academies	187
Books Received	188
Diary of Societies	188

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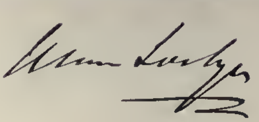

NATURE

1869–1919.

JUBILEE ISSUE.

THURSDAY, NOVEMBER 6, 1919.

VALEDICTORY MEMORIES.

By Sir Norman Lockyer, K.C.B., F.R.S.

It has been suggested to me that some reminiscences relating to the circumstances which led to the establishment of Nature would be of interest, and I am glad to be able to contribute them to this jubilee issue. It is a great satisfaction to me again to have the opportunity of expressing my best thanks to the many friends whose knowledge has always been placed freely at my disposal, and to know that the vitality of the journal is now as strong as ever it was.

At the time when Nature first made its appearance, just fifty years ago, scientific progress was commanding increased attention from the public mind, and British workers were experiencing the need for an organ devoted to their common activities and interests. In 1858 a fortnightly column of scientific notes was started in the *Saturday Review*, and two years later Huxley became the chief editor of the *Natural History Review*, with the intention of providing a quarterly which would deal with scientific matters systematically and thoroughly. He ceased to contribute to that magazine, however, in 1863, and became associated with the *Reader*, a weekly journal of which I was the science editor.

My first literary work arose from observations of a transit of the shadow of Titan across Saturn's disc. I sent an account of these observations to the *London Review*, and it appeared in the issue of May 10, 1862. This communication brought me two letters—one from Mr. W. R. Dawes, who was at that time recognised as one of the keenest astronomical observers in England, and the other from Mr. W. Little asking me to send astronomical notes from time to time to the *London Review*, together with an article each month on the "face of the sky."

I was then living at Wimbledon, and was honorary secretary of the Wimbledon Village Club, on the committee of which were Thomas Hughes, J. M. Ludlow, and George Pollock. It was this connection that led to my appointment as science editor of the *Reader*, when it was established with Hughes and Ludlow among the proprietors. My astronomical work thus led me into literature, and the subject with which I was particularly concerned—astronomy—was also the product of my Wimbledon environment.

When the *Reader* ceased publication the idea occurred to me of starting a general scientific journal of a more comprehensive scope than the *Natural History Review*, which, like other specialised scientific periodicals, had failed for want of circulation. On discussing the matter with my friends, I found that they were favourable to the idea; and one of them, Mr. Alexander Macmillan, greatly encouraged me to develop it. It was in consequence of his sympathy and enthusiastic assistance that the journal was started. He was unwavering in his support of the belief that British science would be advanced by a periodical devoted to its interests—a point on which I had always laid stress as the result of experience up to that time. It was the hope that a more favourable condition for the advancement of science might be thereby secured that led Mr. Alexander Macmillan to enter warmly into the establishment of Nature in 1869. He enlisted the interest of Sir Joseph Hooker and other of his scientific friends, and before the journal had started I was assured of the support of Huxley, Tyndall, and practically all the other leading workers in science of the time.

It may be of interest to reprint here the following circular which was issued broadcast to bring the aims and intentions of the journal before scientific readers and others:—

The object which it is proposed to attain by this periodical may be broadly stated as follows. It is intended:

First, to place before the general public the grand results of Scientific Work and Scientific Discovery, and to urge the claims of Science to a more general recognition in Education and in Daily Life: and

Secondly, to aid Scientific men themselves, by giving early information of all advances made in any branch of Natural Knowledge throughout the world, and by affording them an opportunity of discussing the various Scientific questions which arise from time to time.

To accomplish this twofold object, the following plan is followed as closely as possible.

Those portions of the paper more especially devoted to the discussion of matters interesting to the public at large contain:

I. Articles written by men eminent in Science on subjects connected with the various points of contact of Natural Knowledge with practical affairs, the public health, and material progress; and on the advancement of Science, and its educational and civilising functions.

II. Full accounts, illustrated when necessary, of Scientific Discoveries of general interest.

III. Records of all efforts made for the encouragement of Natural Knowledge in our Colleges and Schools, and notices of aids to Science-teaching.

IV. Full Reviews of Scientific Works, especially directed to the exact Scientific ground gone over, and the contributions to knowledge, whether in the shape of new facts, maps, illustrations, tables, and the like, which they may contain.

In those portions of NATURE more especially interesting to Scientific men are given:

V. Abstracts of important papers communicated to British, American, and Continental Scientific societies and periodicals.

VI. Reports of the meetings of Scientific bodies at home and abroad.

In addition to the above, there are columns devoted to Correspondence.

From the first I was helped by the free kindness of most of the men of science in the country, by their permitting me to appeal to them for assistance and advice, and my election into the Royal Astronomical Society, and afterwards into the Royal Society, in 1869, brought me into closer correspondence and contact with many of the active workers in scientific fields. I am very grateful for what they did, and for what men of science are still ready to do to ensure that NATURE shall represent scientific claims justly and scientific fact and thought in correct proportion. While this common interest in the journal exists among men of science, not only in the United Kingdom, but also in Europe and America, there will be no falling off from the high standard maintained in its pages from the commencement of its existence.

PROGRESS AND PROMISE.

IN the career of a journal, as in the life of a man, stages are met from which it is appropriate to take a glance backward at the road traversed and to contemplate the outlook of the future. Such an epoch has been reached in the history of NATURE, the first number of which was published fifty years ago—on November 4, 1869. The circumstances which led to the establishment of this journal are described briefly by Sir Norman Lockyer in the preceding article. Men of science had felt the need for an organ devoted to their interests in common, and several attempts had been made to meet it, but unsuccessfully. It required the rare combination of scientific authority, untiring energy, wise judgment, and business aptitude to construct a platform on which investigators of the many and diverse fields of natural knowledge could put their trust, and from which descriptions of their work would command attention.

How fully these attributes are possessed by the founder of this journal, and how consistently they have been made manifest in its pages, is shown by numerous appreciative messages received from scientific societies and distinguished workers. Thanks to the sound and comprehensive programme laid down by Sir Norman Lockyer at the beginning, and followed ever since, NATURE now occupies a high place in scientific life. It would be disingenuous to pretend that we are not proud of the testimonies which have been sent by many leading representatives of progressive knowledge as to services rendered by the journal in various ways. Among those who have expressed their congratulations upon the attainment of the jubilee are readers who have never missed a number since the first issue, while others of a new generation equally acknowledge the stimulus they derive from a wide view in these days of minute specialisation.

The intellectual background is different now from what it was in 1869, and the outlook, as well as the conceptions, of science has changed. Specialised work is necessary to acquire new knowledge, but for the great generalisations which provide an impulse to wide inquiry attention must be given to results achieved in the whole sphere of related investigations. It is the particular function of NATURE to present this comprehensive view, and to bring to a focus upon its pages the living picture of scientific advance as a whole, so that workers in separate fields may see the growth of the grand edifice of natural knowledge, and the place their own contributions take in it.

At one time—as, for example, in the early days of the Royal Society—it was possible for every member of a general scientific society to take an intelligent interest in every paper presented. Since then, however, science has passed from the stage of a simple organism to that of a body made up of parts with highly differentiated functions. Numerous specialised scientific societies have been formed, as may be seen by the list published in this issue of those established since 1869, and many periodicals similarly devoted to distinct branches of pure and applied science have come into existence. The common factor is interest in the advancement of knowledge; and a society or a journal concerned with this as a whole can best assist the aim in general by providing the segregated groups of investigators with intelligible accounts of activities in other fields, which may or may not be on the borders of their own.

The remarkable collection of articles published in this issue represents the highest type of contributions of this kind. Each article is by an eminent authority upon the subject with which it deals, and each can be comprehended by everyone who has had a scientific training. It is scarcely too much to say that no such authoritative epitome of fifty years of scientific progress, as viewed by pioneers in particular fields, has ever been brought together in any one periodical. Contributions of such high distinction are rendered possible largely because the writers know that in these pages they are addressing themselves to fellow-workers throughout the world, as well as to other readers having an intelligent interest in the march of scientific knowledge.

Four of the writers—Sir Archibald Geikie, Sir E. Ray Lankester, Prof. Bonney, and Canon Wilson—were contributors to the earliest issues of this journal; and every reader will be grateful for the enlightening descriptions of stepping-stones of scientific progress which we are now privileged to publish. Nature could not have maintained its original standard for so long but for the active support which these and many other leading men of science have been ready to give it since its foundation. This is as true of the new generation as it was when the journal was founded; and the value of the association is most highly appreciated. While Nature is honoured by the active co-operation of the men of genius who are traversing the royal roads of science, its functions will extend, and its influence increase, with the expansion of knowledge. With this assurance, and the encouragement which the past has given, we look with confidence and strength at the prospect of the future.

SCIENTIFIC WORTHIES.

XLI.—Sir Norman Lockyer, K.C.B., F.R.S.

The simple title Nature, embracing all in a single word, was most appropriately chosen by Sir Norman Lockyer when, exactly fifty years ago, he founded this weekly journal, which is devoted to all the sciences, and has had so successful a career. The first article in the journal reproduced profound aphorisms of Goethe on the intimate relations of man with Nature, of which he is a part. The poet-philosopher set forth in striking language, which was rendered into English by Huxley, the innate feebleness of man before the immutable forces and the great mysteries which everywhere surround him, and at the same time the incessant human desire, never completely satisfied, of comprehending and penetrating them. The contribution is a stimulating preface to a scientific periodical; it well exhibits the high character of the journal at the outset, and the spirit in which it has always been conducted.

Indeed, Nature is, of all scientific journals, the most comprehensive in the world; it includes articles of the highest scientific standard, as well as those of a more popular kind; it has open columns for the discussion of current subjects, and it provides summaries of most of the papers presented to the chief academies and learned societies; it gives the latest events of the scientific world, news about men of science, and accounts of the most recent discoveries in scientific fields. It has rendered inestimable services to the cause of science in general.

Since the first issue the journal has maintained the form and character which we see to-day. A comparison of a number issued in the year 1869 with one of 1919 shows the same general arrangement, the same sequence of subject-matter; moreover, the pages and the style of type are nearly identical in appearance. The founder, who in 1869 was only thirty-three years of age, has proved himself a publicist and an organiser of the first rank. During its existence the journal has ably recorded the magnificent discoveries which have distinguished the last fifty years in every branch of science; it has had to deal with subjects beyond one's dreams; and it has been the better able to present them to the public because the founder has himself been one of the foremost builders of this noble edifice.

Sir Norman Lockyer is distinguished not only by his eminent public work, but also as one of the greatest men of science of our time. In the three years which preceded the foundation of this journal he made discoveries relating to the sun which will permanently preserve his memory among men. He was one of the pioneers of astrophysics, the new branch of astronomy which is now of such importance. For fifty years, with untiring activity, he has carried on a multitude of researches in the three observatories established by him and in the physical laboratories associated with them; and, like a true philosopher, he has presented a general synthesis of celestial phenomena. The title "Nature" might be justly given to the record of his personal achievements, to which the remarks which follow are particularly devoted.

Sir Norman Lockyer is not the product of a university; he may be termed a self-made man of science. He was at first employed in a Government Department, where he remained for more than ten years; but he was irresistibly drawn towards science, and especially to astronomy, the wonder of which exercises a powerful attraction. All his leisure and all his personal resources were devoted to scientific pursuits. Spectrum analysis had come into being, and its application to celestial bodies opened up the widest horizons. Sir Norman Lockyer attached a small spectroscope to a modest equatorial telescope of 6-in. aperture, which constituted his private observatory, and he studied the light emanating from the solar spots. The first results were summarised in a note presented to the Royal Society in 1866, where the author discussed the bearing of his observations on the two rival theories which were then to the front as to the nature of sun-spots. He foresaw the possible daily observation of the red flames, or prominences, which up to that time had only been observed on the outer edges of the sun during total eclipses. He conceived the idea that the spectroscope might be able to reveal them at ordinary times under the same conditions as those which caused the appearance of bright lines in the new star in Corona Borealis. This star had appeared a few months previously, and, as observed by Huggins, had presented a stellar nucleus surrounded by a relatively feeble nebulosity; but in the spectroscope the light of the nucleus was spread out in a continuous spectrum and thereby enfeebled, while the atmosphere showed the bright lines of hydrogen with great brilliance.

This idea was really a flash of genius, because it contained the germ, or the principle, of the method which, for fifty years, has revealed to us at all hours of the day the gaseous atmosphere of the sun. The first application of the method to the sun's edge, however, gave no result; the spectroscope employed was not sufficiently powerful. Two years later the observations in India of the total eclipse of the sun of August, 1868, gave valuable information—the solar prominences were gaseous, and showed the red and green lines of hydrogen with very great intensity.

On October 20, 1868, Sir Norman Lockyer, at last provided with a powerful spectroscope, for which he had waited two years, discovered, at Hampstead, a prominence on the sun's edge, and made a drawing of it two days later. The discovery was communicated to the Royal Society on October 20 and to the Academy of Sciences at Paris on October 26. By a striking coincidence, at the same meeting of the Academy, a letter sent from India by the French astronomer Janssen announced the same result. During the eclipse Janssen had recognised in the spectroscope the nature of the prominences, and was able to see them again on the following day with the same instrument. Janssen continued to observe them daily during three weeks, and found that they were composed principally of hydrogen, and were subject to remarkable variations of form which were often very rapid. The astronomer Faye then pointed out that the first idea of the method was certainly due to Lockyer, but that the first application had been realised by Janssen, and since then the two names have been justly united in connection with the discovery.

During the weeks and months which followed, Sir Norman, with praiseworthy activity, continued the study of the sun by the new method without intermission, and he successively recognised several new facts of the first importance, namely:—

1. The prominences emanate from a gaseous layer of the same composition, which envelops the entire sun, and reaches a height of 8–10 secs. of arc. This layer is of a rose colour, like that of the prominences themselves, and Sir Norman Lockyer gave it the name of the *chromosphere*; it had already been glimpsed in preceding eclipses, but its existence was not generally acknowledged.

2. The yellow radiation of the prominences, which had been attributed to sodium by the eclipse observers, proclaimed in reality the existence of a new gas, to which Sir Norman gave the name of *helium*. It was the first recognition of the famous gas which was afterwards obtained from terrestrial sources by Ramsay in 1898; it is emitted by radio-active bodies, and now can be used for the inflation of dirigibles.

3. The green line of hydrogen becomes broader in passing from the summit to the base of a prominence. From a series of experiments on hydrogen at low pressures, carried on in the chemical laboratory of his friend, Frankland, Sir Norman concluded that this widening is simply due

to an increase of pressure. Spectrum analysis disclosed not only the chemical composition of the prominences, but also to a certain extent their physical state.

4. The lines of the prominences are often displaced and distorted. This phenomenon was correctly attributed to the movements of the vapour in the direction of the observer; it was the first real verification of the velocity displacements which have since become of such great importance in astronomy.

This first series of investigations is set forth in some detail, because it represents magnificent work; it is an example for all, and has its place marked out in the history of science, especially as it was carried out with simple means. The greatest discoveries, as one knows, have not been made in the largest laboratories, and the capacity of the man is always of more consequence in research than that of his instruments. In his investigations Sir Norman Lockyer has shown a power, an acuteness of mind, and a creative imagination which are truly exceptional. These are the qualities of men who, like him, have overcome all difficulties placed in their way in order to pursue fixed ideas and follow vocations which they have fully resolved to adopt.

In the succeeding years Sir Norman organised several eclipse expeditions under Government auspices; all the important solar eclipses since 1868 have been observed by him or by his assistants, with programmes laid down by the Solar Physics Committee, of which he was a member. At the same time, he undertook extensive work which may be summarised in the words: "Comparative study of terrestrial spectra and the spectrum of the sun, extended afterwards to stars, nebulæ, and comets. Special and general consequences drawn from them." After fifty years of continuous labour the work has certainly been advanced, but it is not yet completed. It was carried on at first in his own observatory, then from 1879 in the establishment at South Kensington which the Government had created for the development of the new methods and placed under his direction.

The astrophysical observatory at South Kensington was a model of its kind; it consisted of two parts, quite distinct but closely related, namely, an observatory properly so called and a physical laboratory. The astrophysicist must pass constantly from one to the other, and, in fact, the number of publications issued from South Kensington has been nearly the same in the two sections. It has been said that an astrophysical observatory is merely a physical laboratory oriented towards astronomy, the astronomical instruments being in reality nothing more than physical apparatus of large dimensions; and it is therefore necessary to attach to them men who have been trained by the study of physics and capable of immediately applying to the celestial bodies the most recent discoveries made in the laboratory.

In this connection Sir Norman has trained at South Kensington several investigators, including Prof. Fowler, Dr. Lockyer, and Messrs. Shackleton, Baxandall, and Butler, at once physicists and astronomers, and well known by their publications. Prof. Fowler, now president of the Royal Astronomical Society, is already distinguished; we owe to him important discoveries and some fine series of precise measurements.

In 1912 the land occupied by the observatory at South Kensington was required for the extension of the Science Museum, and the observatory, with all its instruments, was transferred to Cambridge. Sir Norman, having passed the age-limit, was obliged to retire from the directorship, but, feeling that his work was not yet accomplished, and still vigorous in body and mind, he forthwith set up another observatory—the Hill Observatory—with the aid of several friends of science. The site chosen, at Sidmouth, is very favourable for astronomical observations, and as the first buildings were erected very quickly and provided immediately with some fine instruments, the researches commenced at South Kensington, especially those on stellar spectra, have been continued with but little interruption. It is hoped to establish there an astrophysical observatory comparable with the American observatories and worthy of the United Kingdom.

The new facts gathered together in the course of these fifty years are extremely numerous; they are set forth with the inferences drawn from them in 200 memoirs, and it is impossible to give any detailed analysis of them here. Fortunately, the author, who has an affection for great generalisations, has always sought to connect the facts in a few leading ideas which are for him "working hypotheses," and he has expounded each hypothesis in a special book. The volume on "The Chemistry of the Sun" (1887) deals with the differences of spectrum emitted by different parts of the sun, and explains them by the dissociation hypothesis, according to which the molecules and atoms are grouped in different ways or are split up into simpler elements. In his book on "The Meteoritic Hypothesis" (1890) the author explains all the celestial bodies by collisions of meteorites; it is a simple and fertile idea, which has been adopted by several astronomers. The last volume, entitled "Inorganic Evolution" (1900), develops the final methods and ideas of the author, and presents a general classification of all the stars. It is only necessary to add one remark: Sir Norman is one of those who publish the observed facts immediately, and also the interpretations which present themselves at once to his mind. This method inevitably involves imperfect detail, or over-sanguine conclusions, which have been freely criticised. Pruning and revision have become necessary, and this work has recently been taken in hand by the author himself. The main body of facts and ideas remains unaffected, and is always worthy of being retained.

It will suffice to mention here very briefly on one part some of the more important results on the sun and the effects of its radiation, and, on the other, the great classification of the stars.

Sir Norman was the first to recognise the presence in the solar spectrum of lines due to a band spectrum, attributed at first to cyanogen, and now assigned to nitrogen alone. He observed the widening of the dark lines in the spectra of sun-spots, a phenomenon which has since been so brilliantly explained by Prof. Hale, of the Mount Wilson Observatory.

With the simple arrangement of the objective prism, he was the first to photograph in an eclipse the spectrum of bright lines given by the reversing layer, situated at the base of the chromosphere, thus obtaining a verification of the general accordance of these bright lines with the ordinary dark lines, and confirming the simple explanation of the dark lines given by Kirchhoff.

He discovered in the fluctuations of the solar prominences a period of 3·8 years, which is superposed on the great eleven-yearly period, and he showed later, in collaboration with Dr. Lockyer, that this same period of 3·8 years reveals itself in variations of pressure of the terrestrial atmosphere. This last result has a practical importance because it renders possible the forecasting of the variations of the monsoons in the Indian Ocean. In addition, the schematic chart of the law of the winds in the southern hemisphere, drawn up in this case by Dr. Lockyer, has been verified by all later observations; it has been reannounced in 1919 by Prof. Hildebrandson, one of the founders of meteorology, in a note on the general movements of the atmosphere presented to the Paris Academy of Sciences.

One of the questions which have most occupied Sir Norman is that of the variation of laboratory spectra with the energy of the excitation. He has from the first distinguished the long and short lines in the same spectrum, and the employment of a very powerful induction spark has given him new lines which he has called "enhanced lines." The three types of lines—long, short, and enhanced—correspond with increasing temperature, and constitute valuable tests which serve to differentiate the stars. Sir Norman has observed the presence of these lines in the spectra of stars, and at the same time the different behaviour of the lines of hydrogen, of helium, and of the metals, which has led to a new classification of the stars. The labour involved in this investigation was considerable, because it became necessary to photograph stellar spectra under the unfavourable conditions of London and with a high dispersion. Its success was secured by the use of an objective prism of large angle and by great patience.

At the same time, the great American astronomer Pickering, with much more powerful means, had entered upon the observation and classification of stellar spectra over the entire sky, and was content to use a small dispersion which enabled him to reach the fainter stars. But as the study of enhanced lines demanded a high dispersion, Sir Norman confined himself to the stars visible to the naked eye.

The classification adopted differs essentially from all previous classifications, which had considered only the actual temperatures of the stars and supposed a continuous cooling. Sir Norman went much further, and in the year 1888 established a distinction between the stars in which the temperature was rising, and those in which the temperature was diminishing. Beginning with a primitive nebula, the body which forms by condensation will at first become hotter, then attain a stationary temperature, and will finally cool. Its natural evolution, expressed by temperature as a function of time, ought to comprise an ascending branch, a steady state corresponding with the maximum, and a descending branch. In the ascending phase the lines of hydrogen are narrow and the chromosphere is of low density; at the time of maximum the enhanced lines predominate and the maximum intensity of the spectrum is far in the ultra-violet; in the later phase the lines of hydrogen are broad and diffuse, and the chromosphere is of greater density. It is certain that one thus penetrates more deeply into the nature of things. Further, Sir Norman does not explain the variable number of metallic lines by a different distribution of the chemical elements in the stellar atmosphere. When the star is very hot the metallic lines are wanting, and he has attributed this to a dissociation of the elements analogous to that of radioactive bodies. On this view the heavier elements are split up into lighter and even into new and simpler elements which he has called "protoelements." The evolution of the stars is accompanied by a simultaneous evolution of the simple elements of Nature.

The great chemist, Ramsay, who was a pioneer in many directions, gave the greatest attention to these new ideas and to the numerous observations which appeared to support them. The classification of the stars in accordance with the foregoing tests has been fully confirmed by optical measurements of their absolute temperatures.

To sum up, in his latest researches, as well as in the first, Sir Norman Lockyer has exhibited an aptitude for experiment, a creative faculty, a penetration, and a breadth of view which are truly remarkable; and the results obtained on the sole basis of experiment are of the first importance. He is one of the great men of science of England and one of the greatest astronomers of all time. Finally, let us hope that, bearing the weight of years in comfort, he may continue his services to science and his association with this journal, and witness for himself the increasing success of his ideas and his methods.

H. Deslandres.

(Vice-President of the Academy of Sciences of Paris, Director of the Astrophysical Observatory of Meudon.)

RETROSPECT AND PROSPECT.

By Sir Archibald Geikie, O.M., K.C.B., F.R.S.

FIFTY years have passed since the publication of the first number of Nature on November 4, 1869. To start successfully a weekly journal entirely devoted to chronicling the onward march of science was an experiment that could not but involve some financial risk, and certainly required no small editorial ability. To maintain such a journal for half a century on a high level of excellence, and to gain for it a place admittedly of importance in the periodical literature of our time, is a feat of which Editor and publishers have good reason to be proud. The weekly contributions of this journal to current scientific literature now amount altogether to more than a hundred volumes, which contain a contemporary record of the progress made by every department of natural knowledge, often contributed by the men to whom the progress was due. It may be appropriate, as we take note of this achievement, to cast an eye back upon the condition of science among us fifty years ago, to survey our present position, and to look forward into the vista that is opening out for the future.

In taking such a retrospect one of the most conspicuous and satisfactory features to attract attention is the remarkable increase and steady growth of fresh centres of higher education all over Britain, where not only is the time-honoured literary side cherished, but ample room and full equipment are found for the theoretical and practical teaching of science. These centres, beginning perhaps as modest colleges, have attracted a constantly increasing number of students, and each of them has become a nursery in which the men of science of the future are being bred. A convincing proof of their vitality is furnished by their successful claim for recognition as universities. They have already added half a dozen new universities to our educational strength, and this year one of the youngest yet most important of them, the Imperial College of Science and Technology, is now in turn demanding the status and powers of a university. There has never been a time in our history when the opportunities for obtaining a thorough scientific training have been thrown open so widely and attractively, and when advantage has been taken of them in so large a measure.

That one of the great duties of a nation is to promote the cultivation of science by appropriating funds not only in aid of education in theory and practice, but also in support of research and experiment, never began to be realised until within living memory. British science has attained its greatness without State aid. There are, indeed, a few directions in which public money has been disbursed for scientific objects, such, for instance, as Greenwich Observatory, the British Museum, and the various geographical expeditions and geological surveys. But not until the middle of last century did it dawn upon the attention of the Ministry of the day, awakened possibly by the portents of the coming Great Exhibition of 1851, that men of science are not as a rule wealthy, that they must often be involved in considerable expense in carrying on their researches, that they cannot always look to the universities, colleges, or learned societies for financial support, and therefore that it might be of public advantage to come to their help from the public purse. Accordingly, in November, 1849, Lord John Russell, then Prime Minister, sent a confidential communication on the subject to the president of the Royal Society (Earl of Rosse), who remitted to a committee to report how a financial grant, if made by Government, could best be employed.

After deliberate Governmental consideration for the space of nearly a year it was decided at the beginning of 1851 to make an annual grant of one thousand pounds to be administered by the Royal

Society, chiefly in aid of private individual scientific investigation. At the end of four years the Treasury declined to continue the grant of this sum (trifling as it was, compared with the revenue of the country), on the ground that the fund from which it was taken would no longer admit of "an annual grant to the Royal Society." The council replied with spirit that it was not a grant to the Royal Society, but "a contribution on the part of the nation towards the promotion of science generally in the United Kingdom," the council being only trustees for the due administration of the fund. The grant was then placed on the Parliamentary Estimates, and the 1000*l*. continued to be paid annually for nearly twenty years. In 1877 the vote was increased to 4000*l*., but the council had still some difficulty in preventing the grant from being regarded as one to the Royal Society, which was in no way benefited by it, but, on the contrary, had an onerous and difficult task in looking after its proper administration. In 1894 application was made for an increase in the amount of the grant, but without success.

Meanwhile the German Government, looking keenly to the future and thoroughly impressed with the importance of stimulating the cultivation of science, was spending large sums to equip laboratories and otherwise further education in science, and to stimulate discovery and invention. The example of that country was often cited here, and contrasted with the unsympathetic attitude and stingy support of our authorities, much to the surprise and annoyance of the permanent officials of the Treasury, who rather seemed to think that their grants to science were remarkably liberal. I remember an occasion when I had to go to the Treasury about a matter connected with the Geological Survey. The official on whom I called was one of the heads of the Department, with whom I had long been on terms of friendly intimacy. He began the interview by saying that he would be glad to hear me, but begged that the example of Germany might not be mentioned.

Happily these times of indifference belong to the past. Twenty years ago an appeal was made to Government for the creation of a National Physical Laboratory for the purpose of standardising and verifying instruments, testing materials, and for the determination of physical constants. After some effort and with the persistent support of Lord Rayleigh, the appeal was eventually successful. The institution began on a modest scale with a staff of only twenty-six, no more than two departments, and a small grant annually voted by Parliament. But under the able supervision of Sir Richard Glazebrook it rapidly increased the scope of its work, the extent of its buildings, and the size of its staff, until the burden of responsibility for its administration was becoming too heavy for the Royal Society. In April of last year it was transferred to the newly established Department of Scientific and Industrial Research, the number of its departments of investigation having now grown to seven, and that of the staff to more than 600. In this enlarged sphere of public utility it will no doubt achieve still greater success, while at the same time research in all directions and its practical applications will be greatly quickened. The day of parsimony in regard to the prosecution of scientific inquiry and its applications is now gone beyond the power of any Government to revive.

Obviously it is not zeal for the advance of pure science that has led to the augmented general interest in research. The appreciation of the practical value of many discoveries in relation to the daily life of mankind has naturally been the main stimulus. The philosophers might have experimented until doomsday upon æther and its undulations without awaking more than a languid interest in their work, or receiving any pecuniary help in their expenses; but when they showed that by means of these undulations messages could be flashed across the ocean without any wires, the public imagination was at once excited, and millions of money were ready for investment in any company that would undertake to fit up the necessary apparatus for sending such messages. In like manner, there might have been but a feeble appreciation of the phenomena of radioactivity, but when it was shown that by means of Röntgen rays the surgeon could see the bones inside a human body and detect there the existence and exact place of any bullet or other dense substance, a wide interest in the discovery was awakened, and little difficulty was found in supplying every hospital with the requisite apparatus.

The War has brought the economic value of science before the world on a colossal scale of demonstration. While scientific inventions have enormously augmented the offensive powers of the belligerents, it is pleasing to know that the applications of science have not been all on the destructive side, but that at the same time the greatest stimulus in the history of mankind has been given to medicine and surgery, and that each of these great divisions of the healing art has made notable advances and gained fresh powers for dealing with diseases and wounds.

Exactly ten years had elapsed after the publication of Darwin's "Origin of Species" when the first number of NATURE was issued. The doctrine of Evolution had long been before the world. Laplace had introduced it into the history of the solar system; Lamarck, after Buffon, had proposed an ingenious ætiology in the history of organised life upon the earth; while towards the middle of last century came the cruder efforts of the author of the "Vestiges of the Natural History of Creation," which so perturbed the minds of his generation. But it was not until after the appearance of Darwin's book, and in consequence of that book, that Evolution came slowly to be regarded as the great law of the whole cosmos. If we consider broadly the relation of the community to scientific progress during the last fifty years, its most outstanding feature will probably be recognised in the general acceptance of this great generalisation.

The views of Darwin made their way with

more speed on the Continent than in his own country. Probably not many survivors are left to recall the astonishment and indignation with which some of the older geologists of the day read his two chapters "On the Imperfection of the Geological Record" and "On the Geological Succession of Organic Beings." To the younger men, on the other hand, these chapters were a luminous revelation. I shall never forget their influence on myself. They gave me a new key to unlock the history recorded in the rocky crust of the globe. They linked together Stratigraphy and Palæontology in the most masterly way, making each of them explanatory of the other, and confirming the doctrine of Evolution more clearly than ever.

The bearing of the "Origin of Species" on social questions was more promptly recognised abroad than at home. Thus, in the first number of Nature, it was stated that when the Austrian Reichsrath, after the disastrous war with Prussia, assembled in December, 1866, to deliberate on the best means of re-consolidating the prostrate empire, a distinguished member of the Upper Chamber, Prof. Rokitansky, began a great speech with this sentence: "The question we have first to consider is, 'Is Charles Darwin right or no?'" Such phrases as "the struggle for existence" and "the survival of the fittest" have not only become household words, but they have been brought into the domain of social relations and of the physical improvement of mankind. Foremost among those who have insisted on the vital importance of these subjects to human society was Darwin's cousin, Sir Francis Galton, to whose writings and persistent advocacy the new study of Eugenics owes its existence.

In one important branch of research Britain has always taken a foremost place. Geographical exploration, where it can be undertaken by the Navy, has long been a favourite task with our Admiralty. The earlier expeditions were mainly intended for geographical discovery. Those of the last fifty years have been in increasing measure devoted to scientific observations in magnetism, meteorology, oceanography, and natural history. A new type of equipment has thus arisen, in which each vessel becomes a kind of floating workshop of laboratories, microscope rooms, photographic chambers, and all the other requirements of physical and biological science. It was the naturalists who asked for State assistance in the exploration of the ocean, its temperature, currents, depths, and living things. In 1868 they succeeded in obtaining from the Admiralty the services of the *Lightning*, and two years later of the *Porcupine*. These tentative missions brought to light so much fresh information and raised so many new problems that, in response to a loud appeal from the scientific world, the *Challenger* was prepared on a more complete and elaborated scale, fitted with every kind of appliance, and furnished with a company of skilled investigators, under the leading of a distinguished naturalist. For the first time in the history of exploration the globe was circumnavigated during four years (1872–76), not for the discovery of new lands, but for an investigation of the oceans from their surface waters to their utmost depths. Splendid in its conception and admirable in its achievement, this great expedition laid a solid foundation for the new department of science which has now been named Oceanography. And the fifty quarto volumes in which its labours and results are recorded form a noble monument of successful research.

Since that time the problems of the Antarctic regions have been attacked by several expeditions. The two brave adventures of Capt. Scott and his associates in 1901 and 1910, amply supported by the Admiralty, were meant not merely for the increase of geographical knowledge, but were fitted out with all the needful appliances for observations of the magnetism, meteorology, geology, and zoology of the area around the South Pole. They have added much to our knowledge of Nature in that region of the globe.

If, now, we cast our eyes towards the future, the prospect for British science is eminently encouraging. The opportunities for research and experiment were never before so ample, the co-operation of the State never so cordial, the ranks of the investigators never so full, and the joy and enthusiasm for investigation never more ardent. For years to come this prosperity ought to continue and increase. But unquestionably in the distance a cloud may be discerned, which has long been in sight, but is now much nearer. Our present great source of power is coal, but at a not very remote date our coal-fields will be exhausted. If before that time some other source is not discovered, our position as a great manufacturing country will be seriously affected. Hopes have been raised on the possibility of finding large supplies of mineral oil in our islands. It is well known that in one or two places oil has long been coming to the surface in small quantities. It is possible that these indications may point to larger supplies below. But we are still so ignorant of the distribution of the oil within the earth that no confident prognostications are warranted. Much misunderstanding still exists on this subject. There can be now no doubt that the oil found so abundantly in some regions has no connection with coal-fields or with any deposits of organic origin, but comes from a depth probably below all the stratified part of the terrestrial crust. The most probable explanation of its origin is that it results from the decomposition of carbides forming part of the original constitution of the globe. These carbides, or compounds of carbon with some metal, such as iron, are decomposable by water and then give rise to the production of hydrocarbons, such as mineral oil and marsh gas. If water descending from the surface through the upper crust should reach those deeper-seated compounds, this decomposition would take place, and the pressure of the generated gas might force the oil up the fissured crust to the surface. Only where it makes its appearance do we know for certain that there must be some oil below, but whether in quantity sufficient even to repay the cost of boring for it cannot be predicted.

But before our coal supplies are worked out, and whether or not we discover subterranean supplies of oil, we may surely hope that some of the sources of power which are now unused will be harnessed to the service of man. To the waterfalls, tides, and winds, which have long been considered, Sir Charles Parsons in 1904 suggested another possible source of power in the internal heat of the globe, and in his recent presidential address to the British Association he has returned to the subject. His proposal is to sink a bore-hole 12 miles deep, which would cost five million pounds and require about eighty-five years for its completion. With the use of a fresh source of power and an extended development of electricity, we should doubtless be able to hold our own in the competition of the nations.

It may be allowed to me to end this article on a more personal note. To the foresight, energy, and constant attention bestowed on NATURE by its founder, Sir Norman Lockyer, the world of science has been indebted during half a century for the possession of a journal which with persistent force has sustained the cause of science in this country, has been an invaluable medium for recording the progress of research and discovery, and has played a most useful part as a medium for the discussion of questions of general interest and for public intercommunication between the cultivators of science, to whom it has become indispensable. I contributed to its first number, and have often sent communications since then, and now I am proud to be asked to write a preface to this jubilee issue and to wish continued life and prosperity to my old and valued friend, the founder of the journal.

THE FOUNDATION OF BIOLOGICAL SCIENCES.

By Sir E. Ray Lankester, K.C.B., F.R.S.

When the first number of NATURE was published in November, 1869, the word "biology" had not the currency now given to it. The word had been adopted by Whewell, and was used by Treviranus and philosophical writers of the early half of last century. What is now called hypnotism was termed "electro-biology," but the extent of the great field of exploration signified by "biology" was little understood. The great event in the history of biological science occurred ten years before the appearance of the first issue of NATURE, namely, in 1859, when Darwin published his book "On the Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life."

The new conception of organic phenomena brought about by Darwin's work took deep root in the ten years from 1859 to 1869, and the main lines of study necessitated by it had been boldly laid by the pioneers, chief of whom were Huxley and Hooker. One main line of work set going, and ever since continued, was the production of further evidence of the kind brought forward by Darwin and Wallace. The period was one of intense activity and movement. The Darwinian theory spread in every direction, and new evidence in its favour was accumulated by naturalists, collectors, and explorers. By a remarkable coincidence, the year 1859 was marked not alone by the publication of the "Origin of Species," but—owing to the work of Joseph Prestwich and a small group of English geologists—it is definitely distinguished as the date when the occurrence of flint implements in the gravels of the Somme was recognised as proving (as had been maintained since 1847 by M. Boucher de Perthes and denied by the French *savants*) the existence of man as a contemporary of the mammoth and the woolly rhinoceros.

When this journal started its career we had already Darwin's additional volume on the "Variation of Animals and Plants under Domestication," which was followed in 1871 by the "Descent of Man." Practically the whole scientific world (and much of the thinking world outside it) had been convinced of the truth of the doctrine of organic evolution and also of the vast antiquity of man. The evolution of man from animal ancestry, with all its consequences as to the development of the human mind, became an inevitable inference.

Elementary Biology.

By the year 1869 the triumph of the Darwinian theory was assured. In that year Huxley began his course of lectures and laboratory work on elementary biology. The class numbered about a hundred, and Huxley's three assistants were (Sir) Michael Foster, Rutherford (then professor at King's College, London, afterwards professor at Edinburgh), and myself. This course of lectures to teachers, which was given also in the following year, largely emphasised the unity of animals and plants, and it aroused great enthusiasm. Each lecture by Huxley was followed by demonstrations by his assistants in the laboratory, which lasted all day. This became the model for the courses in biology in all English-speaking countries, and formed the basis of the examinations in the University of London.

Huxley by no means sought to put forward zoology at the expense of physiology and botany. In the new laboratories at South Kensington the first course of botany dealing with the vegetable kingdom as a whole, and not, as heretofore, merely with flowering plants, was given at Huxley's invitation by Thiselton-Dyer. It included the very complete study of lower as well as higher plants. This and the publication of the translation of Sach's "Text-book of Botany," in which Dyer was chiefly concerned, were the starting points of the rapid and remarkable development in botany in the English-speaking universities, which has continued very actively ever since. Profs. Vines and Marshall Ward and others who became leaders in botany were pupils of Dyer at that time.

About the same date, and as part of the same general movement, the development of "physiology" began, so far as this country is concerned. This name has been curiously, by sheer chance, assigned to a study which would more properly be called "organology." Originally physiology meant the study of Nature, but it has been whittled down until now it means essentially the activities of organisms. Burdon Sanderson, together with Michael Foster and Rutherford, were especially active in the introduction of the laboratory study of physiology in connection with physical measuring apparatus, such as the kymograph and other devices already in use in German and French universities. This has resulted during these fifty years in great progress in both the teaching and the understanding of physiology in every university in Great Britain and America.

In 1868 our greatest teacher of physiology in London—Prof. Sharpey, of University College—used to exhibit the mode of record by means of a kymograph by fitting a piece of paper round his tall hat and slowly rotating it on the lecture-table! There was no physiological laboratory in the place at that time.

Methods of Research.

Another great development connected with the new outburst of biology was the improvement both of the microscope itself and of methods of microscopical research. In 1870 all biological workers and teachers became convinced that the long tube and immensely complicated brass-work of English microscopes were superfluous, and that the smaller microscopes of the Continent were better suited to ordinary work. Moreover, the high powers made by Hartnack, of Paris, especially the No. 10 immersion, were found to be more suitable for work upon living and biological material generally than the equivalent powers of English makers. In Vienna in 1869 I worked with Stricker in his laboratory, and learnt from him the method of embedding in waxy materials for the purpose of section-cutting, of which he was the actual inventor. I also studied the methods which he had devised for the investigation of living protoplasm—the outwandering of white corpuscles in inflammation, movements of the large connective tissue-cells of the cornea, etc.

In 1870, owing to the connection thus established, Dr. Emmanuel Klein came to London as assistant to Burdon Sanderson, and was afterwards, by his appointment at Bartholomew's Hospital, the chief teacher of Continental methods of staining, section-cutting, and refined histology, which at once took firm root in English schools of medicine. Previous to this it was not realised in England that it was easy to watch the movements of the white corpuscles of the blood and other living cells of the animal body.

Also previous to 1870 a few individuals, such as Lockhart Clark, had in this country used the method of carmine staining for the study of such tissues as the spinal cord. But the method of hardening in various fluids, passing the sections from absolute alcohol to chloroform and ultimately to Canada balsam or Damma varnish, and so rendering them transparent, was practically unknown. But since 1870 the methods of staining and section-cutting have enormously developed in this country. English workers are especially responsible for the development of the microtome and the methods of producing long ribbons of consecutive sections, which has had an immense effect on the study of the microscopic structure of all organisms.

Embryology.

Obviously, a line of research the importance of which was greatly accentuated by the Darwinian point of view was embryology. The discovery in 1866, by Kowalevsky, of the identity in the early stages of cell arrangement in embryos of the Ascidians and Amphioxus gave an enormous impulse to the study of embryology, and raised the hope that secrets of organic relationship in plants and animals might be revealed in other cases. Indeed, Kowalevsky's great discovery may be considered to rank in biology with that of his fellow-countryman Mendeléeff in chemistry. For he showed that the study of cell development could be carried further, and laid the foundation of cellular embryology, which culminated in what is called the ascertainment of "cell-lineage." That remarkably accurate pursuit had its inception in a paper by Whitman published in the *Quarterly Journal of Microscopical Science* in 1878, and has been largely continued by Conklin and others in America.

The actual study of embryology took a new departure in this country under the influence of Frank Balfour, who published papers on the development of the Elasmobranchs, and established the origin of the notochord and the cœlomic cavity in Vertebrates as identical with that shown in Amphioxus and Ascidians by Kowalevsky. My own part in this embryological work was chiefly in regard to the Mollusca, but general conceptions were, I think, facilitated by the introduction by me of the terms "archenteron," "blastopore" (orifice of invagination by which the two-cell-layered sac, called by Haeckel the gastrula, is formed), "stomodæum," and "proctodæum" (the in-pushing of the outer layer relating respectively to the mouth and anus). The German terms "Vorderdarm" and "Hinterdarm," referring merely to the anterior and posterior ends of the alimentary canal, were not identical with my terms, which apply only to portions of ectodermal origin. The doctrine that the cœlom throughout the animal kingdom is actually or implicitly an out-growth or a series of out-growths of the archenteron was maintained by me in opposition to the views of Haeckel and Gegenbaur and others, and was finally established by the observations of Sedgwick on Peripatus. It was further proved by me that the vascular system was an organic unit entirely independent of the cœlom, and my conception of "phlebœdesis" made an end of the German misinterpretations of the body-cavities of Arthropods and Molluscs. The abundant cumulative study of embryology during these years has led to most important conceptions with regard to the relationship of various animals—*e.g.* the origin of vertebrate limbs. Present conclusions are really based on inquiries into embryological beginnings, and the whole interpretation of morphology in its embryological aspect is still in progress.

The Cell.

The study of the structure of the cell itself, and of the processes of cell division, shortly after 1869 made a very great advance. Chromosomes and their importance, and the whole subject of mitosis, became a part of our fundamental knowledge. This very naturally, in view of the importance of heredity with regard to the whole theory of organic evolution, led to the minute study of the structural facts connected with the egg- and sperm-cells, as well as fertilisation and the earliest divisions of the fertilised egg-cell to form the embryo. This study, beginning about the commencement of the period under consideration, is still actively proceeding. Whilst it seems that in the chromosome we have got very much closer to an understanding of the actual visible features relating to the phenomena of heredity, yet there are important facts in course of discovery.

Oceanic Research.

Another line which also suddenly came into activity and has been a prominent feature since 1869 is deep-sea exploration, which began with the voyage of the *Challenger*. When the first number of NATURE was published, this was having its initiation under Dr. W. B. Carpenter and Prof. Wyville Thompson, who, led by the discoveries made by those who laid the first deep-sea cables, had conceived the notion of exploring great depths of the ocean by means of the dredge. They obtained the brief loan of a warship from the Government for the purpose of their explorations. This led to the three years' voyage of the specially fitted ship *Challenger* and its staff of scientific experts, and the publication afterwards of a magnificent series of reports. This example of the *Challenger* has been followed by every country, and valuable explorations of the ocean—oceanographical research as it is called—has become an established branch of scientific inquiry.

A complement of the pursuit of oceanography by means of ships and apparatus for deep-sea dredging has been the establishment of zoological laboratories in specially suitable localities on the seashore. The one organised on an international basis by Dr. Anton Dohrn was the first to become widely known and useful, although the French naturalists had some years before this founded marine laboratories—Coste at Concarneau and Lacaze-Duthiers at Roscoff. Now they are established everywhere.

Palaeontology.

Beginning with our starting point, and more especially connected with the founders of the Darwinian theory, there has been an immensely important and productive activity in palæontology. A large part of Huxley's scientific work consists of the thirty or more valuable memoirs on the remains of extinct fishes and reptiles published by him as naturalist of the Geological Survey. By his palæontological studies he was led to views as to the genealogical history and connection of the birds and reptiles, and also as to the special development of certain mammalian forms, such as the horse. Also at this period there developed in America an enormous activity in palæontological discovery. Up to 1869 we knew some few of the extinct animals of America through the work of Leidy. Marsh and Cope then burst upon the scene with most astonishing and valuable accounts of extinct dinosaurs, birds, and mammals. These have been followed ever since by a stream of important discoveries in which Henry Fairfield Osborn is now the leader. The stimulus of this work for the Darwinian theory and its vast importance in relation to that theory are obvious.

Pathology.

A study which has greatly developed, and has had an effect on Darwinism and been re-acted upon in turn by Darwinism, is that of the whole field of pathology. Before 1869 the germ theory and the importance of bacteria in disease had begun through Pasteur's work to be appreciated. Since then knowledge has accumulated, and the work of Lister has fundamentally altered views as to the effective nature of asepsis in the treatment of wounds. The outcome of this is an immensely increased study and knowledge of bacteria and other parasitic organisms, and also of the means of resistance to their attack.

Special importance attaches to the recognition by Metchnikoff of the function of the colourless corpuscles as scavengers in the blood and tissues—his doctrine of phagocytosis and the *rôle* of phagocytes in immunity. Perhaps most strikingly significant is his explanation of inflammation, which is now seen in the light of the Darwinian theory to be a life-preserving property of the higher organisms in which, by local arrest or slackening of the circulation, the access of phagocytes to injured and diseased tissues is facilitated.

General Retrospect.

All these developments will be found recorded in successive volumes of NATURE, in reviews of books, correspondence, and articles. In this way greater perfection of record and comprehensiveness of treatment have been attained than in any other scientific journal.

Whilst all these studies were going on, the more direct observations by the Darwinian method have been accumulating enormously. Classification and general views on morphology have been affected accordingly. Various serious attempts have been made to improve upon or to add to Darwinian theory, perhaps to its detriment. One example of this is Romanes's notion of physiological selection. Another is the attention given to the experiments and conclusions as to hybrid breeding of the Abbé Mendel. Mendel's conclusions differ but little from those contained in Darwin's own work, as was pointed out in a letter to NATURE for August 14 last, p. 463. No doubt the breeding experiments which are now carried out in the name of Mendel might equally well be performed in the name of Darwin. The importance of this work was little assisted by those interested in Mendelism, when in the early days they called it a "new science."

Within the limits of a short survey it is impossible to measure the heights of more than a few peaks of biological science, or to describe the boundaries of even a few fields of work. Others will deal with particular branches of biology, including psychology, which will be developed in the near future as the basis of anthropology, and should be to education what physiology is to medicine. Physiology itself has yet to come under the full influence of the Darwinian doctrine —"the preservation of favoured races in the struggle for life." As yet there has been no investigation of the *development* and survival of functions. It is necessary to study their evolution from simpler types and to analyse by experiment the progressive series of chemical activities involved in digestion, secretion, excretion, and so on. At present physiology is as incomplete as morphology would be if no forms below terrestrial vertebrates had been studied.

In concluding this sketch I desire to bear testimony to the valuable services in the promotion of scientific progress which NATURE has rendered throughout its existence. In the hundred and three volumes which have been published since 1869 the names of all the most active workers in the realm of natural knowledge will be found in their pages, not only in papers and books recorded and epitomised, but also as the authors of articles, letters, and other contributions. Every man of science knows the useful function performed by NATURE, and appreciates its essential importance to the vitality of the scientific organism. I am particularly glad that my friend, Sir Norman Lockyer, has lived to see the completion of the fiftieth year of the journal established by him. The high and secure position which NATURE occupies is due to the sympathetic, impartial, and honourable editorial traditions gained for it by him and still maintained. As a personal friend I cherish the recollection of association with the founder of the journal throughout the long period of its existence, and with all other scientific workers I tender him grateful congratulations for what he has done through it to stimulate the increase and application of knowledge.

SCIENCE AND THE CHURCH.

By the VEN. JAMES M. WILSON, D.D., CANON AND VICE-DEAN OF WORCESTER.

THE Editor of NATURE reminds me that in its first year of publication I was one of its contributors, and he asks me to write something for its jubilee issue. He goes on, further, to assign me a subject—"The General Attitude of the Church and the Religious Laity towards Science now compared with what it was fifty years ago"—and he limits me to "about a thousand words." It is a sufficiently large subject for, say, ten or twenty thousand, and yet I am going to double that subject by adding the words "and that of the scientific world towards the Church." I think there has been an equal change in both, and I take the latter half first.

About fifty years ago I was more at home in the scientific than in the clerical world. I was a fair mathematician; an enthusiastic, though ill-equipped, teacher of science; an observer in astronomy; on the council of the Royal Astronomical Society; and associated with Huxley and Tyndall in a small British Association Committee on teaching science in schools. They were among my friends. I had also many friends among the rank and file of men of science. Such are my credentials to speak of the attitude at that time of men of the scientific world to the Church.

That world, impressed and dazzled as it was by the vast extension of the sphere of the natural —that is, of what was sure to recur in like physical circumstances—felt, speaking generally, that "the Church," which insisted on the supernatural, was *ipso facto* an upholder of error and superstition, an enemy to truth. They were out to sweep the Christian faith away. It might hold out, they thought, for a few decades in obscure circles, but its time had come. They were as cocksure and contemptuous of believers in the supernatural as were the Germans of the English in 1914. I am speaking generally, and chiefly of the smaller fry and hangers-on. But some of the leaders occasionally showed the same tone.

The attitude of men like Huxley, Adams, Stokes, H. J. S. Smith, Asa Gray, Salmon, Maxwell, and others was very different. They never wavered in their sense of the duty of setting truth first, and of the value of knowledge. They saw and welcomed the setting far back the traditional boundary between the natural and the supernatural. But they stopped there. They felt the presence of the unknown, and humbly suspended their judgment, conscious of limitations. Tyndall and his admiring school seemed to feel no such limitations. I remember talking with him at his house on the Bel Alp one glorious evening. He gave some two or three of us a brilliant monologue on his doorstep. But that universe of stars and snow-peaks was to him a magnificent field of exercise of atomic forces. Further knowledge, he doubted not, would establish the fact that we also, with our mental faculties, were only items in the same field, products of the same forces.

Such was the impression given of their beliefs by the dominant and aggressive school of men of science of that time—that freedom in spiritual life, and therefore responsibility, were illusions, though goodness was no illusion.

Insensibly a change has occurred which is not easy to define. Perhaps it may be described broadly as the discovery by that scientific world that the sphere of religion is not inherently anti-rational; that faith, like knowledge, rests ultimately on experience; that science has its sphere in the world of matter leading up to forces of unknown origin and nature; and that faith has its sphere in a world of personality leading up to a similarly unknown goal of personality: that their methods are not inconsistent; and that their goals may be identical.

There is a pregnant saying of Augustin: "Interrogate thyself, O man, and make of thyself a step to the things which are above thee." Science has of late begun to do this. Previously it had turned its face to things which are below us. Faith has ever turned its eyes to that which is above us, dim though it is, proofs of the existence of which it finds in its own mental and spiritual faculties—in the sphere of the good, the beautiful, and the true. Through that experience faith is led up to the conviction of a Personal origin of Nature, with whom it is possible for us to be in some communion.

Miss Jane E. Harrison, in her recent "Conway Memorial Lecture on Rationalism and Religious Reaction" (Watts and Co.), has laid us all under a debt by her characteristic frankness on this subject. "If you will pardon," she says, "a personal reminiscence, I should like to acknowledge my debt as a rationalist to a reviewer. Mr. Clutton-Brock, in reviewing a review of mine—I do not think he has read my book—noted, truly enough, that I always implied that religion was obsolete, and only to be examined as a curious survival of man's past. 'And,' he ended, 'it is hardly scientific to lecture on the corpse of religion when all the while religion is alive and laughing at you'! It is a staggering experience to learn anything from a reviewer. That sentence made me reel for a moment. When I recovered I determined that religion anyhow should not go on laughing at me any longer. So I turned to the study of modern developments, and I confess the result has in some ways surprised me."

This is an illuminating statement.

There has been also, during the last fifty years, a corresponding change in the attitude of religious faith towards science. The following points strike me as the most obvious.

First, the clergy and the educated laity have lost their fear that the predictions of the science of fifty years ago would be verified, and that we should find ourselves in a world of determinism and materialism.

Secondly, the younger generation of both clergy and laity take it as a matter of course that science has helped faith to extricate itself from many crude mythological forms in which its exponents in pre-scientific days expressed their beliefs. Science has shattered some of our idols, and we are grateful, and shall be more grateful as the years pass.

Thirdly, all Christians value highly the enormous extension of knowledge of the works of God due to scientific labour and genius. Moreover, not a few would like to say emphatically that the disinterested search after truth, which is the very soul of science, is in itself a worship of the God of truth. It is faith. It is a religion. It is a consecration.

Lastly, the ordered reason and method which have won such conquests in the physical world, and revealed fresh sources of power, have helped religious thinkers to see an inexhaustible source of spiritual power in that conception of the divine indwelling life which leads, not to the quietism and the static passivity of Pantheism, or to a selfish individualism, but to ever-hopeful and ever-fruitful activities for the common good of men.

May we not in conclusion say that the human and spiritual energies which in the past have created religion and science have now begun to see that they can work as independent allies, urged by a common motive, which one of the two would describe as the elevation of humanity in the scale of being, and the other would call seeking the kingdom of God?

THE EXPANSION OF GEOLOGY.

By Prof. T. G. Bonney, F.R.S.

IN the fifty years since this journal began, the progress in geology has kept pace with that of the other natural sciences. In regard to them, in an article contributed to the first volume, I wrote of what had been done and what yet required to be done for their study in Cambridge, where I was then resident, and whither I have since returned. The changes may almost be called a transformation. The museums and laboratories, though the supply is not yet quite equal to the demand, far surpass what we desired in those early days, and the class-list of the Natural Sciences Tripos, instead of containing about a dozen names, had risen before the war to fully 130. The same is true of the other older universities, while more than as many, non-existent fifty years ago, are now busily engaged in educating natural science students.

But to refer to geology only. In 1869 even the geography of considerable regions on the earth's surface was unknown. There were large areas in Africa, away from the coasts, where only here and there had a traveller passed. Hundreds of square miles about the North and South Poles were blanks upon the maps. With the exception of Western Europe, North America east of the Rocky Mountains, some portions of Asia, and a little of Australia, geological knowledge was very limited. Now careful surveys have been made far beyond the original boundaries, and it is not too much to say that a general idea has been obtained of the geology of the earth as a whole, for, in addition to exploration of its surface, deep-sea sounding has revealed the nature of the deposits now forming on the ocean floor.

The advances in stratigraphical knowledge have told on every branch of geology, but especially on palæontology. Much valuable work had no doubt been done by 1869 on the Corals, the Echinoderms, the Crustaceans, the Brachiopods, the Molluscs, and the Vertebrates, but great discoveries have been made, particularly in regard to the last. The work on them, begun by Cuvier and carried on by Owen, has now been extended to most parts of the globe. Even so near as Belgium, the buried ravines of Bernissart have yielded up whole skeletons of the Iguanodon; the more central parts of North America show that, when the Rocky Mountains had partly begun to rise, reptiles, stranger in form and vaster in bulk than the founders of palæontology had imagined, haunted their swamps, and lakes, and rivers. Cope and Marsh, fifty years ago, were only beginning their work. Such giant reptiles as Brontosaurus; Atlantosaurus; Diplodocus, with its inordinately long neck and tail; Stegosaurus, with its strangely serrate back; and Triceratops, with its horned and armoured head, have all been reconstructed. Some century and a half ago a forerunner of the sea-serpent had been discovered at Maestricht, but the list of Mosasauroid reptiles has been much augmented from the inhabitants of the inland seas of late Cretaceous age near the Rocky Mountains of the present day. Dentigerous birds, and the Archæopteryx, half-bird, half-reptile, have been discovered, and some of the earliest Tertiary mammals, again more especially in Central North America, are no less weird in shape than the above-mentioned reptiles.

Since the publication of the "Origin of Species," which antedated that of NATURE by ten years, scientific palæontology may almost be said to have been born. Missing links in the chain of living creatures have been found, gaps in knowledge have been filled in, difficulties which raised opposition from not a few good naturalists have been removed; evolution has passed from the stage of hypothesis to that of theory, and extended from natural history to other branches of science and into yet wider fields. The pedigree of not a few forms of life has been constructed, so that "zoning" by fossils has greatly aided the stratigrapher, and the zoologist finds it possible in many cases to retrace the steps of that pedigree until, in this tree of life, the twigs are followed down into the branches, and the branches to the primary stems, though, notwithstanding recent discoveries in regard to the fauna of early Cambrian times, not a few pages have disappeared from the history of life, especially in its opening chapter. Discovery is now proceeding with quickened pace in the history of plant life, so that when NATURE celebrates its centenary the zoology and botany of the world will undoubtedly be understood far more completely than they are at the present day.

In 1869 petrology was at a low ebb. Macculloch and De la Beche had done what was possible without the microscope, but the great majority of field-workers remained well contented if they could recognise the commoner igneous rocks and vaguely identify the metamorphic. Clifton Sorby, by applying the microscope to petrological study, had pointed out, nearly twenty years before 1869, the way to success, but had attracted very few followers, so that even our official surveyors did more to retard than to advance this branch of geology, while in regard to metamorphism the wildest ideas were not seldom proclaimed. Light gradually dawned, misconception after misconception was dispelled, until in 1883 Prof. Lapworth made the great forward step in this branch of the subject by discovering the "Secret of the Highlands." Petrology now claims dozens of students, busily engaged in clearing up the difficulties and solving the puzzles of this or that region, and the study of rocks has become as truly scientific as that of palæontology.

The value of geology for economic purposes has been increasingly recognised during the last fifty years, though for no small part of that time the so-called "practical man" was accustomed to make light of it. By the middle of last century the importance of some knowledge of stratigraphy was beginning to be generally realised in regard to coal-mining; yet cases sometimes occurred such as making boreholes in search of that material in hopeless places, or carrying a shaft down into the Wenlock Limestone in the hope of striking a valuable seam, which, as the result of an unconformity, had never been deposited. Much information, however, has been obtained about underground stratigraphy by some of these borings for minerals or for water, even when they proved fruitless in themselves. Shafts also for coal and for metals have been carried to much greater depths than formerly, one or two even going down to as much as 5000 ft. below the surface. But the late war repeatedly proved the practical value of a good knowledge of geology, in the cutting of deep trenches, in driving tunnels, mines, and counter-mines, and in constructing underground shell-proof shelters, so that we may now reasonably hope that our military and political authorities will recognise the importance of geology as a subject of education.

This increase of knowledge is not without its attendant drawbacks. The microscopic study of rocks and minerals, the minute observance of the variations in closely allied species, the distinction of geological areas, tend to foster specialism. In the present age the emergence of men like Darwin, Hooker, and Huxley, men with far-reaching views and wide outlook, who make great forward steps, has become increasingly difficult, while the literature of all the subjects, though it aids, also lays a heavy burden on the student. Much time has often to be spent in searching through many volumes, for fear of overlooking some fact which may have an important bearing on a special investigation; in short, there is sometimes a great danger in being unable to "see the wood for the trees." But we may hope that these obstacles will in due time be overcome, and details be regarded in their right relation to principles.

THE NEW BIRTH OF MEDICINE.[1]

By Sir T. Clifford Allbutt, K.C.B., F.R.S.

WITHIN the period of fifty years during which NATURE has been published, medicine has undergone a revolution. It has become enlarged from an art of observation and empiricism to an applied science founded upon research; from a craft of tradition and sagacity to an applied science of analysis and law; from a descriptive code of surface phenomena to the discovery of deeper affinities; from a set of rules and axioms of quality to measurements of quantity. When I turn back to the medical text-books of my pupilage, to the wise and scholarly Watson or the respectable Alison, and contrast them with the text-books of to-day, I marvel that a change so vast, so profound, so revolutionary, should have come about in one lifetime! Many a generation had to pass before Harvey's researches established animal mechanics; many again before the half-lights on animal heat of Willis, Mayow, and Boyle were brought to quantitative verifications.

In medicine, observation cannot carry very far—not so far, let us say, as in astronomy; while skill and sagacity, if they do not die with the individual, keep in the axioms and exercises of the school but a transitory life. No observation of a thunderstorm could unravel its affinities to the action of a loadstone on a scrap of iron; no observation on diet could reveal the relation of food protein, by way of the amino-acids, to the tissues; no observation bestowed on scurvy or beri-beri could detect the occult and elusive but all-potent influence of the vitamines; no observation of secretory and muscular action could reveal the play of surface-tension in muscular contraction, or its relations to lactic acid and oxygen. By what sagacity could the shrewdest observer, let us say of heart disease, perceive the likeness of the formations of a soap bubble, or a raindrop, to the contraction of a muscle-fibre in terms of its length; or that muscular contraction is not so much a chemical as a physical system with a negative temperature coefficient? Again, the relation of sexual hormones to the development of men and women, and to the phases of their respective organs of reproduction, is an issue of the academic laboratory. The prodigious harvest medicine has reaped in the recent operations of war was derived from the original researches of a chemist into the occult causes and laws of fermentation by microbes, and from a field apparently so alien as of the silkworm disease.

One of the main lessons of our history has been that, in neglect of research into truths below the surface, medicine, for lack of a deeper anchorage, has always sunk back into empiricism and routine.

Research is the salt of the most practical training; it cannot begin too soon; it is the light of the wisdom of the man, of the mind of the boy, of the heart of the child. Education has lingered on Hellenistic and scholastic ways, on the systems of abstract notions unvexed by verification, so long that the hard-shell practical man is still occupied by the notions of antiquated theory and the phrases of a dead or moribund nosology. The

[1] Abstracted from an address by the author to the Scientific Meeting of the British Medical Association in April, 1919.

majority of medical men have to work upon the store of scientific ideas and facts with which they set out in practice; onwards they may gain in adaptiveness and technical facility, but can dig little deeper into the strata of knowledge; but for the modern academic spirit this would spell, as in our history it has spelled, stagnation.

Physics and Medicine.

Let us glance, however hastily, towards some of the fields in which new knowledge has been gained. In the venerable study of anatomy in its static aspects the student has long been taught the value of precision; but the recent tide of anatomical study towards its dynamic aspects, as by the work of Sherrington and Head, is bringing in new currents, not of theory only, but also of practice. Of other casements opening upon new visions of medicine that from the chambers of physics is perhaps the most arresting, at any rate at present. How fascinating, in their application to pathology, are the principles of osmosis with its curious reversals, of surface action and adsorption, of electrolytic differentials and electric methods of taking quantitative measurements, of mechanical pressures in the circulation of body fluids and, in the heart, as measured and graphically delineated by Hales, Ludwig, Gaskell, and Mackenzie, of the behaviour of fluid veins, and of the relative diameters, normal or variable, of the cardiac chambers and their main outlets. I need not do more than allude to the recent work on the CO_2 tension in the pulmonary alveoli, and to its immediately practical bearing on so-called acidosis, on the treatment of persons gassed in military or civil operations, and so forth.

By physics again we are shown, especially in plants, how in life the less complex molecules, working not only in planes below those in which the higher functions are developed, but also upwards by pacific penetration, moderate where they do not command. How instantly such researches as these must govern the practice of medicine we perceive, for example, in the gum-saline treatment of surgical shock. It would seem indeed that some of the most mysterious phases of immunity and anaphylaxis, of phagocytosis, as also of narcotism, may depend, at any rate in great part, on surface action; and that the behaviour of lipoids released from disintegrating proteins may lower surface energy, as in the retention of water in renal dropsy; or again in a different field may determine the touch or the permeability of synaptic neurons. These, and such physical laws, as they are revealed to us, teach that the multiplication and co-ordination of surfaces, let alone their chemistry, are operations which do not arise in mere mixtures of the same ingredients. So far it seems as if all biological reactions were determined by physico-chemical laws—that is, by molecular structure. The laws of selective absorption, as revealed in incandescent vapours, might throw some light upon those of biology; for in both fields we have to study vibration of molecular systems in unison, harmony, or discord.

When we rise from physics into systems of biological activity two conceptions especially strike us as new and marvellous; namely, those of the colloids and the cell. But throughout these systems we shall find the physical phases, if no longer constructively dominant, yet still active and effectual. We cannot even guess at the links of these chains where physics recedes and biochemistry takes the lead. The mere size of the molecules now concerned alters their relation to the spaces in or about which they move; not only so, but in organic compounds a mere change of position of a radical profoundly alters the properties of the compound and leads to manifold changes of function.

Often, moreover, these changes, as in the cases of immunity and susceptibility, do not vary gradually, but by leaps and bounds, as flames respond to musical scales of vibration. Thus great diversities, contrasts, and strange conjunctions of morbid phenomena do not necessarily signify great divergence of nature in the morbific agents; so that again we cannot get very far by grouping phenomena by direct observation. Processes outwardly disparate may be alike at the core. A small and latent change of chemical constitution may turn a benignant into a virulent substance, and conversely; as we may see in such substances as cacodylic acid and the cyanides, or as saliva, serpent's poison, and trypsin; and so forth. On a small deviation in a secretion we may be destroyed by those of our own household.

How far are hormones a particular category, how far universals? Do they differ in nature from other secretions, enzymes, antisubstances, and so on? Do they by their interactions, compensations, and inhibitions cover the ground of concerted chemical action in kind, as the nervous system does in time; or are they few and peculiar to certain limited needs? Whether inhibitory or stimulatory may often depend rather upon the term of the series to which the hormone is applied than to a difference in quality. Merely to glance at such questions as these reveals to us how vast is the realm of knowledge yet unconquered, nay undiscovered—

> . . . mazes intricate,
> Eccentric, intervolved, yet regular
> Then most when most irregular they seem.

A very interesting transition from physics to chemical biology is found in the phenomena of catalysis. By some elusive property certain inorganic substances—spongy platinum, for example, or manganese dioxide—themselves unaltered, exercise an accelerating influence upon chemical change; properties which are utilised to-day on an enormous scale in industrial processes. Now by our increasing knowledge of biochemistry we perceive that the function of which the inorganic catalyst is a simple case is manifested also in more complex orders by certain enzymes, or colloidal catalysts, upon which depends in great part the sweep of our health and of our diseases. In these enzymes which accelerate metabolism we may admire again, as in the simpler catalysts, the exquisite economy of energy in vital processes; how small the energy transactions may be, and these often reversible, which may compass great ends. A striking example of such economy is now being demonstrated to us in the calculated balances of voluntary muscular activity. The minute quantities of vitamine suggest that they, too, are catalysts, and function without much waste.

Diet and Nutrition.

During the last half-century the subject of dietetics has been strictly analysed on quantitative lines, and its energies calculated in caloric and other units. Yet even herein our attainment is far from complete. About this well-worn, almost hackneyed subject a breeze of new and far-reaching ideas is gathering. Our balances, as in the children's milk, and in the analysis of the diseases of deficiency, are eluded by imponderables, by the infinitely little; our quantities are set at naught. For health and disease the new vitamines to which I have alluded, like some other hormonic and enzymic imponderables, are as potent as they are intangible. Hormones work in infinitesimal ranks; and I believe no antibody has as yet been isolated. Once more we find that Nature laughs at our formal categories, at our several compartments of protein as such, of carbohydrates as such; a straitlaced reckoning. No one class of foods, it appears, will build or burn without another; carbohydrate metabolism leans on that of protein, the protein on carbohydrates, and all these on the fats, in mutual function; each of these is engaged in the totality of the chemical changes. For instance, deficient carbohydrate means deficient oxygenation of fats, and imperfect protein distribution.

Nor is this all; some of our great ancestors, likewise having penetrating ideas of the infinitely little, supposed that the sources of nutrition must contain a supply to each and every living tissue of its own form of minute identical elements; be they of bone, of muscle, of blood, of "nerve," and so forth, each being proper to its particular tissue, to which it attaches itself (Homœomerism). This crude notion, it is true, made no great way; still until lately we have all of us supposed some, if a more general, congruity of form between the nutritive elements and the qualities of their various destinations. But the study of the reduction of foods to amino-acids, and issues of like researches, are telling us to-day that there is no necessity even for the food proteins to be of similar constitution to the tissues which they subserve. To the almost magical part played by certain elements, such as calcium, as stabilisers, or of the alkali-metals as labilisers of equilibrium I need but allude. The bearings of these dietetic researches upon practice, for example in the treatment of diabetes, are too obvious for reiteration.

If we turn now to the cell, as described to us by Virchow, we realise that our knowledge of this tiny microcosm is as yet only beginning. The infinity of extension is not strange to us, for some of it we can see; but the infinity of the universe of the little, which far escapes even our microscopes, does not so strike the imagination. Still, even of this inward universe and its intense activities, as by present research they emerge into the field of the mathematical physicist, of the spectroscopist, of the radiologist, of the physical chemist, we are beginning to conceive something. The microcosm is no longer Man, but the cell of which he is built. To our wonder we see that, even within such tiny spheres, some of them filtrable, are multiple systems moving in relative independence of each other. The cell membrane is formed chiefly perhaps by the physical processes we have considered. Yet puzzling and intricate as these reactions are, they are all-important to the physician; as, for instance, in the relations of the glomerular epithelium to sugars; its unerring discrimination between substances, even isomeric, in the blood, as between glucose and lactose; or again in the constant and subtle opposition of the normal intestinal epithelium to the entrance of poisonous elements, or foreign proteins, into the vessels and tissues.

For the Future?

This rapid glance over a small part of the field of the medical sciences may serve to reinforce the lesson of their profound and instant bearing upon practice, and the need for linking up the laboratory with the wards. Only by disinterested research on the large patient and prophetic lines of the pure sciences can progress be made. The isolated academic worker, as well as the practitioner, loses by this isolation; he loses the spontaneous outcrops of problems and crucial instances which so often spring up in practice, but fail to show themselves in the laboratory. So complete and mischievous, however, has been the barrier between research and the industry of medicine that a reaction from "laboratorism" to symptomatology has set in, because there are no intermediary workers—no engineers—between the knowledge getters and the knowledge dealers. Thus we have laboratory investigators completely out of touch with practice, and practitioners faithless of theoretical principles—just "Philistines."

As the engineer is something of a mathematician, something of a physicist, so the professor of medicine must be something of a physicist, something of a biochemist. Through these middlemen the man of science and the practitioner should mutually feed each other. In every adequate clinical school, then, there must be a *professoriate*; whole time—or nearly whole time—professors, each with his technical laboratory, biochemical and pathological, who with their assistant staffs shall be engaged continually in irrigating our profession from the springs of the pure sciences.

DEVELOPMENTS OF PHYSIOLOGY.

By Sir Edward Sharpey Schafer, F.R.S.

MOST of the fundamental facts of physiology had been discovered before 1869, but nearly all the progress in the nineteenth century up to that time was made in France and Germany; and those who wished to learn the subject properly had perforce to seek instruction abroad—a condition of affairs which is fortunately in great measure now reversed. During the sixties of last century physiology had ceased to exist as an active science in this country. There were no laboratories, and no systematic investigations of a physiological character were carried on. The men who professed the subject in our medical schools were physicians or surgeons who were switched on to it as it came to their turn, and imparted to their hearers such knowledge as they might have acquired from books, but were themselves ignorant of the methods and aims of the science they were appointed to teach.

There was, however, one notable exception in William Sharpey, who was called from Edinburgh to fill the newly-constituted chair of general anatomy and physiology in University College, London, in 1836, and retained it until 1874. Sharpey, although a great teacher, was not really a physiologist. His training was wholly that of an anatomist, and his teaching was largely anatomical. Of the physiology he taught very little was acquired as the result of personal investigations, and his knowledge of the methods employed in modern physiology was nil. But he had clear ideas regarding the principles of the science, and an extraordinary facility for imparting his ideas and for interesting his hearers in them, so that when the opportunity came for learning the methods they were in an advantageous position to pursue the subject.

It was a pupil of Sharpey—Michael Foster—who founded the famous school of physiology at Cambridge, and it was through Sharpey's influence that Burdon Sanderson was induced to give up the practice of medicine in order to install the practical teaching of physiology in London. These were the pioneers, and their influence gradually spread, so that before very long England succeeded in again taking a foremost place in a science which may be said to have had its birth in our country, for before the immortal discovery of Harvey no true physiology was possible.

The development of the science during the last fifty years has occurred partly along the old lines, which have been thrust forward far in advance of the position they occupied half a century ago, partly on new lines which were at that time not only untraced, but even unthought of. The immense progress on the old lines of investigation is evident whatever be the branch of the science to which we may turn our attention. This progress is actively correlated with the parallel development of the sciences upon which physiology is based—physics and chemistry. More than all, perhaps, has physical chemistry—a branch of science which, if already born fifty years ago, had at any rate not been baptised—enabled the physiologist to see—if still very dimly—into the processes which make up life itself further than could ever have been dreamed of in those distant days.

To give an account of the progress which has been made on the old lines of investigation would occupy a large volume; the shortest description would take many pages. Fifty years ago nothing was known of the constitution of the proteins or of the manner in which they are built up into the tissues. The mode of action of the heart and the factors which regulate circulation and respiration were still obscure. The localisation of functions in the brain had not been discovered. The important changes which cells undergo in the performance of their functions and in multiplication were unknown. The relation of the sympathetic to the rest of the nervous system was in no way understood. But perhaps the most striking fact which has come out as the result of modern investigation is the dominant action of the central nervous system upon all physiological processes. Not that this is entirely new; it was undoubtedly indicated before the period with which we are dealing. But the paths and manner of its action have been so thoroughly studied, and the accumulation of evidence regarding it has become so great, that one may fairly look upon this as the most important development of physiology along the lines it was pursuing some fifty years since. That this advance has been assisted by the remarkable conception of the structure of the nervous system, which we owe in the first instance to an anatomist—Golgi—is willingly conceded, for it must be admitted that our understanding of the mode of action of the nervous system has become vastly simplified thereby.

The new lines on which the science has undergone development within the period with which we are dealing relate to the influence of chemical agencies in regulating the functions of the body. New lines, do I say? Nothing under the sun is ever entirely new. From the earliest times with which history deals, and doubtless even in prehistoric days, it was known that the functions of the body are affected by chemical agencies. For have not drugs, many of them of a potent, not to say poisonous, nature, been administered from time immemorial? Was it not known that the chemical condition of the circulating fluid influences the functions of some organs; that an excess of CO_2 in the blood affects respiration, an excess of sugar the kidneys; whilst any alteration in its constitution or reaction is liable to have a deleterious action on the body, and may produce fatal effects? For all that, fifty years ago no one suspected that the body itself produces drugs destined to influence its own functions, that certain organs pass chemical substances (chemical messengers, as they have appropriately been termed) into the blood to affect distant parts, and that many functions of the organism are regulated by these chemical agents and self-formed drugs, sometimes in conjunction with the nervous system, sometimes to the exclusion of its action.

The discovery of these internally formed drugs has led to the development of a new branch of physiology to which the term "endocrinology," or physiology of the internally secreting glands, has been applied. Fifty years ago the pituitary body, the thyroid gland, and the suprarenal capsules were mere names. Little was known of their structure, nothing of their functions. The account which we are now able to give of these organs reads like a fairy-tale. That one of the smallest should by its secretion be able to influence the growth and stature of the body, rendering this man a giant, that man a dwarf; that another should produce a material without which the nervous system is not in a condition to perform its functions; that yet others should elaborate materials which when discharged into the blood exercise a profound influence upon the activity of totally distinct and distant organs of the body, are secrets of Nature which were unrevealed fifty years ago, although now amongst the commonplaces of physiological instruction.

The individuals who have been responsible for these advances—whether on the old or on the new lines—are too numerous even to be mentioned here; those who most deserve such mention would indeed be the last to desire it. But History will carve their names on the monument they have joined in erecting, and Science, no less mindful of her votaries than Religion of hers, will not fail to reward their services with the grateful encomium: Εὖ, δοῦλε ἀγαθὲ καὶ πιστέ.

THE MODERN SCIENCE OF PSYCHOLOGY.

THE progress made by psychology since 1869 may be justly described as unparalleled. In that year the subject had no laboratories, and it was regarded as a matter of philosophical study. To-day a psychological laboratory exists in nearly every important university, and psychology has become recognised as the youngest recruit to the natural sciences—the natural science of mental processes.

The modern science of psychology, while admitting the great value of the older purely introspective psychology of the philosophers (represented in this country by the writings of Ward and Stout), realises its dangers and its inadequacy, and seeks to remove it from all metaphysical implications and to study mental processes under known variable conditions. From experimental psychology, thus established, have arisen the sub-sciences of (i) physiological psychology, in which the relation of mental to nervous processes is investigated, (ii) animal psychology, which studies the relation of animal to human mentality and behaviour, and (iii) individual and racial psychology, which determines the mental differences between different individuals and races of mankind.

There have also developed various "applied" psychological sub-sciences—*e.g.* (iv) educational psychology, the results of research in which are now taught to teachers in their period of training; (v) social psychology, which includes the psychology of religion and other social institutions and characteristics; (vi) abnormal psychology, which forms a subject of examination for the post-graduate diploma in psychological medicine now established in the Universities of Cambridge, Edinburgh, Manchester, and elsewhere; (vii) industrial psychology, which is concerned in discovering the best conditions for the highest mental efficiency of the workers, in connection with which applications for the services of psychologically trained investigators are now coming from pioneer industrial and commercial firms; (viii) the psychology of æsthetics, in which laboratory investigations of importance for art have been published in this country and elsewhere. Particularly in America, but also in Germany, many special journals have arisen devoted respectively to the psychology of education, abnormal psychology, individual psychology, animal psychology, industrial psychology, the psychology of evidence, etc. In this country we have the British Psychological Society, consisting of about 500 members, and publishing the *British Journal of Psychology*.

Fechner, who worked at Göttingen, and Wundt, of Leipzig, who in the 'seventies established the first psychological laboratory, may be reckoned the fathers of experimental psychology. Fechner was the first to formulate the psychophysical methods, a thorough grounding in which is indispensable for the avoidance of the many pitfalls of psychological experiment. To Wundt or to his pupils (especially Külpe) flocked students from other parts of Europe, and notably from America, who sought to be trained in the principles of the science. But in Italy, Austria, and Russia experimental psychology has attracted few workers. In Switzerland it has followed the

French guidance of Ribot and Janet, who laid the foundations of our modern conceptions of the disorders of memory and personality, and of Binet, who was among the first systematically to study individual mental differences and to devise tests of mental ability.

In the United States, under the influence of Stanley Hall and Titchener, and in Scandinavia, the German tradition was at first faithfully upheld. Most American, like most German, psychologists had their earlier training in philosophy, and the work published generally followed along German lines, consisting often in "maiden" papers written by candidates for the doctorate of philosophy. In this country, especially through the influence of Rivers, who went to Cambridge in the early 'nineties at the invitation of Michael Foster as lecturer in the physiology of the sense-organs, experimental psychology has developed on rather different lines. It has seldom received more than lukewarm support from philosophy, and it has been taken up by maturer workers, fewer in number, who in several instances came to it from physiology and medicine. Thus, Rivers and MacDougall began their psychological work on vision, and Myers on hearing, while later Spearman, who had graduated under Wundt, specialised in the correlation of mental abilities. In this country scientific psychology has never suffered, as in America, from the dangers of excessive popularity. Here stress came to be laid on one or other of the aspects of comparative psychology, rather than on the pure experimental psychology of the German laboratory. For it was quickly recognised that the mental differences found under different experimental conditions in any given individual are generally less in degree and less in significance than those observed under the same conditions in different individuals. True, both in England and in Germany there have been important investigations carried out upon the effects of alcohol and other drugs on the mental processes of a given individual. But even here, as also in the striking researches of Ebbinghaus and G. E. Müller on memory, the special interest has been found to lie in the study of the behaviour of different individuals. The Cambridge Anthropological Expedition to the Torres Straits, under the leadership of Haddon, which included in its *personnel* three psychologists, and the later rapid growth of the applied sciences of educational, industrial, and medical psychology, have likewise helped to stimulate the study of comparative psychology in this country.

But in Germany and in America there have also been signs of a breaking away from the initial, less fruitful (though fundamental) themes of research. Stern's work on individual psychology, following the pioneer investigations of Francis Galton in this country, and the work on animal behaviour by Jennings, Thorndike, and Yerkes in America, based on the foundations laid here by Romanes and by Lloyd Morgan, are examples in point.

The insufficiency of the older introspective psychology, whether studied in the laboratory or outside it, has since been growing more and more obvious. Watson and others have vainly sought to establish a psychology expressed merely in terms of behaviour, Loeb and Pawlow in terms of purely mechanical or physiological processes. Head and his collaborators have shown the impossibility of analysing and tracing the evolution of sensory and higher processes save by studying the effects of lesions in the peripheral nerves and the central nervous system. Freud and his foremost pupils and critics have indicated the enormous importance of the study of the emotional, instinctive, and sub-conscious processes which are inaccessible to introspective examination. Whether or not we accept Freud's views in their entirety, his work has given an enormous impetus to psychology by laying stress on the conflicts arising from rival incompatible mental (especially emotional) processes, and by indicating the different principles which Nature and the physician may employ to combat such conflicts. The published experiences of MacCurdy and others of the American Army, and of Brown, Hart, MacDougall, Myers, Pear, Rivers, Rows, and other psychologists engaged in the treatment of functional nervous and mental disorders in the British Army during the recent war, have also shown how much can be done by the early application of appropriate psycho-therapeutic methods to the cure of such disorders.

The war has likewise emphasised, both in this country and especially in America, the great value of psychological tests in the selection of candidates for the work to which they are best fitted. The importance of psychological experiment is now becoming recognised not only in regard to vocational guidance, but also in regard to industrial fatigue, the effects of different lengths and distributions of periods of work and rest, etc.

There was a time now past when in the popular view psychological research was supposed to be limited to reaction time experiments, or was confused with "psychical research" into spiritualistic phenomena. It is true that the enormous amount of labour spent in Germany on reaction time experiments promises at length useful results in the study of emotional complexes and of vocational selection. And only by the narrow-minded can psychical research be excluded from psychological science provided that it be conducted by workers systematically trained in experimental methods and freed from personal bias and prejudice. But the most promising future developments of psychology may be looked for along quite other lines, which have been already briefly indicated in the foregoing account of its present position, more especially in the study of the effects of nervous lesions and of mental and nervous disorders, and in the examination and recognition of individual mental differences.

PREVENTIVE MEDICINE SINCE 1869.

By Dr. C. J. Martin, F.R.S.

Preventive medicine is concerned with the application of knowledge to the prevention of disease. To this end all the sciences have been laid under tribute, but physiology, pathology, bacteriology, and epidemiology to the greatest extent, as these have the more immediate bearing.

The rapid progress of preventive medicine during the last half-century is due primarily to the increase of physiological and pathological knowledge, and pre-eminently to the completer understanding of the process of infection which has been acquired during this period. So long as defective development and disease were regarded as wholly constitutional or inherent in the individual, the only prospect of improvement lay in the weeding out of the unfit by the ruthless process of natural selection. A greater hopefulness has, however, arisen as the part played by prejudicial environmental conditions, such as improper feeding and housing, undue fatigue, the abuse of alcohol, and, above all, the invasion of pathogenic agents, was realised.

By the end of the 'sixties the necessity of supposing a *contagium vivum* as the cause of many diseases was fairly generally recognised. Pasteur's researches on fermentation and putrefaction had led him to the opinion that infectious diseases might be interpreted as the result of particular fermentations due to specific microbes, and it was the ambition of his life to substantiate this conception. Lister had launched his antiseptic methods on the basis of Pasteur's work, and these were already beginning to revolutionise surgical practice. Villemin had just demonstrated that tuberculous diseases, hitherto regarded as "constitutional," were due to a common infective agent capable of multiplying indefinitely in the bodies of animals and of being handed on from one animal to another by inoculation. Hitherto, however, although various microscopic organisms had been found to be associated with disease, and indications had been obtained of their ætiological significance, not one of them had been isolated. The causal relationships claimed were thus unproven and much of their life-history unknown.

The first isolation and propagation in pure culture of a pathogenic organism took place in 1876, and was accomplished by Koch in the case of a bacillus derived from cases of splenic fever or anthrax. Inoculations of cultures made *in vitro* into animals reproduced the disease. Progress in bacteriological discovery remained slow until in 1880 more appropriate methods for the isolation of bacteria were derived by Koch. Then followed a period of extraordinary fertility. Within fifteen years the causal agents of cholera, typhoid fever, diphtheria, tuberculosis, various types of suppurative processes, gas gangrene and erysipelas, glanders, gonorrhœa, pneumonia, food poisoning, meningitis, Malta fever, leprosy, and plague, as well as of a larger number of diseases of animals, were discovered.

The discovery of pathogenic agents of another kind soon followed. The association of relapsing fever with the presence of a minute motile spiral organism in the blood was observed by Obermeier in 1873. Later, a number of diseases of man and animals were found to be caused by various spirochætes, most important among them being relapsing fevers, syphilis, yaws, and infective jaundice.

In 1881 Laveran described the parasite of quartan malaria. This observation was followed by the discovery of more than a hundred microparasites belonging to the protozoa which are responsible for diseases in higher animals. The most important human diseases due to protozoan parasites are the three types of malaria, sleeping sickness, and kala azar.

Another class of pathogenic agents which is already known to be responsible for upwards of thirty separate diseases of man and animals remains to be mentioned. These viruses are either on the margin of visibility or invisible with the microscope. They are so small as to pass through biscuit porcelain. The causal agents of infantile paralysis, yellow fever, *molluscum contagiosum,* dengue fever, the three-day fever of the Mediterranean, and typhus fever belong to this category, as well as those of many important animal diseases, as rinderpest, horse sickness, and foot-and-mouth disease, and there are a number of indications that the infective agents of the common exanthemata—measles, scarlet fever, smallpox—are at some period of their life-history so small as to be included amongst the "filter-passers."

Since 1880 the ætiological factor of most human maladies has been brought to light. A correct ætiology is fundamentally necessary, but for preventive measures mere identification of the cause of a disease is not sufficient. The life-history of the parasite within and without its host, and particularly the channels and method of entrance and exit, must be known if a successful attack is to be made upon it. Indeed, some of the most striking triumphs of preventive medicine have been gained in the case of diseases in which the virus had not been seen or isolated (such as hydrophobia, yellow fever, and trench fever), but in which, nevertheless, many properties of the virus and the method whereby it effected entrance and exit had been revealed by experiment.

In the first half of the period under review researches were more particularly directed to the discovery and isolation of the causative factors of disease; the latter half, for the reasons outlined above, has been characterised by the amount of knowledge gained regarding the details of the life-history of various parasitic agencies, the maintenance of the infection in the absence of obvious cases of the malady, and the transmission of the infective agent from one individual to another.

If the infective agent is present in a superficial lesion, as in smallpox, syphilis, diphtheria, or pneumonia, or passes out with the excreta, as in cholera and typhoid fever, more or less direct transmission can occur, but in the case of a parasite situated only in the blood or internal organs it was for long a mystery how the disease was transmitted. The secret was revealed by the discoveries of Manson, Smith, and Bruce on filariasis, red-water fever, and Nagana, showing that in these diseases mosquitoes, ticks, and tsetse-flies respectively acted as transmitters. These observations were soon followed by those of Ross on the transmission by mosquitoes of malaria, and afterwards it was shown by the American Commission that yellow fever also was transmitted by a particular species of mosquito.

Relapsing fever, sleeping sickness, and bubonic plague were also found to be spread by the agency of insects; ticks or lice in the first case, a tsetse-fly in the second, and fleas in the last, and the most recent addition to the list is trench fever, which has been proved to be louse-borne.

The dependence of these maladies for their dissemination upon particular species of insects has afforded a long-looked-for explanation of their distribution—*e.g.* sleeping sickness, yellow fever, and dengue—and the very extensive investigations into the life-history of the parasites and their insect hosts has enabled the sanitarian to choose the stage in the cycle most convenient for attack. He could strike at the enemy whilst it was resident in either host or indirectly by preventing the insect from biting the patient and other individuals until in course of time the infection died out. By netting-in patients suffering from yellow fever so that mosquitoes could not attack them, and at the same time insisting on the removal of all small collections of water in the neighbourhood of habitations in which these insects were wont to lay their eggs, Gorgas rid the city of Havana of yellow fever. By a campaign on similar lines against malaria-bearing species of mosquitoes, the Isthmus of Panama was converted into a health resort. Equally satisfactory results have followed elsewhere when it has been possible to institute equally thorough measures.

Before leaving the subject of infection, I must not omit to mention that biological discoveries regarding the life-history of the parasitic worms —*e.g.* the hookworms and Bilharzia—have shown how diseases caused by this class of parasites could be successfully controlled.

It has not often been found possible to eliminate the cause of a disease. In some cases knowledge has not been sufficiently complete. In others its application has been too difficult, and it has been found impracticable sufficiently to control the lives of the population. In many such cases, however, preventive medicine has another arrow in her quiver. This is aimed at reducing the susceptibility of a population to a particular infection by protective inoculation. The earliest effort of preventive medicine along these lines was that of inoculation against smallpox practised in Asia for some centuries and introduced into England in 1721 by Lady Mary Montagu. Cutaneous inoculation of smallpox usually produces a local and comparatively mild illness, but the method suffers from the disadvantage that it propagates the virus of the disease. Jenner's vaccination with cow-pox—a modified virus—obviated this disadvantage.

With the discovery of the microbial origin of disease, Pasteur saw that the principle of Jennerian vaccination might be further exploited, and in 1881 successfully employed attenuated cultures of the microbes of splenic fever and chicken cholera to protect flocks and poultry against the depredations of these diseases.

In the case of man, the possible danger from the employment of living cultures of the germs of fatal diseases led to researches to determine whether the injection of the microbes which had been killed by heat or chemical agents also induced some measure of protection against a subsequent inoculation with living virulent organisms. By experiments on animals this was found to be the case, and the use of such bacterial "vaccines" was employed by Haffkine to protect man against cholera and plague. Shortly afterwards Wright and Semple elaborated a similar method of protective inoculation against typhoid fever. Anti-typhoid inoculation has been extensively used. The experience in the British and American Armies during the last fifteen years has been that a material reduction in the incidence of the disease has occurred amongst inoculated troops.

The greatest triumph of preventive medicine during the late war was the comparative rarity of typhoid fever amongst our troops. This was the case not only in France, but also in military operations in other areas, where the conditions were such that satisfactory hygienic measures could not be carried out. No other explanation of this freedom from enteric is forthcoming other than the periodic prophylactic inoculations to which our armies were subjected.

So far I have dealt exclusively with infection by living pathogenic agents. I make no apology for so doing, for the great developments in preventive medicine throughout the world which are characteristic of this period have been due to the impetus given by the conceptions of Pasteur and the methods of Koch.

At the same time, knowledge in all departments of physiology and pathology has steadily, though less dramatically, progressed. The increased understanding of animal nutrition must, owing to its important bearing upon the maintenance of the health of the peoples, be briefly referred to.

Before the period under review Pettenkofer and Voit had been able to strike a balance-sheet of the net in-goings and output of matter by the animal body. Within the last fifty years the applicability of the principle of conservation of energy to animals has been established by Rubner. The energy-value of the important foodstuffs has been ascertained, and the requirements of the human body under various conditions of age, climate, and occupation have been determined.

This knowledge has been inadequately exploited because everyone prefers to be a law unto himself in the matter of food intake. It has served as a basis for the rationing of armies and for the construction of institutional dietaries. During recent years, however, it has become increasingly apparent that man cannot live on protein, fat, and carbohydrate alone, but that a diet must contain in addition small quantities of what, until they can be isolated and identified, have been designated "accessory food factors." The best example of these is the for long recognised antiscorbutic substance in fresh vegetables and fruits. The existence of at least three accessory food substances has been since established. For all of these the animal is dependent directly or indirectly upon the vegetable kingdom. An insufficient supply of any one of these leads to trouble. If one of them is inadequate, scurvy results; deficiency of another leads to the disease beriberi; and if deprived of the third an animal fails to grow. There appears also to be no doubt that rickets in children is due to a similar cause.

This knowledge has for long been utilised to prevent scurvy. Where it has been intelligently applied it has eliminated beri-beri from coolie-camps, the population of jails, and industrial communities of the Far East, and if it is utilised in the efforts to feed the famished population of the unfortunate countries of Eastern Europe it will be the means of saving thousands of young lives during the ensuing winter.

Science has also been successfully applied in recent years to the diminution of the dangers incident upon certain industrial occupations, such as mining, caisson working, and deep-sea diving. During the last ten years, too, the influence of industrial fatigue, alcohol, improper atmospheric conditions in workshops, etc., upon the health and efficiency of the worker has been seriously studied. In these inquiries America has shown the greatest energy, but in Britain the subject is beginning to receive the attention its importance demands.

It is impossible to assess the effect of preventive medicine and improved hygienic surroundings upon the health and happiness of mankind; but the influence upon longevity can, in the case of civilised communities, be determined. During the last fifty years upwards of ten years have been added to the mean expectation of life of a child born in Britain or in the United States of America. An increase of 25 per cent. in so short a time is cause for congratulation, but, on the other hand, the fact that a million young men were found unfit for active service indicates that all is not well with Britain.

We are still far from the possession of sufficient knowledge to regulate satisfactorily our environment or to avoid all noxious influences, but owing to lack of power, money, or sometimes sense, we apply far less than we possess.

THE ANTIQUITY OF MAN.

BY DR. A. SMITH WOODWARD, F.R.S.

AT the beginning of the Tertiary period, when mammals began to spread widely over the world, they were all very small and so uniform in character that it is scarcely possible to classify them into groups or orders. They all had a comparatively small brain of a simple kind, and as in course of time they became gradually subdivided into the groups with which we are now familiar, the brain increased both in size and effectiveness, while many of the animals themselves grew larger. In the middle and towards the end of the earliest Tertiary (Eocene) epoch some of the low-brained hoofed mammals attained their greatest size and then became extinct. Next in the Oligocene another group with somewhat improved brain grew even larger just before extermination.

In the following Miocene epoch several groups that had by that time acquired a still more efficient brain, such as rhinoceroses, horses, certain carnivores, and primitive elephants, attained a comparatively large size and soon reached their maximum in the Pliocene. About the middle and towards the end of the Miocene epoch true apes, with a higher development of brain than any mammal up to that time had acquired, also began to grow to as large a size as most of the apes of the present day. It may therefore be predicted that the earliest remains of the largest members of the ape-series, with a truly overgrown brain—the great ground-apes which were the immediate forerunners of man—will not be found in rocks of older date than the Pliocene, and probably not in any but the latest of this epoch. For other reasons Sir William Boyd Dawkins came to the same conclusion so long ago as 1880, and as discoveries progress it becomes increasingly clear that true man, of the family Hominidæ, cannot be earlier than late Pliocene or the dawn of the Pleistocene.

So few fragments of apes and man have hitherto been met with that it is difficult to decide upon the region of the world that may be most hopefully searched. If, however, conclusions may be drawn merely from teeth, the most promising field at present seems to be south-central Asia. By the discovery of such teeth, Dr. Pilgrim has shown that a varied assemblage of apes lived in the forests of northern India in the Miocene epoch. At that time the Himalayan Mountains did not exist, and the late Joseph Barrell ingeniously suggested that it may have been during the uplift of this mountain range at the end of the Miocene and beginning of the Pliocene that primitive man originated. As the land rose, the temperature would be lowered, and some of the apes which had hitherto lived in the warm forest would be trapped to the north of the raised area. As comparatively dry plains would there take the place of forests, and as the apes could no longer migrate southwards, those that survived must have become adapted for living on the ground, and acquired carnivorous instead of frugivorous habits. By continued development of the brain and increase in bodily size, such ground-apes would tend to become man.

Unfortunately, we are still ignorant of fossils to test this hypothesis. We know from fragments of jaws, isolated teeth, and one limb bone that generalised apes as large as chimpanzees existed in Europe so far north as the latitude of Darmstadt until the end of Miocene times, but the only giant ground-ape, which many have claimed to be an ancestral man, was found by Dubois in Java in deposits of much later age which may even be Pleistocene. *Pithecanthropus erectus*, as the Javan species is named, is still known only by a cranial roof, two molar teeth, and a diseased thigh-bone, which bear many resemblances to the corresponding parts of the existing gibbon, and are tantalising in their imperfection.

It is, however, curious that almost the only traces of true man hitherto found with distinctively ape-like characteristics are from Western Europe. The imperfect skull and mandible of *Eoanthropus dawsoni* discovered by the late Charles Dawson at Piltdown, Sussex, represents a man with the lowest of all known human brains, and with an ape-like jaw in which typically human molar teeth are accompanied by large canines as completely interlocking as in any ape. The massive lower jaw of *Homo heidelbergensis* from Mauer, near Heidelberg, still retains much reminiscence of an ape in its retreating chin. The fine skeleton of Neanderthal or Mousterian man described by Prof. Marcellin Boule from La-Chapelle-aux-Saints, France, combines more ape-like features in a single individual than are known in any existing man. The Piltdown and Heidelberg fossils are shown by associated mammalian remains to date back at least to the beginning of the Pleistocene, perhaps even to the end of the Pliocene epoch. Neanderthal man is later, and is very soon followed by typical modern man.

As to the actual age of these various remains in years or centuries there has been much discussion, but it must be confessed that on present evidence only vague guesses are possible. It is true that Penck and Brückner have made some plausible suggestions as to the length of Pleistocene time based on their studies of the glaciation of the Alps. Baron de Geer has also been able to date more precisely the retreat of the Pleistocene ice-sheet in Scandinavia by counting the annual layers in the mud which its flood-waters left behind. It is impossible, however, with our present knowledge, to correlate the isolated patches of Piltdown gravel, Mauer sands, or cavern deposits with the surface phenomena of distant areas; and it is doubtful whether this difficulty will ever be overcome.

Our knowledge of the ancestry of man has, indeed, progressed much during recent years, but unfortunately it is necessary to depend on accidental discoveries. Systematic exploration seems to meet with little or no result. Mrs. Selenka made great and prolonged excavations in Java in the river-deposits whence Pithecanthropus was obtained, without any success. The great sandpit at Mauer has been continuously worked and most carefully watched since the famous jaw was discovered, but without recovering any further traces of man. I have worked hard in the Piltdown gravel, but for the last three seasons I have not found a fragment of either bone or tooth. The research needs much patience, but we may hope that as interest in the subject is more widely spread a larger proportion of the accidental finds relating to it will escape destruction.

THE PRESENT POSITION OF THE MUTATION THEORY.

By Prof. Hugo de Vries.

DARWIN assumed that species originate by the gradual accumulation of infinitesimal, ordinarily invisible variations on account of their utility in the struggle for life. The difficulties inherent in this conception have led to the theory of mutation, which supposes that the production of species and varieties proceeds by small but distinct steps, each step corresponding to one or more unit-characters. It is only after their appearance that the environment can decide about their utility.

The new theory reduced the time necessary for the evolution of organic life on earth to the limits deduced by Lord Kelvin and others from physical and astronomical data. It explained the appearance of the numerous useless qualities of animals and plants, and eliminated the objection that the first almost imperceptible changes could scarcely have any beneficial significance for their bearers. It developed the doctrine of two essential types of variability, which are now called fluctuating variability and mutability. The first of these describes the small but always present differences among individuals of the same stock, whereas the second is the way in which varieties are known to arise in horticulture and arboriculture.

Since the publication of my book on the mutation theory (1901–3) numerous instances of mutation have been observed by different investigators among animals as well as among plants. Half a dozen species of Œnothera, some types of Primula, the walnut, the sunflower, Narcissus, Antirrhinum, Ligustrum, and many other instances might be cited. Among insects Morgan and his pupils have described more than a hundred mutations from the fruit-fly, Drosophila. Other cases have been studied by Tower for Leptinotarsa, etc.

The production of new races of agricultural crops by means of continual selection constituted for Darwin one of his strongest arguments. He showed conclusively that new species and varieties are produced in Nature in the same way as agricultural novelties. But at that time the practical method was far from being clearly understood. The work of Hjalmar Nilsson and Hays has since shown that selection may be conducted according to the principle of the mutation theory, only one choice being necessary to start the whole new variety.

It is now generally conceded by mutationists that the initial change takes place in the production of the sexual cells before fecundation. From this conception it follows that the chance of two similarly mutated cells to meet one another in this process must be very small, whereas ordinarily the mutated cells will combine with normal ones. This must produce half-mutants, and these may, in ordinary cases at least, split off the full mutants after the same rules which Mendel discovered for his hybrids. Sometimes the half-mutants will be distinct from their ancestors, as in *Oenothera Lamarckiana rubrinervis* and *erythrina*, and, therefore, will easily be discovered. In other instances external differences may be absent, and only the unexpected production of a new type in about 20–25 per cent. or more of the individuals will betray the internal change. This explains the mass-mutations discovered by Bartlett. Such an indirect way of producing mutations by means of two successive steps seems to be very common in Nature, and will probably afterwards prove to be the general rule.

Willis has made an elaborate statistical study of the appearance of endemic species, which he considers to be the youngest of their region. He finds that utility of the new characters cannot have had any part in their production, since it cannot be shown to have any influence either on their first local extension or on their subsequent spreading over larger regions. Wide spreading is mainly the result of age, the oldest species having, as a rule, the largest areas. Moreover, in comparing the diagnoses of endemic species with the differences among the mutated forms of such a group as the evening primroses one finds a close parallelism, showing that our experimental mutations are quite analogous to the species-producing steps of Nature.

Objections against the mutation theory have been made by different investigators. Some systematists and palæontologists still adhere to the old view either wholly or only for special cases. Biologists rarely attack the theory in a direct way, but mainly discuss the question whether the observed mutations are really the representatives of the species producing changes in Nature, as is claimed. They assume that the splittings seen in our experiments are due to hybridism, and that every mutating species is a hybrid between supposed ancestors which possessed the mutative characters as specific marks. This idea can scarcely aid in simplifying the question, since it puts the origin of the characters involved on to unknown parents. Sterile varieties cannot produce hybrids, and therefore cannot originate in this way. This fact seems sufficient to disprove the hypothesis. In the case of the evening primroses this view has led to fantastic diagnoses of hypothetical ancestors, but even these fail to explain the facts observed in our cultures. Morgan's hypothesis of crossing over, which goes far to explain the splitting phenomena of the fruit-fly, fails in its application to the evening primroses, since here half-mutants are the rule. These must evidently be produced without the aid of that process. Moreover, the heterogamous mutants have dominant characters which are handed down by the egg-cells, and not by the pollen, instances of which are given by the mutations called *lata, scintillans, cana, liquida,* and others of *Oenothera Lamarckiana*. Evidently these can never be explained by the assumption of a hybrid condition of the parent species.

Thus we see that the broad arguments for the mutation theory are continually increasing in number, whereas the criticisms are more and more directed against special cases. They are concerned with the possibility of experimental proof and with the fitness of our material for further studies, but are not expected to invalidate the theory as such.

THE PROGRESS OF MENDELISM.

By Prof. W. Bateson, F.R.S.

FROM the discoveries to which the Mendelian clue immediately led, many lines of research and speculation are diverging. These enterprises have still aims in common, a fact which we recognise by including all under the one name, genetics; for, though various in their methods, all relate to the physiology of breeding, a department of science the growth of which is a feature of the period surveyed on this occasion.

Stocktaking at the present moment is, however, not easy. Much of the new work is in an incipient stage, and that which is the most attractive of all—namely, Morgan's effort to establish a close connection between cytological appearances and the results of experimental breeding—promising though it is, must be tried by tests on a scale far wider than experience of Drosophila provides before we are able to assess its value with confidence. Whether the theory that the factors are arranged in the chromosomes, like beads on a thread, stand or fall, it has already served the purpose of a good theory. It has fired the minds of many workers, and has directed their inquiries with manifest success. Its weakness lies first in the narrowness of the field studied, but besides this it is not yet wholly free from the objection that the subordinate and incidental hypotheses are not altogether independent of each other.

Various as are the methods of attack, the objects before us are sufficiently clear. Among them the most important is a determination of the moment or moments at which segregation may occur. To the solution of this problem most of the investigations contribute. On one hand, we have the large body of facts consistent with Morgan's view that synapsis is the critical moment. Were our outlook confined to animals, we should scarcely hesitate to accept that hypothesis as satisfying the conditions, but the plants give no such clear answer. Not only is an obvious somatic segregation leading to genetic diversity of the parts not rare, as in many variegated plants and plants which give dissimilar forms from adventitious buds, but there is now a large group in which the male and female organs of the same plant differ in the factors which they carry. Miss Saunders's stocks are the classical example, where the male side carries doubleness and cream plastid colour, whereas the ovules are mixed in these potentialities. Similar sex-linkage, as, following Miss Pellew's use, it may provisionally be called, has been shown to exist in Petunia, *Campanula carpatica, Begonia Davisii,* and in certain forms of Œnothera.

In all such examples segregation cannot be supposed to occur later than the constitution of the sexual organs. Collins's experiment, showing that in Funaria the scales surrounding the male organs by their vegetative growth give rise exclusively to male mosses, is another and very striking indication to the same effect. The genetics of "rogue" peas point to a similar conclusion in regard to the distinction between the rogues and the type from which they come. In some way not yet clear, the type-elements are wholly or partially excluded from the germ-lineage of the heterozygotes, being apparently relegated to the lower parts of the stem. Such facts raise a suspicion that, considered as genetic machines, plants may be fundamentally distinct from animals, an idea already suggested by the contrast between their modes of growth. In the animal the rudiments of the gametes are often visibly separated at an early embryonic stage, whereas in the plant they are given off from persistent growing points. Indeed, since Baur's work with variegated chimæras, which led to his brilliant interpretation of Winkler's "graft-hybrids," this possibility has inevitably been present to our minds.

In knowledge of the nature of sexual difference many very substantial advances have been made, which have much extended the original discovery that sex depends on a segregating Mendelian factor, in some forms the male, in others the female being the heterozygous member. In the fowl femaleness is dominant, and the hen is heterozygous in sex, from which Morgan drew the interesting corollary that the "henny" character of the Sebright cock is also a dominant. Not only has this been proved experimentally, but he has lately shown that after castration the Sebright cock acquires ordinary cock's plumage, much as hens do in ovarian disease. Perhaps we may regard the henny male as containing part of the large compound factor which normally constitutes femaleness. Conversely, we may interpret the spurs frequently present in normal Leghorn hens as indicating that they have lost that part of the female factor which inhibits the growth of the spur. Whether such transference involves actual detachment of chromosome material, as Morgan's theory would demand, is uncertain. Nevertheless, an approach to such evidence is provided by the extraordinarily interesting observation of Bridges of a condition which he calls non-disjunction. Certain crosses in Drosophila failed to exhibit the normal sex-limitation, and unexpected terms appeared. Bridges was able to show that in the families which behaved in this way an extra sex-chromosome sometimes occurred, carried over, as he imagines, by some error of division. Not improbably Doncaster's female-producing strains of *Abraxas grossulariata,* in which evidence of an extra chromosome was found, are an analogous case. Patterson with great probability proposes a similar explanation for the curious phenomenon which he has investigated in Copidosoma, where, by polyembryonic division of a single egg (almost certainly), males, females, and inter-sexes may result. The inter-sexes seen by Kuttner in Daphnia, and those produced by J. W. Harrison with considerable regularity in some hybrid combinations of species of Geometers, are obviously to be considered in this connection, and doubtless the sterile males, accompanied by fertile females, which Detlefsen found as the normal produce of a species cross in Cavia, will be investigated with such possibilities in view.

But though sex behaves in so many ways as a Mendelian allelomorph, showing, of course, frequent phenomena of linkage, it begins to be remarkable that no case of crossing-over in respect of these linkages has yet been established. Were the sex-chromosome always mateless, this fact would fit admirably with Morgan's views, but since the x-chromosome not rarely has a mate, a distinct problem is created. As bearing on the same question, we have also to remember Tanaka's observation that a certain linkage found in the male silkworm is absent in the female.

Another far-reaching discovery has been made by F. Lillie. When in horned cattle twins of opposite sexes occur, the female is sometimes sterile, being called a free-martin. We were inclined to interpret these twins as arising by division of one fertilised ovum, but Lillie, in a study of material from the Chicago stockyards, found that an ovum had dehisced from each ovary, and the twins were therefore originally distinct. Moreover, he showed that in some instances the twins have an actual anastomosis in the fœtal circulation. We are thus driven to believe that the presence of a male embryo may influence—in cattle—the development of a female embryo, poisoning it, in so far that the development of the generative organs is partially inhibited.

Many complex cases of interaction between factors have been successfully analysed. Punnett's elaborate experiments on the colours of rabbits and sweet peas, Emerson's studies in Phaseolus, and several more such investigations are gradually laying a solid foundation from which the mechanism of factorial determination may be deduced. The discovery made by Nilsson-Ehle, and independently by East, that in some forms there are several factors with identical powers, is another notable advance.

Controversy is proceeding respecting the divisibility of factors. When on segregation, either in the gametes of F_1 or in later generations, instead of two or three sharply differentiated classes of zygotes, much intergradation occurs, or when one of the parental types fails to reappear, the result may be interpreted either as showing imperfect segregation, or as an indication that the number of factors involved is very large. The balance of evidence perhaps suggests that many factors can, and on occasion do, break up (as the sex-factor almost certainly does), some commonly, others exceptionally, while others, again, seem to maintain their individuality indefinitely unimpaired.

As bearing on evolutionary theory, the new work leaves us much where we were. Progress in genetic physiology has been rather a restraining influence. The notion that Mendelian segregation applies to varieties and not to species has been often refuted. One of the most useful contributions to this subject is Heribert-Nilsson's evidence respecting Salix hybrids. Wichura believed himself to have proved that they and their derivatives are simple intermediates between the parental forms, and this statement, which has passed current for fifty years, is now shown to be a mistake due to insufficient material. Interest also attaches to Castle's recent withdrawal of his conclusion that by continued selection certain Mendelian characters in rats could be modified, an opinion which, though consistent with his own experimental work, has not stood a crucial test. We are still without any uncontrovertible example of co-derivatives from a single ancestral origin producing sterile offspring when intercrossed. This, one of the most serious obstacles to all evolutionary theories, remains. The late R. P. Gregory's evidence that tetraploid Primulas, derived from ordinary diploid plants, cannot breed with them, though fertile with each other, is the nearest approach to that phenomenon, but the case, though exceptionally interesting, does not, of course, touch this outstanding difficulty in any way.

Space does not suffice to enumerate the practical applications of genetic science to economic breeding, of which some have already matured and many are well advanced.

TELEGONY.

By Prof. J. Cossar Ewart, F.R.S.

THE belief in telegony is probably as old as the belief in maternal impressions, so intimately associated with Jacob's breeding experiments, recorded in the thirtieth chapter of the Book of Genesis. In prehistoric times, when breeds of sheep and cattle brought from the East by the Alpine race were crossed with the more recently formed European breeds striking new varieties would now and again appear. The ancient shepherds would doubtless endeavour to account for the differences between the cross-bred offspring and their pure-pred ancestors, and later biologists would be called upon to decide which of the views of the ancient breeders were most worthy of support.

The doctrine of the infection of the germ now known as telegony was more or less firmly believed in by men of science as well as by breeders up to the end of the nineteenth century. Beecher, writing at the close of the seventeenth century, says: "When a mare has had a mule by an ass and afterwards a foal by a horse there are evidently marks on the foal of the mother having retained some ideas of her former paramour, the ass." Agassiz held that the ovary was so modified by the first act of fecundation that "later impregnations do not efface that first impression." Similar views were entertained by Haller, Darwin, Herbert Spencer, Carpenter, Sir Everard Home, and others, and up to 1895, when I started my experiments, physiologists as a rule either admitted the possibility of the blood of a mare imbibing from that of the fœtus some of the attributes which it had derived from its male parent and thereafter handing them on to offspring by a different sire, or believed that some of the unused germ plasm of the first mate penetrated the immature ova and eventually took part in controlling the development of offspring by subsequent mates.

Up to the end of last century Lord Morton's experiments with a male quagga and a young chestnut seven-eighths Arabian mare were regarded as affording strong evidence of telegony. Hence at the outset I decided to repeat as accurately as possible Lord Morton's experiment. The quagga being extinct, a Burchell zebra was mated with Arab and other mares belonging to different breeds and strains. The mares, after producing one or more hybrids, were mated with Arab and other stallions.

In an account of my experiments, illustrated by numerous figures, published in the Transactions of the Highland and Agricultural Society of Scotland for 1902, it is pointed out that, though, to start with, I believed there was such a thing as telegony, I eventually came to the conclusion that "there never has been an undoubted instance of infection in either dogs, rabbits, or horses." Though a full account of my investigations, by Mr. Hermon C. Bumpus, appeared in the *American Naturalist* (December, 1899), and an abstract was published in the 1910 Report of the United States Bureau of Animal Industry, it is related in a recent American work on evolution[1] that the idea of telegony "rests mainly upon what are known as the Penycuik experiments (Ewart, 1899), the initial one of which was the impregnation of a mare, 'Mulatto,' by a quagga, a species of zebra which is now extinct. The offspring of this union was the foal 'Romulus,' which showed the quagga-stripes of his father very distinctly. Later, 'Mulatto' was bred to a pure Arab stallion and her second foal also showed traces of stripes, although by no means as distinctly as his half-brother 'Romulus.' . . . Definite instances are neither numerous nor well authenticated with the exception of the one in question, and even this may be due to some other cause."

It is scarcely necessary to say that I am not responsible for the idea of telegony—without going far afield, Lull might have discovered that the doctrine of "infection" had been dealt with by Agassiz and was especially associated with a mare belonging to Lord Morton—but it may be as well to point out that I used a Burchell zebra (the quagga had been extinct for nearly a quarter of a century); that the hybrid "Romulus," instead of being striped like his sire, approached in his markings the very richly striped zebra of Somaliland; and that the two subsequent foals of "Mulatto" were decidedly less suggestive of zebras than pure-bred foals of a near relative of "Mulatto" who had never even seen a zebra.

In 1910, when giving a course of lectures in Iowa, I gathered that the doctrine of telegony had few adherents in America. This view is supported by a statement in the recent work by Jordan and Kellogg, who "think it probable that the phenomena called telegony have no real existence."

[1] Lull, "Organic Evolution." (New York: The Macmillan Co.)

PROGRESS OF CHEMISTRY.

By Sir Edward Thorpe, C.B., F.R.S.

THE half-century which has elapsed since the first issue of NATURE has witnessed an extraordinary development of science in general, but in no department has it been more marked, or the changes more profound, than in chemistry. Before dealing with the period over which the existence of this journal extends, it may not be uninteresting to indicate, in the broadest possible outline, the main features of progress in chemical science to which the growth we have witnessed during the last fifty years is in reality due.

The opening years of the nineteenth century constituted a new era in the history of chemical science. The revolution initiated by Lavoisier and his associates—Morveau, Laplace, Monge, Berthollet, and Fourcroy—was by this time accomplished, and its influence had extended throughout Europe. The French chemists, who emancipated chemistry from the thraldom of a false German doctrine, swept phlogistonism into the *limbus fatuorum* of extinct heresies. The early years of that century saw the passing of the more prominent adherents of Stahl's philosophy; of the English chemists, Priestley died in 1804, and Cavendish, who for some years previously had ceased to pursue chemical inquiry, followed him six years later.

Within the first quarter of the century appeared some of the most eminent of those who were destined to consolidate the principles upon which the New Chemistry was founded. Dumas and Wöhler were born in 1800, Liebig in 1803, Graham in 1805, Laurent in 1807, Gerhardt in 1816, Wurtz, Kopp, and Marignac in 1817, Kolbe and Hofmann in 1818, Pasteur in 1822, Alexander Williamson in 1824, and Edward Frankland in 1825. But there was already a generation at work the members of which, although not specially distinguished for their direct contributions to speculative chemistry, yet served by their labours to strengthen the foundations upon which it is based; among them were Wollaston and Davy, born in 1766, and Gay-Lussac, born in 1778. Berzelius, who was born in 1779, first published his electro-chemical theory in 1827. A revolution scarcely less momentous than that of Lavoisier had, moreover, by this time been effected by John Dalton; the enunciation of the atomic theory in 1807–8 wholly altered the aspect of chemistry; henceforth it was brought within the domain of mathematics, and its laws and processes were established on a quantitative basis. It consummated a change which Cavendish may be said to have originated. It can be proved that Cavendish was cognisant of the principles underlying what we term the "law of constant proportion" and the "law of reciprocal proportion"; that he foresaw that the facts embodied in these laws are at the foundation of all quantitative analytical work, and that in his practice he implicitly recognised their truth.

In spite of the widespread political and social disturbance which marked the early years of the last century, a tide in the affairs of chemistry then set in, which, with periods of ebb and flow, reached a high-water mark at the time this journal was founded.

The first two decades of the century not only witnessed the establishment of the fundamental laws of chemical combination and their rational explanation by means of the atomic theory; they also saw the enunciation of the gaseous laws; the discovery and application of voltaic electricity as an analytic agent; the isolation of the metals of the alkalis and alkaline earths; the determination of the nature of the halogens; and the discovery of many new metallic elements. In 1802 these were only twenty-three in number, as against sixty-three at the present time. They saw, too, the discovery of fulminating mercury and fulminating silver, acetylene, carbonic oxide, phosgene—some of which have played a large part in the Great War, but which when first made known were regarded as mere chemical curiosities, incapable of application. This period also saw the invention of the miner's safety lamp and the creation of the gas-lighting industry—two new departures of which it is impossible to exaggerate the consequences, immediate and remote. It witnessed also the discovery of isomorphism, the enunciation of the law of Dulong and Petit, and the first synthesis, by Wöhler, of an organic product.

The third decade brought us Faraday and the discovery by him of tetrachlorethylene and perchlorethane; the liquefaction of the gases; the isolation of benzene; the preparation of naphthalene sulphonic acids; and the formulation of the laws of electro-chemical decomposition. It witnessed also the activity of Graham; the promulgation of the law of gaseous diffusion; the recognition of the basicity of acids and the constitution of salts; the establishment of the doctrine of compound radicals by Liebig and Wöhler; the discovery by Dumas of chlorine substitution and the publication of his theory of types. It saw also the death of Wollaston and Davy, and the birth of Cannizzaro, Berthelot, Kekulé, and Lothar Meyer. The early 'thirties are memorable, too, for the attempts made to regularise chemical notation and for the gradual adoption of the system of Berzelius.

But, with the exception of the work of Graham and Faraday, the decade 1830–40 is not particularly remarkable for British contributions to chemical science. Although the volume of published work was no doubt considerable, it was not of the epoch-making order. As Edward Turner wrote, "the era of brilliant discovery in chemistry appeared to have terminated for the present." Thoughtful men deplored the condition of British science at this period, and they were concerned at the general apathy of the public with respect to it. One result of their action was the foundation, in 1831, of the British Association for the Advancement of Science. At the same time, it cannot be said that Continental workers were much more active. Apart from those already referred to, we find no noteworthy contribution to the theory of chemistry. The extent of the retrogression in this country may be judged from the fact that at this time the number of communications to the various societies, and to scientific periodicals dealing with chemistry, was not much more than half of what it was in 1802.

With the advent of the fourth decade there was a great awakening. It was signalised by the discovery of the first of the organo-metalloid radicals by Bunsen in 1841; the recognition of homology by Schiel in 1842; the early work of Pasteur on racemic acid; the synthesis of acetic acid by Kolbe; the dissociation of water by heat by Grove; the work of Frankland on ethyl and zinc-ethyl; the discovery by Wurtz of the compound ammonias and their synthetical formation by Hofmann; and the elucidation of the constitution of ether and the theory of etherification by Williamson. This decade was further made memorable by the creation, in 1841, of the Chemical Society of London, and by the foundation, in 1845, of the Royal College of Chemistry. At that time organic chemistry was scarcely studied in this country, and schools of practical chemistry were very few in number here. English chemists who sought instruction in operative chemistry and in the methods of original investigation for the most part resorted to Liebig at Giessen or to Wöhler at Göttingen. Liebig soon made his influence felt abroad, and his memorable English tour in 1842 gave a strong stimulus to the study of chemical science in this country. One of its immediate effects was the foundation of the Royal College of Chemistry, with Hofmann, one of Liebig's most brilliant pupils, as its director.

This was the first institution of its kind in Great Britain in which chemistry was studied for its own sake, and not merely as subordinate to other professional training. Space does not permit of any detailed account of its activities, or of the circumstances which led to its absorption into the School of Mines. It is only necessary to recall the names of Warren de la Rue, Abel, E. C. Nicholson, How, Bloxam, Blyth, Price, Rowney, Muspratt, Mansfield, Field, Noad, Brazier, Medlock, Crookes, Spiller, Tookey, Church, Perkin, Groves, Valentin, Vacher, O'Sullivan, Duppa, McLeod, Reynolds, Griess, Holzmann, Martius, Geyger—among the most distinguished of Hofmann's pupils and coadjutors—to indicate the influence he exercised on the development of chemistry in Great Britain during the twenty years of his residence amongst us. That he should have been allowed to depart was nothing short of a national calamity.

As regards British contributions to chemistry during this and the succeeding decade, the most noteworthy may be said to have emanated from the Oxford Street institution. Williamson, however, was still active at University College, and to this period belongs Frankland's recognition, in 1851, of the principle of valency. The synthetic colour industry originated in 1856 from Perkin's discovery of mauve, and Hofmann himself, with other of his pupils, contributed greatly to its development. As regards other workers, notable contributions to chemical theory at about this time were Clausius's work on electrolysis, Deville's studies on dissociation, Couper's conception of atomic linkage, and the resuscitation by Cannizzaro of Avogadro's hypothesis and his demonstration of its sufficiency at the memorable Congress of Karlsruhe in 1860. The introduction of spectrum analysis by Bunsen and Kirchhoff belongs also to this epoch.

NATURE was founded at a time of extraordinary development in chemistry. Kekulé had made known his fruitful conception of the constitution of benzene, and a host of workers, more particularly in Germany, were exploiting with feverish activity the chemistry of the so-called aromatic compounds. The synthetic colour industry received a remarkable impetus by the synthesis of alizarin. Newlands had already adumbrated Mendeléeff's great generalisation, of which the validity seemed to be established by the dramatic discovery, in quick succession, of the new elements it had predicted.

During the fifty years of its subsequent existence this journal has recorded and made intelligible to the general public every notable advance in chemistry. It has witnessed great and fundamental changes in the science. New conceptions have arisen and time-honoured doctrines have been modified or altogether supplanted. Chemical knowledge has been augmented by the inclusion of the theories of stereo-isomerism, desmotropy, the gaseous theory of solutions and free ions, and the Walden inversion. It has had to note and describe the methods of liquefaction of all the so-called permanent gases, and it has seen the universal recognition of the principles, first indicated by Andrews, on which the change of physical state depends. It has chronicled the discovery of argon by Rayleigh, and that of terrestrial helium, krypton, neon, and xenon by Ramsay. It has seen the rise and progress of radio-activity, the isolation of radium and its associates, and the discovery of isotopic elements. Lastly, it has seen a profound change in our conception of the Daltonian atom as an indivisible entity, and a strengthening of our belief in the intimate connection between matter and energy.

Throughout the whole of its existence NATURE has been true to the ideals which it established at its birth, and has been consistently faithful to the traditions it created. It has insisted from the outset that national progress must be based upon new ideas, and that the main source of new ideas is original research. It has shown that the greatest practical realities of our time have originated from the search for truth; that invention waits upon discovery—the most powerful of all agents of civilisation; and that new knowledge means new power. Hence it has with a uniform insistence pointed out that it is the duty of the State, in its own interest, to encourage and foster research and to remove the hindrances which beset the pursuit of science and impede its progress. Nor has its advocacy been based solely on the lower ground of material advantage, or on the fact that original research has proved to be the source of new industries and of wealth—that it creates employment and alleviates labour. It has striven to show that mental and moral progress have a scientific basis—that our knowledge of Nature and the universe, our modes of thought, our criteria of truth, our detection and avoidance of fallacies, are dependent upon that habit of mind we call "scientific"—a habit which can be cultivated and strengthened only by the study and pursuit of science.

It has a record of which it may justly be proud. By the manner in which it has discharged its functions and fulfilled its obligations, it has earned the gratitude of all men of science, and it now celebrates its jubilee with the knowledge that it has merited, and will receive, the unstinted appreciation of all true lovers of science.

CHEMISTRY IN THE MAKING.

By Prof. Henry E. Armstrong, F.R.S.

THE period covered by NATURE happens to be that which just comes within my ken. In chemistry, both pure and applied, it has been one of astounding progress and fulfilment. Frankland and I published our new method of water analysis—involving combustion *in vacuo* with the aid of the Sprengel pump—in the year of its birth: people then ran their sewage into a cesspit and drank the water from an adjoining well. Typhoid fever was rife throughout the land. Bacteriology was an unknown science. Frankland's work on the Rivers Commission gave the nation a pure-water supply and contributed greatly to a complete sanitary system, in this respect placing us ahead of the world. The systematic use of the Sprengel pump dates from our inquiry; Crookes afterwards used it in constructing his radiometers.

It is noteworthy that sulphuric anhydride was a laboratory curiosity at that time: when I prepared several pounds of it, in Leipzig, in the autumn of 1868, I was regarded with wonder: Squire and Messel began its manufacture here at Silvertown in 1873: it soon came into vogue, especially in the alizarin industry. During the war, many thousands of tons have been used in the production of propellants and high explosives. I then also made the chlorhydrol, SO_3HCl, in quantity, and suggested to my student friend, Karl Knapp, Liebig's nephew, that he should test its value as a sulphonating agent. He sulphonated benzene. I took up the work afterwards and first applied it to toluene, so laying the foundation of the method now preferred in manufacturing saccharin.

In 1868 chemists were waxing enthusiastic over Mendeléeff's great generalisation, brought home to us not only in his paper in the *Annalen* but also by Lothar Meyer's well-known book, then recently published, especially by Meyer's justly famed atomic volume curve. At that date those of us who could think in terms of systematic organic chemistry were possessed by the view that the "elements" must be compounds: the "periodic" inter-relationships were so similar to those manifest in homologous and isologous series. Soddy's "isotopes"—the word is unnecessary—are simply the chemist's homologues. That the two leads should be as like as the two Dromios—recent observation shows that they are perceptibly different—is in no way surprising: methane and ethane are all but indistinguishable chemically; we can also foresee isomeric as well as homologous primaries. Now that the "primaries" have been robbed of their position as "atomic" materials, by the appearance on the scene of radium, this view is proved to have been justified; but none of us ever dreamt that they would come to be regarded as made of lumps of electricity—still less that we should ever dare to think of energy in terms of quanta or to discard the doctrine of the other in favour of one of relativity.

All my life, I have regretted the aloofness of chemistry from physics: that the physicist shows so little real interest in chemistry. It is a welcome finish to find him at last entering upon the fringe of our domain and taking up our work, though it is a pity he cannot become one of us instead of a mere extrapolation; probably it cannot well be otherwise, as the mathematical habit of mind is required for the new work and chemist and mathematician are different natures. Ours must be the task of digesting the material to the point at which our mental enzymic machinery no longer suffices and that of the mathematician and physicist comes into play. The two recent lectures to the Chemical Society by Nicholson and Jeans—both astounding displays of eloquence and imaginative power—are demonstrative of the new departure. If fifty years hence the new field be as fully grasped as that has now been which I saw opening up in 1868, NATURE at its centenary will indeed have cause to congratulate its readers.

In 1868, we were only beginning to write $C=12$; our symbolic system was barely stabilised; the importance of Avogadro's theorem was but coming home to us, mainly through Cannizzaro's insistence. Structural constitutional chemistry was in its infancy. Frankland's theory of valency—it is now clear that he included carbon in his scheme—and Kekule's benzene symbol were new weapons; we were only beginning to interpret isomerism in terms of structure; we scarcely thought of position as its cause. A vast edifice has been erected in the interval but the foundations are simple: Frankland's postulates have but been supplemented by van't Hoff's extension of Pasteur's geometric conceptions. What is most noteworthy is the surprising simplicity and sufficiency of the system.

Latterly we have begun to think in terms of solid structure: it is already clear that the next advance will come from the geometric, crystallographic side: and having learnt to see through a brick wall, we are now beginning to peer directly into the molecular structure of crystalline solids. Low temperature phenomena have been probed to their depths, especially in this country; indeed, we have seen a series of important industries grow out of the work.

The growth of our knowledge of method, of our analytic and synthetic powers, has been marvellous—full use has been made of this development by the manufacturer, so that we can now not only reproduce natural colouring matters but match the rainbow in every tint. Although British chemists cannot claim the credit of much of the matching, they can at least rejoice in the fact that the foundations were laid in London—by Faraday's discovery of benzene in 1825, in Albemarle Street; and by Perkin's discovery of mauve, in Oxford Street and at Sudbury in 1856.

It is noteworthy that mauve was made in attempting to synthesise quinine: as we are not yet certain as to the structure of this alkaloid and in no way near to a method of producing it artificially, it is clear that even now our powers of interrogating and copying Nature are but limited: remarkable as our progress has been, she yet defies us in many directions. We stand ashamed before the unassuming ease with which she fabricates starch from glucose underground in the dark; indeed, cane-sugar, starch, cellulose and not a few other compounds of primary importance are still to be ranged with the Delphic mysteries.

But whilst, on the organic side, we have secured a wonderful mastery and the odds in favour of our structural conceptions are many thousands to one—because we have been able to ring the changes so often with success; on the inorganic side, almost complete ignorance prevails—because we have not been able to ring the changes. Thus we cannot say, with any approach to certainty, what is the structure of so simple a substance as sulphuric acid. In this and similar cases probably the clue will come through X-rays.

On the biological side the advance has been very great and it can no longer be said with truth that "Thierchemie ist Schmierchemie"—Emil

Fischer's expression; but physiologists are still far from being sufficiently schooled in our science and progress has been chiefly due to men such as Emil Fischer, who have had sympathy with biological problems and been alive to the fact that it is desirable to walk before running. It is strange that few chemists have biological leanings—but the biological is still further removed than the chemical from the mathematical habit of mind.

The chief feature of progress in later years has been the ongrowth of the physical school. This has had both its advantages and its disadvantages—for whilst we have been led to widen our vision and increase our grip on the philosophy of our subject, we have lost in manipulative skill, as we have given inadequate attention to the development of method and technique. This probably is one of the chief causes of our comparative failure on the industrial side. Though based on analysis, chemistry is mainly a constructive, practical science: our success has been in proportion to the extent to which we have been able to confirm analytic by synthetic results. The man who does always gets ahead of the man who doesn't—of the man who merely seeks to explain; though the latter is often more useful than is supposed in controlling practice. Still it is because fingers and artistry come first in the practice of chemistry, that the chemist proper is not and cannot often be a mathematician. The superior value of the preparative side has been so brought home to us during the war, that it is to be hoped that full attention will now be given to its development.

Our ill-balanced bookish system of examinations is one of the main causes of the incomplete practical training chemists have received of late years; we have yet to teach the real value of books, that they are meant for constant reference; to force students to memorise them is the worst of policies: thoughtful, dextrous fingers and knowledge of materials are the chemist's chief needs.

Much progress has been made, on the physical side, in correlating properties with structure. Also great attention has been paid to the problems of solutions: unfortunately the men who have dealt with this latter side of chemistry have not been working chemists—in fact, scarcely chemists at all—and the pseudo-mathematical treatment they have introduced has often savoured far too much of dogma. The result has been to introduce an unscientific, partial habit of mind into our subject. We are strangely behind in having no proper, accepted theory of chemical change in general. Our elementary text-books too are behind the times—full of half-truths and superficial when not inaccurate: there is no lack of detail but little philosophy and still less logic. Chemistry is the most fundamental of the sciences, the one by means of which it is alone possible to teach the principles and practice of scientific method in their entirety—and yet chemists are rarely trained to be masters of method.

To make chemistry a truly philosophical science, for the guidance of students, we need a man of giant mind, well versed in practice, who will survey and weigh the facts and give sympathetic consideration to all hypotheses, then summarise the situation in broad and simple terms which all can understand. Fitzgerald was a man of the type I have in mind.

Certainly the progress made during the fifty years is astounding—the extent of our collective knowledge is extraordinary. But we must be on our guard—there are too many "bits of chemist" about: the most pretentious member of the species is of modern invention—the "research chemist." No chemist is a chemist who is not fully imbued with the spirit of inquiry. Not a little of the work that is now called research is of a trivial character; the majority are incapable of original effort and far more careful direction of advanced work is required. If care be not taken, "research" will become a word of reproach. The effort of the future must be to produce the whole chemist—the man who will know his subject and be ever careful and modest, both in word and deed, being possessed by scientific method.

THE DISCOVERY OF CHEMICAL ELEMENTS SINCE 1869.

By Prof. H. B. Dixon, F.R.S., and H. Stephen, M.Sc.

A GLANCE at the history of the chemical elements reveals the fact that no fewer than fifty-three of them were recognised so early as 1818, and since that time some thirty more have been discovered. The search for new elements between 1818 and 1869 represents an empirical programme without considerations of marked theoretical interest, and the investigations were directed more particularly to an examination of minerals. The chief results were the isolation of new metallic elements, and the work of the great master, Berzelius, stands out pre-eminently during this period, and his quantitative work surely paved the way for future investigations.

The later period extending over the past fifty years marks out a new era in the history of the chemical elements, inasmuch as it opened with the discovery of the periodicity of the elements in connection with their atomic weights. The elaboration of the system in its final form was due to Mendeléeff in 1869, although Newlands had foreshadowed such a system in his law of octaves (1863).

Mendeléeff's system had a profound effect in bringing about radical changes in respect of the atomic weights of certain elements, notably beryllium, uranium, and indium; and in affording predictions of the existence and properties of new elements, which were confirmed with astonishing exactitude in the cases of scandium, gallium, and germanium.

Another factor which played an important *rôle* in the development of the chemistry of the elements in the early years of this period was the application of the spectroscope by Bunsen and Kirchhoff to chemical analysis, when, by a comparison of the bright lines in the spectra of the vapours of metallic elements with the dark lines in the solar spectrum, they showed that many terrestrial elements exist in the sun. During the last two decades the interest in spectroscopy has revived, and much of the valuable information which we now possess of the intra-atomic structures of the elements is due to the remarkable developments in the construction of diffraction gratings, and in particular the concave gratings of Rowland.

Notwithstanding the great possibilities for research opened up by Mendeléeff's periodic table, the latter remained only slightly modified until 1893, when a period of rapid development and continual progress began. The later discoveries with regard to the chemical elements fall in a remarkable way into three distinct groups: the rare earths, the inactive gases, and the radioactive elements, and it is to be lamented that the pioneers in the two first-named groups have passed away.

Much of our knowledge of the rare earths is due to the late Sir William Crookes, who was the first to advance the conception of the meta-elements—*i.e.* elements which show great resemblance to each other, and have many physical and chemical properties in common, and, in consequence, are not easy to separate. Such in a few words sums up the chief characteristics of the rare earths, which have found so far only a temporary resting place in the periodic table. Apart from their purely academic interest and the high degree of accuracy attained in their separation, the rare earths have found important technical application as catalytic agents and in the manufacture of the modern incandescent mantle. Our knowledge of them, however, remains in many respects incomplete.

Of the second group, the inactive gases, we possess a more complete history of their chemistry, due in no small measure to the brilliant achievements of Lord Rayleigh and Sir William Ramsay, who were the first (1894) to characterise the inert gas argon in the atmosphere, and so confirmed the almost forgotten work of Cavendish more than a century before. The discovery of helium in cleveite by Ramsay followed shortly after that of argon; his attention had been directed by Miers to Hillebrand's discovery of nitrogen in the mineral uraninite—and gas-containing minerals seemed to be a possible storehouse of condensed argon. He sought for argon and found helium, the presence of which in the sun's atmosphere had been detected by Lockyer twenty-five years before.

The proof that helium was an inert monatomic gas like argon led to many speculations as to the position of these new elements in the periodic system. Ramsay predicted the existence of another inert gas between, and forming a "triad" with, helium and argon, having an atomic weight between that of fluorine (19) and that of sodium (23), and he and his fellow-workers deliberately hunted for the missing element. They found it in the atmosphere, but besides the gas they sought—neon (20)—they also isolated the heavier elements krypton and xenon. All the inactive gases are colourless; they form no chemical compounds, and are monatomic. They have definite boiling points, give characteristic Geissler-tube spectra, and occupy a unique position in the periodic table—the neutral points in Crookes's descending figure of eight.

The last group of elements to be discovered include the remarkable and interesting series of radioactive elements, which originated in the discovery of radium by Mme. Curie in 1898. The development of this field of research has produced a profound effect upon chemical theory and given us entirely new conceptions of the structure and nature of the atom, foremost among which is the nuclear atom proposed by Sir E. Rutherford, and recently modified by Prof. Bohr.

The chief interest of the radioactive elements centres round two elements of highest atomic weights, uranium and thorium, which are continually decomposing into a series of other elements at definite rates over which we have at present no control. These new elements in a similar way undergo spontaneous changes into still another series of elements. Accompanying these changes in both cases there is a high-speed emission of three distinct kinds of rays, now designated the α-, β-, and γ-rays respectively. The first-mentioned have been identified as electrically charged atoms of helium, and it is now believed that all radio-elements are built up of lead and helium, a conclusion reached by Rutherford and others, and thus after the lapse of a century the hypothesis advanced by Prout (1815), concerning the existence of a primordial substance, makes a reappearance in modern guise.

The majority of the elements formed in the transformations associated with uranium and thorium (which are the progenitors of a long line of descendants) have not as yet been obtained in a pure condition, and are characterised at the present time solely in connection with radioactive properties. Two substances, radium and niton—the gaseous emanation from radium—have been definitely described, and their atomic weights and positions in the periodic table fixed. Niton belongs also to the group of inactive gases; its existence is transitory, since the gas disappears after a few days, during the course of which radioactive disintegration takes place. Its atomic weight being 222, four units less than radium, the difference is attributed to the loss of a helium atom from radium.

Based on a consideration of their researches, Rutherford and Soddy have formulated a theory of atomic disintegration (1902) in connection with which Soddy has recently introduced the term *isotope*, by which he defines very closely related elements which are chemically inseparable but have different atomic weights. The non-separability of isotopes by chemical methods has recently been confirmed by Richards and his co-workers, who found that the atomic weight of lead obtained from Australian carnotite (containing uranium-lead) was unaltered even after the nitrate into which the lead was converted had been subjected to more than a thousand fractional crystallisations. Furthermore, Richards has determined the atomic weight of uranium-lead, and the number found (206·08) is less by as much as 0·25 per cent. than that of ordinary lead, which differs from it in other physical properties involving weight. It is possible that lead descended from thorium (208) and lead descended from uranium (206) have enough in common to be each called lead, but are varieties or isotopes of the same element, common lead (207·2) being a mixture of the two.

We may conclude, therefore, that in radioactive substances there is a continual transformation of one element into another of lower atomic weight, such transformation (apparently quite independent of temperature and external electrical conditions) being accompanied by the liberation of enormous amounts of energy, compared with which the magnitudes of energy of chemical reactions fade to insignificance. Has the earth passed through its element-building epoch? Instead of spinning "for ever down the ringing grooves of change," are we mounting backwards up the spiral as our larger empires of matter disintegrate into smaller and perhaps more stable states?

Just as the beginning of the last half-century was marked by the epoch-making discovery of the periodic system of the elements, so in effect is the close of it marked with another—namely, Moseley's discovery of the atomic numbers of the elements, the importance of which we have as yet scarcely realised.

The atomic number of an element as suggested by van der Broek defines the place-number occupied by the element in the periodic table, and at the same time is the number of electrons in the atom or nuclear charge of it. Moseley showed from a spectroscopic examination of the frequencies of characteristic X-rays emitted when X-rays bombard anticathodes of various metals, that the square roots of the frequencies are proportional to the atomic numbers. The latter are known for all elements up to uranium—thus, hydrogen one, helium two, lithium three, and so on until finally uranium 92, and the anomalies which appear in Mendeléeff's table disappear, as in all cases the correct chemical order is maintained. The atomic numbers appear to be even more fundamental than the atomic weights.

PHYSICAL CHEMISTRY—PAST AND PRESENT.

By Prof. J. C. Philip, F.R.S.

THE cultivation of the border-lands between the various sciences, so actively prosecuted in the last few decades, has nowhere led to more notable results than on the frontiers of physics and chemistry. This particular field of investigation, covering phenomena in some measure common to both these sciences, has gradually taken shape, and has attracted crowds of workers, keen to apply the exact methods of physics to the wealth of problems and material presented by chemistry. With the passing of the years physical chemistry has ultimately emerged as a definite branch of natural knowledge, full of intrinsic interest, but comprising also much that is of value for other sciences.

Fifty years ago the foundations of physical chemistry had to some extent been already laid. Faraday's experiments on electrolysis and the liquefaction of gases, Graham's observations on gaseous and liquid diffusion, and Hittorf's investigations of electrolytic migration had been put on record, although in some cases, notably the last-mentioned, the full significance of the work was not to be realised for many years to come. Avogadro's hypothesis and the kinetic theory were also before the scientific world, and the Brownian movement of minute particles suspended in water, destined ultimately to figure so prominently in the physical chemistry of recent years, had been not only recorded but, for the time, forgotten.

During the period in which NATURE first appeared, new methods of investigating chemical change, and new conceptions of chemistry as a quantitative science were being developed. The work of Harcourt and Esson, of Guldberg and Waage, on the action of mass as a factor in equilibrium and velocity, as well as Horstmann's application of thermodynamics to chemistry, inaugurated a new epoch, with which, in both directions, the name of van't Hoff was afterwards so brilliantly associated. It was van't Hoff who put the science of chemical dynamics on a secure experimental basis, and thus prepared the way for a rational study of catalysis, a particular development of vital significance for the growth of important chemical industries. It represents part of the contribution which physical chemistry has made to the advance of chemical knowledge from the purely descriptive to the rational and quantitative stage.

Appreciable progress towards the recognition of physical chemistry as a distinct branch of knowledge resulted, at a somewhat later date, from van't Hoff's study of osmotic pressure, and his extension of the gas laws to solutions. This remarkable work was followed, at a short interval, by Arrhenius's hypothesis of electrolytic dissociation, a conception that has left its mark deep on the physico-chemical research records of the past thirty years. This hypothesis has been the guiding principle in countless investigations, and although it presents difficulties not yet satisfactorily solved, and appears to require modification in some respects, notably in regard to the *rôle* of hydration, it holds the ground to-day as the most acceptable and intelligible interpretation of the properties of electrolyte solutions. The history of the electrolytic dissociation theory may be fairly described in Larmor's words: "In the case of every successful scientific theory the time must come when its first easy triumphs become exhausted, and what prominently confronts the investigator are its outstanding defects and difficulties." Such is the present position in regard to the ionisation theory, and during recent years there has been a concentration of effort on such outstanding problems as the application of the mass action law to strong electrolytes, the catalytic action of ions, and the differences existing between the values of the ionisation ratio deduced for one and the same electrolyte by the osmotic and conductivity methods respectively.

The decade in which the theories of van't Hoff and Arrhenius were propounded saw also the establishment of the first journal exclusively devoted to the record of physico-chemical research. The first number of the *Zeitschrift für physikalische Chemie* appeared in 1887, and an inspection of the early volumes reveals the extraordinary variety and attractiveness of the problems that were being attacked under the ægis of the new science, and on the more definitely quantitative lines for which this branch of chemistry stands. It was not long before the influence of physical chemistry began to be apparent beyond its own borders in a renascence of inorganic chemistry which continues to the present day. Important reactions between well-known substances, regarded as completely worked out, have been explored afresh in the light of physico-chemical principles, and have yielded an extraordinary amount of valuable quantitative data. In this connection one might refer to the phase rule and its practical utility in connection with the conditions of existence of salt hydrates, the constitution of alloys, and various technical problems.

Prominent among the later developments of physical chemistry has been the examination of matter in a condition coarser than that corresponding with the molecular state. The study of mechanical suspensions, and the investigation of colloidal solutions with the aid of the ultramicroscope, have opened up a whole new world of fascinating phenomena, and bridged the gap between the visible particle and the molecule. Perrin's epoch-making count of the particles at different levels in a vertical column of a mechanical suspension, and the evaluation of the Avogadro constant which follows therefrom, have notably extended the validity of the gas laws, and supplied at the same time definite quantitative proof of the molecular movements postulated by the kinetic gas theory. Of extraordinary interest also in this connection is the fact that purely physical evidence, based on the atomic character of electricity and depending on measurements of the elementary electric charge, gives strong support to the Avogadro conception.

At the present moment fresh means of attacking the still unsolved problems of the physico-chemical field are being developed. Planck's quantum theory, for example, coupled with such experimental work as that on the heat capacity of solids at low temperatures, and on the origin and relationship of spectral lines, appears likely to have a notable influence on the future of physical chemistry. The thorough investigation of colloids along physico-chemical lines, which is actively proceeding to-day, promises to throw light on many problems which are of interest not only from the purely scientific point of view, but also to the industrial chemist. The sister sciences, too, are vitally concerned in the exploitation of this field, and, indeed, the physical chemist of to-day may point with legitimate pride to the fact that the principles of his science are welcomed by the metallurgist, the physiologist, the geologist, and others, as valuable aids in the elucidation of their respective problems. This ever-widening influence is the guarantee of the future vitality of physical chemistry.

THE INFLUENCE OF INVESTIGATIONS ON THE ELECTRICAL PROPERTIES OF GASES ON OUR CONCEPTIONS OF THE STRUCTURE OF MATTER.

By Sir J. J. Thomson, O.M., Pres. R.S.

All workers in science owe much to Nature, and so I am glad to comply with the request of its Editor to write a few words on the progress of some branch of physics in the fifty years since Nature was started. I shall confine myself to the effect which results obtained by investigations on the electrical properties of gases have had on our conceptions of the structure of matter and the potentiality of further applications of these results to increase our knowledge of physical and chemical problems. In these investigations we study atoms and molecules when they are charged with electricity, and the success which has been obtained is due in the main to the fact that the methods by which we can detect the existence and follow the behaviour of these charged particles are almost infinitely more powerful than those which are available when the particles are uncharged. We can by the aid of their charges detect the presence of a few thousand atoms, while the most delicate methods of chemical analysis will scarcely detect a million million. Again, when an atom or molecule is charged we can by acting upon it by electrical forces increase its energy a million-fold, and thus enable it to produce effects by which its presence can be detected. We obtain in this way very powerful and accurate methods for measuring some of the fundamental constants associated with atoms and molecules. We know now, for example, with great precision the masses of the molecules of the different gases; we owe this to the study of their electrical properties.

Again, the study of the positive rays has shown that all the atoms of an element have to a very high degree of approximation the same mass, and has disposed of the idea that the atomic weight only represented an average value taken over a considerable range. The positive rays, too, have demonstrated the existence in most gases of both atoms and molecules; not only have they shown that atoms exist, they have also proved the independent existence of the radicles of organic chemistry such as CH, CH_2, CH_3. These rays will, I think, in the future play a considerable part in the determination of the atomic weight of those elements which can exist in the gaseous form, as they furnish a method which is independent of impurities, and can distinguish between "isotopes," should such exist. The rays provide a powerful method for detecting new elements and compounds, as they demand only an infinitesimal amount of material and the atomic weight of the new body can be calculated at once from the position of its line in the positive ray spectrum. As a side issue the rays show the complexity of the conditions when electricity passes through compound gases. I have found cases in which there were as many as thirty-seven different types of positive carriers at work simultaneously.

The convection of negative electricity presents a remarkable contrast, for one of the most striking results of the study of the electrical properties of gases is that at very low pressures the carriers of negative electricity are not atoms or molecules, but electrons, the mass of which is only about 1/1700 of that of the smallest known atom, that of hydrogen; these carriers are unaltered in character whatever changes may take place in the nature of the gas through which the electricity is passing. These electrons can be obtained from atoms of every kind, so that they form an integral part of the normal atom. The number of electrons in an atom which are not fixed too rigidly to be shaken when struck by Röntgen rays has been determined, and it has been found that the number of such electrons in an atom of any element is equal to the atomic number of the element. The positive rays show that the atoms of elements other than hydrogen which occur in these rays must contain more than one electron, for atoms which have lost two or more electrons are a common feature in these rays; mercury atoms have been observed which have lost as many as eight electrons. The speed which the electrons may attain is very great; some of the electrons emitted by radio-active substances (the β-rays) travel at a speed only a few per cent. less than that of light.

The source of the mass of the electrons is interesting; it was known before they were discovered that a charged body had in virtue of its charge a larger mass than an uncharged one, the difference increasing as the size of the body diminished. The result at that time looked very academic, as even molecules were far too large for the effect to be appreciable; the result became of practical importance when electrons (the linear dimensions of which are only about one-hundred-thousandth part of those of atoms) were discovered; and the experiments indicate that the whole of the mass of an electron is due to its charge. Mass of this kind depends upon the velocity and becomes infinite when the velocity is that of light. The mass of the electrons accounts, however, for only a minute fraction of that of the atom of which they form a part.

Since we know the number of electrons in an atom, the problem of finding the structure of the atom is that of finding the configuration of these electrons when they are in equilibrium under their mutual repulsions and whatever forces may be exerted upon them by the positive charges. The solution of this problem would give representations of the structure of the atoms of the various elements. The consideration of the positions of equilibrium when two such atoms of the same or different kinds are brought near together would lead to clear views as to what constitutes chemical combination and the conditions under which it is possible. This is one of the problems which call most urgently for solution. It must be noticed, however, that we cannot explain the properties of the atoms of the elements by a system of positive and negative point charges exciting forces varying inversely as the square of the distance. These would not give rise to systems of atoms sharply limited to definite and distinct types, but to systems passing continuously from one type to another. To get the requisite definiteness in the model atom we must introduce some other condition, such, for example, as that the force between the positive and negative forces is not always an attraction varying inversely as the square of the distance, but that it changes from attraction to repulsion at definite distances (such distances giving a length to measure the size of the atom), or we may assume some condition such as is imposed by the quantum theory, which rules out all but a small fraction of the solutions otherwise possible.

RADIUM AND THE ELECTRON.

By Sir Ernest Rutherford, F.R.S.

WHEN we view in perspective the extraordinarily rapid progress of physics during the last twenty-five years, we cannot fail to be impressed with the great significance to be attached to the discovery of X-rays by Röntgen in 1895, not only from its intrinsic interest and importance, but also from the marked stimulus it gave to investigations in several directions. In fact, this discovery marks the beginning of a new and fruitful epoch in physical science, in which discoveries of fundamental importance have followed one another in almost unbroken sequence.

It does not fall within my province to discuss the great advances in our knowledge that have followed the close study of this penetrating type of radiation, but to indicate, I am afraid very inadequately, the progress in two other directions of advance which were opened up by the discovery of X-rays, and have revolutionised our ideas of the nature of electricity and the constitution of matter.

Following Röntgen's discovery, attention was concentrated on two aspects of the problem. On the one side it was thought that the excitation of the X-rays might be connected with the phosphorescence set up in the glass of the discharge tube by the impact of cathode rays, and experiments were consequently made by several observers to test whether substances which phosphoresced under ordinary light emitted a type of penetrating X-rays. By a fortunate combination of circumstances, H. Becquerel in 1896 tried the effect of a phosphorescent uranium salt, and this led to the discovery of the emission of a penetrating type of radiation, and thus laid the foundation of the new science of radioactivity, the further development of which has been attended by such momentous consequences.

On the other side, the problem of the nature and origin of the X-rays led to a much closer study of the cathode rays and to the definite proof, as Sir William Crookes had long before surmised, that the cathode rays consisted of swift charged particles of mass small compared with that of the hydrogen atom. It was soon shown that these corpuscles of small mass or negative electrons, as they are now termed, could be set free by a variety of agencies, by the action of ultra-violet light on metals and copiously from glowing bodies, while they were ejected with high speed spontaneously from the radioactive bodies.

The interpretation by Lorentz of the Zeeman effect in which the spectrum lines were displaced by placing the source of light in a magnetic field showed that electrons of the same small mass were present in all atoms, and that their vibrations constituted visible light. Sir J. J. Thomson early pointed out the significance of the electron as one of the units of atomic structure and its importance in the mechanism of ionisation in gases, and the rapid growth and acceptance of electronic ideas owes much to his work and teaching. An important stage in advance was the proof by Kaufmann that the mass of the electron was entirely electrical in origin. Sir J. J. Thomson had shown in 1881 that a charged particle acquired additional or electrical mass in virtue of its motion. The variation of mass with speed has been shown to be in accord with general theory, but is in best agreement with the formula based on the theory of relativity. It would be of great interest to compare theory with experiment for the highest attainable speed of the electron from radium which is so near to the velocity of light that the variation of mass with velocity is very rapid.

The proof that the electron was a disembodied atom of negative electricity was a great step in advance in electrical ideas. Information as to the nature of positive electricity is far less precise and definite, for no positive electron, the counterpart in mass of the negative electron, has ever been observed. In all experiments with positive rays and with radioactive transformations where the processes are very fundamental in character, no positive charge has ever been found associated with a mass less than that of the atom of hydrogen. While it is well to keep an open mind on this fundamental question, the evidence as a whole suggests that there is an essential difference in mass between the carriers of positive and negative electricity. In fact, such a difference seems to be essential to fit in with our knowledge of the structure of atoms. The nucleus of the lightest atom hydrogen may prove to be the positive electron and its much greater mass than that of the negative electron would then be ascribed to the greater concentration of the electrical charge in the former.

From consideration of the passage of electricity through gases, it had long been surmised that electricity, like matter, was atomic in character. The study of the deflection of the cathode rays and α-rays in magnetic and electric fields showed that the carriers of each type had all the same charge, and the atomic nature of electricity was implicitly assumed by all workers. Townsend showed that the charge carried by the ions in gases was equal to the charge carried by the hydrogen atom in the electrolysis of water and made the first measurements of this fundamental unit. Other methods of attack were developed by Sir J. J. Thomson and H. A. Wilson, and by a skilful adaptation of methods Millikan was able to demonstrate in a very direct way the unitary nature of electricity and to measure the value of the unit charge, probably the most important and fundamental constant in physics, with an accuracy, it is believed, of one in a thousand. By combining the value of this constant with electrochemical data, the number of molecules in a cubic centimetre of gas and the mass of the atoms can be deduced with equal accuracy. The convincing proof of the atomic nature of electricity and the accurate measure of the fundamental atomic and molecular magnitudes are two of the greatest triumphs of the new era.

One of the most important properties of X-rays is their power of making gases a temporary conductor of electricity. The study of this small conductivity led to a clear idea of the transfer of electricity through gases by means of charged ions, and the nature and difference of the positive and negative ions have been closely studied. The proof by Townsend of the production of ions by collision in electric fields opened up a new field of investigation and gave us for the first time a clear idea of the processes leading up to an electric spark. The ionisation theory was found to explain the conductivity produced by radium rays and the conductivity of flames. The laws controlling the escape of electricity from glowing bodies were closely examined by H. A. Wilson and O. W. Richardson.

It is a striking fact that these purely scientific researches on the conductivity of gases, which had their inception in the Cavendish Laboratory, and appeared at first to have only an academic interest, should so soon have resulted in important practical applications. We may instance the use of a hot filament in a low vacuum as a rectifier of alternating currents and a detector of electrical waves. The supply of electrons from a glowing filament coupled with the generation of ions by collision has led to the production of powerful electric oscillators and amplifiers for magnifying minute currents to any desired degree. These amplifiers have not only been of great service in war, but have also rendered possible radiotelephony across the Atlantic. Last, but not least, we have the invention of the Coolidge X-ray tube, which has played such an important part in research and in radiography.

While the mechanism of ionisation of gases by X-rays and radium rays and the transfer of electricity in ordinary electric fields is in the main well understood, it is a striking fact that the passage of the disruptive discharge through a vacuum tube, which was the starting point of so many discoveries, is still almost a mystery. While no doubt some of the main factors involved in the discharge are known, the phenomena in gases at low pressure are so complex that we are still far from a complete elucidation of the problem. This complexity is well instanced, for example, by the sign and magnitude of the charges communicated to atoms and molecules in the positive rays, which have been so closely studied by Wien and Sir J. J. Thomson, and in the hands of the latter have given us a very delicate method of chemical analysis of gases in a discharge tube.

The discovery of the electron as a mobile constituent of the atom of matter has exercised a wide influence on electrical theory, and has been the starting-point of attack on numerous electrical problems. In these theories the electron may be considered as a point charge with an appropriate mass associated with it, and in many cases no assumptions as to the nature and constitution of the electron itself are involved. One of the first problems to be attacked was the passage of electricity through metals where it was supposed that the negative electrons are continuously liberated from the atoms, and are in temperature equilibrium with the matter. While the theories as initially developed by Drude and Sir J. J. Thomson have been instrumental in accounting for a number of relationships, they are unsatisfactory on the quantitative side. These difficulties have been enhanced by the recent discoveries of Kamerlingh Onnes of the supra-conductivity of certain pure metals at very low temperatures and the marked departure from the law of Ohm under certain conditions. As in the case of the theory of radiation, it may be necessary for an ultimate explanation to introduce the ideas of quanta as recently proposed by Keesom. Langevin has applied the electron theory to the explanation of magnetism and diamagnetism, but there are still many difficulties. The suggestion, first proposed by Weiss, that there exists a natural unit of magnetism called the magneton, analogous in some respects to the atom of electricity, still lacks definite confirmation.

In this brief review reference can be made only to the apparently insoluble difficulties in the explanation of the facts of radiation brought to light in recent years, and to the application of the theory of quanta which has had such a large measure of success in many directions.

Radioactivity.

The rapid growth of the subject of radioactivity after the discovery by Becquerel of the radiating power of uranium was greatly influenced by the discovery and isolation of radium in 1899 by Mme. Curie, for the radioactive properties of this element were on such a scale of magnitude that they were difficult to explain and still more difficult to explain away. The systematic chemical analysis of uranium ores disclosed the presence of new radioactive substances like polonium and actinium, while the study of thorium, radium, and actinium disclosed the emission of radioactive emanations or gases and their apparently remarkable power of conferring temporary activity on all bodies in their neighbourhood. The changes in activity of these substances with time and the different types of radiation emitted at first gave an appearance of great complexity and confusion to the rapidly accumulating mass of facts, but the whole subject took on an orderly and systematic development after the transformation theory was put forward by Rutherford and Soddy in 1903 as an explanation of radioactivity. On this view radioactive matter is undergoing spontaneous transformation of its atoms with the appearance of a succession of new radioactive bodies, each marked by characteristic chemical and radioactive properties. The radiations accompany the transformation of atoms and are a measure of the rate of transformation. Guided by this theory, the whole sequence of changes in the uranium-radium series, the thorium and actinium series, were investigated in detail, and in a remarkably brief space of time more than thirty new radioactive elements were brought to light and their position in the scheme of radioactive changes determined. Special interest attaches to the discovery by Boltwood of the substance called ionium, which is directly transformed into radium. This afforded a direct experimental method of determining the average life of radium with a result that is in close accord with the value calculated from the rate of emission of α-particles. The position of actinium in the main scheme of changes has occupied much attention. The constancy of the relative amount of actinium and uranium in uranium minerals showed that it must be derived ultimately from uranium, but the activity of actinium is too small to be in the direct line of succession. This has led to the view that actinium is a branch product at some point of the uranium series where about 6 per cent. is transformed into the actinium branch and 94 per cent. into the main line of descent. The general evidence indicates that this branching occurs near to uranium, and possibly the branch product called uranium-Y by Antonoff is the first member of the family. Recently the intermediate parent substance of actinium itself has been discovered.

While in the majority of cases the atoms of a radioactive product break up in a very definite fashion and in only one way, certain cases are known where one substance breaks into two chemically distinct substances. Examples of this are: radium C, thorium C, and actinium C. Usually the transformation is mainly in one direction with a small fraction in the side branch. It is quite probable that further study may lead to the discovery of a number of such dual transformations. In the violent cataclysm that must accompany the transformation of an atom, it is not unexpected that the constituents of the residual atom may arrange themselves in more than one configuration of temporary equilibrium.

Much attention has been directed to the properties of the radium emanation—the radioactive gas constantly produced by the transformation of radium atoms. The equilibrium volume of this gas from one gram of pure radium is only six-tenths of a cubic millimetre, but contributes more than three-fourths of the total activity of radium. By concentration of purified emanation into fine glass tubes, very powerful sources of radiation have been obtained, which have proved of great utility both in the laboratory and for therapeutic purposes. Although only about one-tenth of a cubic millimetre of purified radium emanation has ordinarily been available for experiments, methods have been devised to determine its spectrum, molecular weight, freezing and boiling points.

We owe to Hahn the discovery of two fairly long-lived products of thorium called mesothorium and radiothorium. The mesothorium, which is separated with the radium from ores containing both thorium and uranium, is transformed into radiothorium. These products can be obtained of activity greater than radium for equal weights, and give us another source of powerful radiation.

The discovery of the production of helium from radium by Ramsay and Soddy was of great importance in emphasising the reality of the transformations occurring in radium. Rutherford showed that the α-rays which are shot out from radium consist of positively charged atoms of helium so that all radioactive substances which emit α-rays give rise to helium. The production of helium by radioactive substances explains the occurrence of large quantities of helium in uranium and thorium minerals, and indeed the prediction by Rutherford and Soddy that helium would prove to be a product of radioactive transformation was based in part on this fact.

The great majority of radioactive substances are transformed with the expulsion of helium atoms with great velocity, but in a few cases swift electrons appear. The appearance of helium in so many changes, coupled with the observation that many of the atomic weights of many known elements differ by four units—the atomic weight of helium—indicates that helium must be one of the secondary units of which many of the ordinary elements are built up. It is noteworthy that so far no definite evidence has been obtained that hydrogen is a direct product of radioactive transformation, although its complete absence would be very surprising.

The proof by the Curies of the rapid and continuous emission of heat from radium showed clearly the vast amount of energy that must be stored up in radioactive matter and released by its transformation. This heat emission has been shown to be a secondary effect of radioactivity, for it is a measure of the energy of the expelled radiations, the greater part being due to the energy of the expelled α-particles.

The transformation of an atom is the result of an explosion of intense violence in which a part of the atom, whether a helium atom or an electron, is shot out with great speed. In order to produce α-, β-, or γ-rays of equal energy to those emitted by radioactive substances, potential differences of about two million volts applied to a vacuum tube would be necessary. These spontaneous radiations have been of great utility in studying the ionisation, scattering, and other properties of particles moving at high speed, while in the very penetrating γ-rays we have a type of X-rays of much shorter wave-length than can be produced at present or is likely to be produced by laboratory methods.

The properties of the α-rays have been very closely studied and their speed and mass have been determined accurately. The definiteness of the range of α-particles, to which Bragg first directed attention, is a matter of remark, and so far the apparent disappearance of the α-particle while still moving with a high velocity has not been adequately explained. The analysis of the β-rays has disclosed the presence of groups of electrons emitted at a definite velocity, so that the pencil of β-rays deflected in a magnetic field shows a veritable magnetic spectrum. The presence of these groups of β-rays appears to be connected with the emission of characteristic X-radiation from the atom, and the evidence as a whole strongly supports the view that the γ-rays from radioactive substances, like the X-rays from a vacuum tube, contain rays of a wide range of frequency in which the characteristic rays from the atom predominate.

Space does not allow me to do more than mention the extraordinary delicacy and definiteness of the electrical methods devised for measuring minute quantities of radioactive matter. By their aid the chemical properties of the numerous radioactive elements have been studied and their position in the periodic table established. The orderly sequence of changes in the chemical properties of successive elements in the radioactive series has been shown to be intimately connected with the type of radiation, whether α- or β-ray, emitted by the preceding element. One of the most important fruits of these chemical investigations has been the proof of the existence of non-separable elements, named isotopes by Soddy, which are identical in ordinary physical and chemical properties, but have different atomic weights. In the case of lead, six isotopes are already known which differ from one another either in atomic or radioactive properties. On the nucleus theory of the atom, this indicates that the charges on the nuclei are the same, but that the masses differ. The proof of the presence of isotopes promises to open up a new and very fundamental field of chemical inquiry which must inevitably exercise a great influence on atomic weight determinations and also on our ideas of atomic constitution. In a recent letter to this journal Merton has indicated that the minute change in the wave-length of spectrum lines of isotopes may give us a simple method of attack on this problem.

While the subject of radioactivity belongs in essence to the border-line of physics and chemistry, with affiliations to both sciences, it has had numerous connections with other fields of work. The examination of the earth's crust has shown that radioactive matter is very widely distributed, and has disclosed, notably through the work of Strutt and Joly, that the heating effect due to this matter vitiates to a large extent the old arguments of the duration of the earth's heat. While showing that the old views are not tenable, radioactivity has at the same time supplied new methods of estimating the age of minerals and the duration of geological epochs. The minimum age of minerals can be deduced from the helium accumulated from the transformation of radioactive matter, and the maximum age from the accumulated lead which is the product of both uranium and thorium. Now that the atomic weights of the lead isotopes are well established, the atomic weight of the lead in a uranium mineral should serve as a definite guide to the fraction of lead present which is due to the transformation of uranium and thus give a trustworthy estimate of the age of the mineral. Joly has demonstrated in a striking way that the pleochroic haloes observed in mica are of radioactive origin, and he has also estimated their age. The presence of radioactive matter in the atmosphere has been shown to account for its electrical conductivity. Just before the war, evidence was obtained indicating the presence of a very penetrating type of γ-radiation in the upper atmosphere. It is to be hoped that soon a further study will be made to determine the nature and origin of this interesting radiation. Finally, numerous investigations have been carried out to determine the effects of the radioactive rays on living tissue and on the growth of plants and organisms. With the increased use of radium for therapeutic purposes, it is likely that our knowledge of this important field of inquiry will grow rapidly.

It is a matter of remark that while the study of radioactivity has disclosed in a striking way the transformation of heavy atoms through a long series of stages, it has at the same time provided us with indubitable proof of the correctness of the old atomic theory of matter. The electric method devised by Rutherford and Geiger of counting single α-particles allows us to count the total number of α-particles projected from one gram of radium per second. By determining the volume of helium produced by the collected α-particles, we have a simple and direct method of determining also the number of molecules in a cubic centimetre of helium at standard pressure and temperature. This number is in good agreement with the number found by Millikan by measuring the charge on the atom of electricity. On account of the great energy of motion, a single α-particle can be detected in a variety of ways, by the electrical method, by the scintillations produced in zinc sulphide or the diamond, and by its action on a photographic plate.

The most striking proof of the individuality of the electron, the α-particle, and the ion has been given by C. T. R. Wilson by his beautiful photographs showing the trails of α- and β-particles through gases. By a sudden expansion, each charged ion produced by the flying particle is rendered visible by becoming the centre of a visible drop of water. In the case of the swift electron, the number of ions per centimetre of path is so small that the number may be directly counted. These photographs bring out in a vivid and concrete way the phenomena accompanying the passage of ionising types of radiation through gases, and are, in a sense, the ultimate court of appeal of the accuracy of theories of the properties of these rays.

The discovery of the electron and of the property of radioactivity has given a great stimulus to attempts to deduce the structure of the atom itself, and numerous types of model atoms have been proposed. The great difficulty in these attempts is the uncertainty of the relative importance of the *rôle* played by positive and negative electricity. In the model atom proposed by Sir J. J. Thomson the electrons were supposed to be embedded in a sphere of positive electricity of about the dimension of the atom as ordinarily understood. Experiments on the scattering of α-particles through large angles as the result of a single collision with a heavy atom showed that this type of atom was not capable of accounting for the facts unless the positive sphere was much concentrated. This led to the nucleus atom of Rutherford, where the positive charge and also the mass of the atom are supposed to be concentrated on a nucleus of minute dimensions. The nucleus is surrounded at a distance by a distribution of negative electrons to make it electrically neutral. The distribution of the external electrons on which the ordinary physical and chemical properties of the atom depend is almost entirely governed by the magnitude of the positive charge. The experiments by Marsden and Geiger on the scattering of the α-particles, and also on the scattering of X-rays by Barkla, show that the resultant units of charge on the nucleus of an element is about equal to its atomic number when arranged in order of increasing atomic weight. Strong proof of the correctness of this point of view has been given by the work of Moseley on the X-ray spectra of the elements, for he has shown that the properties of an element are defined by a whole number which changes by unity in passing from one element to the next. It is believed that the lightest element, hydrogen, has a nuclear charge of one, helium of two, lithium of three, up to the heaviest element, uranium, of charge 92.

Radioactive evidence indicates that the nucleus contains both positively charged masses and negative electrons, the positive charge being in excess. Apart from the difficulty on the ordinary laws of electric forces of explaining why the nucleus holds together, there is a fundamental difficulty of accounting for the stability of the external electrons on the ordinary laws of dynamics. To overcome this difficulty, Bohr has applied the quantum theory to define the position of the electrons and to account for the spectra of the lighter atoms and has made suggestions of the structure of the simpler atoms and molecules. Space does not allow me to discuss the important developments that have followed from Bohr's theory by the work of Sommerfeld, Epstein, and others. The generalised theory has proved very fruitful in accounting in a formal way for many of the finer details of spectra, notably the doubling of the lines in the hydrogen spectrum and the explanation of the complex details of the Stark and Zeeman effects. In these theories of Bohr and his followers it is assumed that the electrons are in periodic orbital motion round the nucleus, and that radiation only arises when the orbit of the electron is disturbed in a certain way. Recently Langmuir, from a consideration of the general physical and chemical properties of the elements, has devised types of atom in which the electrons are more or less fixed in position relatively to the nucleus like the atoms of matter in a crystal. It appears necessary, in Langmuir's theory, to suppose that electrons, in addition to their electrical charges, are endowed with the properties of a magnetic doublet, so that at a certain distance the forces of attraction and repulsion between two electrons counterbalance one another.

The whole question of the possible arrangements and motion of the external electrons in an atom or molecule still remains a matter of much doubt and speculation. While there are strong indications that the conception of the nucleus atom is in the main correct, we are still very uncertain of the laws controlling the position of the external electrons on which the ordinary physical and chemical properties depend. The study of the light spectra and also of the X-ray spectra already promise to throw new light on this very difficult but fundamental problem.

From the above hurried survey of the progress of atomic physics, it will be seen that the investigations of the past twenty-five years have dealt mainly with three great outstanding problems, viz., the nature of electricity, the structure of the atom, and the nature of radiation. While great additions have been made to our knowledge of these questions leading to a much wider outlook, we cannot but recognise that much still remains to be done before we are certain that we are building on a firm foundation for the future. Notwithstanding the prolonged halt during the war, the scientific outlook is one of good augury for the immediate future, and there is every prospect that the vigorous attack on these outstanding problems will be continued.

ATOMS AND MOLECULES.

By PROF. FREDERICK SODDY, F.R.S.

IT may be doubted whether, fifty years ago, chemists and physicists believed very deeply in the actual reality of the molecules and atoms, which they used as convenient and simplifying conceptions to interpret the behaviour of matter. The half-century, indeed, has not passed without strong protest from the thermodynamical school of physical chemistry that the science should be so wedded to pure hypotheses and unverifiable assumptions, then, apparently, for ever beyond the power of being actually apprehended and demonstrated. That the modern student of physical science believes in the reality of the existence of his atoms and molecules, as much as he does in that of chairs, tables, and lamp-posts, probably sufficiently epitomises one of the most striking features of the change of outlook since NATURE made its first appearance in 1869. Vague ideas of their actual individual mass, size, shape, and constitution have been or are being replaced more and more by exact quantitative knowledge, which invites our literal acceptance and grows in fruitfulness the more implicitly it is used as the basis for further investigations.

But the latter half of the period under review witnessed an even greater change of outlook. The atom, since the discovery of radio-activity in 1896, has ceased to be the smallest coin of the realm of material change. The farthings of 1869 have proved to resemble 1000*l.* notes, and the potentialities of the world in consequence have been multiplied a million times. The change of the single atom of matter is well within the range of direct perception by the senses, and, stranger still, the change reveals that, under the image and superscription of the same Cæsar, coins of different mass and mintage have been circulating unsuspected in the chemist's currency.

As regards the physical reality of molecules, by no means the least important factor contributing to the result has been the recognition that, if the molecules were not the smallest parts of matter capable of free independent existence and motion, heat would not be the final permanent form which all kinetic energy liberated in the world assumes. The limit that fixes the physical sub-division of matter limits also the sub-division of motion. Though in the real world of matter in bulk, as contrasted with the ideal fictions of mathematics, friction and imperfect elasticity quickly reduce all moving masses to apparent rest, that "rest" is the perpetual heat motion of the molecules, which, literally and necessarily, must be perfectly frictionless and elastic because they are the smallest particles capable of free independent motion, and no smaller particles exist among which their motion can be further distributed.

Moreover, in accordance with the law of equipartition of energy, all molecules at the same temperature, whatever their mass, become, in consequence of their ceaseless mutual collisions, possessed of the same average amount of kinetic energy, and, therefore, of a velocity of translation inversely proportional to the square-root of their mass. This serves to clarify the conception of the real molecule from misnomers still unthinkingly retained.

For example, it is a pure survival of past confusion to speak of the molecule of a crystalline solid, if not of any solid, for in such the smallest parts are not free to move, but are anchored in fixed, unchanging positions in the crystal space-lattice, as the resolution of X-rays by the crystal structure has shown. It is, similarly, always a pure misnomer to give the name "molecule" to the least number of atoms which represent the chemical composition and properties of a substance, in the absence of experimental knowledge of the molecular magnitude, and therefore of any knowledge as to whether such a particle really exists in a form capable of free independent movement.

Cleared of these ambiguities, the conception of the individual molecule has become very real. We have been led by Perrin, and the mathematical physicists who paved the way for his experimental work, to recognise the Brownian movement as but one aspect of the perpetual motion of the molecules, which, though invisible to the naked eye, becomes swift and ceaseless for particles even of the scale of minuteness resolved by the microscope, and we can extrapolate with assurance to the minuter world which science had long before visualised by faith.

Or, again, we may follow Langmuir, with none of the feeling of hesitancy and diffidence that would have held back an earlier generation, into the explanation of catalysis, adsorption, and allied phenomena, as caused by surface layers of molecules "one molecule thick." Nor do we consider it fanciful to explain the spreading of animal and vegetable oils upon water and the non-spreading of mineral oils, as due to the attempt, in the first case, of the one end, the soluble glycerine ester end, of the rod-like molecule to dissolve in the water, and the refusal of the other end, the insoluble, hydro-carbon, or oily end, to do so. Wherefore the molecules of such oils stand up on end and cover the surface with a one-molecule thick layer of the oily ends of the molecules, whereas the mineral oils, with molecules oily at both ends, do not spread! Real in one sense as the structural formulæ of organic compounds have been for many decades, an earlier generation would scarcely have thought of this.

The discovery that the X-rays are of a character identical with light, but of wave-length of the order of one ten-thousandth of that of light of the visible spectrum, has made the structure of crystalline solids as open to direct examination as the ten-thousand-fold coarser structure of the Rowland grating, ruled by the dividing engine, is by means of ordinary light. In this way many of the space-lattices hitherto arrived at only by the aid of the second-sight of the mathematical crystallographer have been tested and found real.

Since the explanation by Le Bel and van't Hoff of optical isomerism as due to structural differences of the arrangement of the atoms in the molecule, of the kind that exist between an asymmetrical object and its mirror-image, and therefore only capable of representation in space of three dimensions, chemists have, not without reproach, used model carbon atoms in building up the structure of organic compounds, and have found them capable of accounting, for example, in cyclic structures, for many of the properties of these compounds far removed from the field of optical activity. That the real carbon atom should possess any resemblance to these little wooden balls bearing four spokes radiating symmetrically from the centre may have appeared to many too crude a conception for literal belief. Yet when the character of the space-lattice of the diamond crystal was elucidated by means of the X-rays, these very models were used to represent it—a striking proof, surely, of the basis of physical reality underlying the conceptions of stereo-chemistry.

But these triumphant vindications of what only a generation ago were described as purely hypothetical and unverifiable conceptions have been to some extent overshadowed and eclipsed by the startling progress made since the discovery of radio-activity in 1896 and its almost immediate interpretation as due to the explosive disintegration of the atoms of the radio-elements. This subject is being treated by Sir Ernest Rutherford in another article, and need be only briefly alluded to here. The change is attended by the liberation of energy a million times greater than is liberated in any previously known change of matter, and so it has come about, as for example in the spinthariscope, that the effect of each individual atom disintegrating can be perceived by the senses. The counting of the number of atoms disintegrating per minute has become one of the regularly used methods of investigation, whereas it requires, at least, some 25,000 times as many atoms as there are people alive in the world before an element can be detected by the spectroscope. The condensation of moisture on the columns of ions, lying in the tracks of the fragments of the atom after its explosion—both of the α- and β-particles, which may be likened to projectiles fired from a gun, and of the recoiling residue of the atom or gun itself—has in the hands of C. T. R. Wilson enabled the individual atomic explosions to be photographed. These permanent records, of extraordinary interest and value as they are as confirmatory evidence, yet revealed nothing new. Every detail of the whole phenomenon had been correctly comprehended and established without such direct aid. In particular, the photographs show well the almost rectilinear flight of the α-particle through the myriads of gas atoms in their path, and their rare and occasional wide-angle deviation when perchance they pass near enough to the heart of the atoms penetrated, which is the experimental basis for the present provisional representation of the internal structure of atoms.

The atom is regarded now as a solar system, but the massive central sun, comprising all but a negligible fraction of the whole mass, is an exceedingly minute positively charged nucleus, attended by numerous rings or shells of the almost mass-less electrons. In spite of its relatively great mass, the nucleus is so minute that the chance of an α-particle—which itself is the nucleus of a helium atom—in its passage through the atom approaching or colliding with the central nucleus, is exceedingly small. Mass and radio-activity alone seem to depend directly upon this hitherto unsuspected and all-important nucleus. The chemical and physical properties, including the light spectrum, are governed probably by the outermost shell or ring of valency electrons, which alone are variable in number. The coming and going of these seem to constitute chemical change and to give rise to ordinary light radiation. Barkla's various series of X-rays characteristic of each element probably originate in the successive completed rings or shells of electrons surrounding the nucleus.

All the properties of the atom, practically, save mass and radio-activity, depend solely upon the numerical value of the positive charge of the nucleus, which is equal to the number of the surrounding negative electrons. This number, which is known as the atomic number, increases unit by unit in passing from one place of the periodic table to the next. From numerical relationships between the wave-lengths of the characteristic X-rays, Moseley was able to determine or infer this atomic number for all the elements. So he called the roll of the elements for the first time and found between hydrogen, the first, and uranium, the last and ninety-second element in the table, only five still missing.

In the course of successive radio-active changes the radio-element expels from its nucleus an α- or β-particle, so losing two positive charges, or, relatively, gaining one, and shifting back two places or moving forward one in the periodic table. The expulsion of one α- and two β-particles produces an isotope of the parent, chemically and spectroscopically identical with it, but of atomic mass four units less. The ultimate products of uranium and thorium have been identified as isotopes of lead of atomic mass 206 and 208 respectively, and this has been confirmed by an examination of the atomic weight of the lead derived from uranium and thorium minerals. Of all strange consequences of the atom changing, this is perhaps the most subtle and hitherto unsuspected, for now nothing is more certain than that the analysis of matter into chemical elements depends on a superficial identity of the outer shell of the atom, and that the same type of outer shell may contain internal nuclei of different mass and different constitution.

Naturally, the many, at first separate and independent, lines of evidence which have led to the present results cannot all be even mentioned in an article of this length. The significant fact is that all the new and powerful methods of attack developed by physics and chemistry during the last quarter of a century are converging successfully on the problem of the internal constitution of the atoms. The prospects of successful accomplishment of artificial transmutation brighten almost daily. The ancients seem to have had something more than an inkling that the accomplishment of transmutation would confer upon men powers hitherto the prerogative of the gods. But now we know definitely that the material aspect of transmutation would be of small importance in comparison with the control over the inexhaustible stores of internal atomic energy to which its successful accomplishment would inevitably lead. It has become a problem, no longer redolent of the evil associations of the age of alchemy, but one big with the promise of a veritable physical renaissance of the whole world.

Even in the present year a further significant advance in this direction has been made. For it appears, from the latest results of Sir Ernest Rutherford on the passage of α-particles through nitrogen, as though the nuclei of an exceedingly minute proportion of the nitrogen atoms struck by the α-particle were shattered by the collision. If this is so, artificial transmutation on an infinitesimal scale has already been accomplished, though, it is true, only by the aid of a previous natural transmutation, still impossible artificially to imitate.

IONISATION OF GASES.

By Prof. J. S. Townsend, F.R.S.

During the last fifty years many physicists have been occupied in studying problems connected with electric currents in gases. The earlier work was principally confined to experimental investigations of the general outlines of the phenomena which occur in discharges obtained with high potentials. The large number of complicated and surprising properties of gases which were thus discovered naturally attracted much attention, and it is very interesting to read the accounts of the first experiments of the discharges in air and through vacuum tubes which were written before any special investigations of the theory of the conductivity were undertaken.

It would clearly have been extremely difficult to obtain from these experiments any general theory of electricity to explain what was taking place, as such a large number of different phenomena seemed to occur simultaneously. From the first, some physicists maintained that the currents through gases were carried by means of ions, as in liquids, although there were peculiar differences between the two cases, and it was not evident why under a given force a gas might act either as an insulator or as a conductor.

The greatest success in advancing the theory of electricity was obtained from careful studies of the discharges at very low pressures. In this direction some remarkable experiments on the cathode rays were made by Hittorf in 1869. He found that the rays travelled in straight lines from the cathode; when they fell on glass they caused the surface to fluoresce, and an obstacle in the path of the rays cast a shadow on the glass. He also found that the rays were deflected by a magnet into circles, or more generally into spirals, which were described in the direction which would be taken by negatively charged particles moving from the cathode. Notwithstanding these results, and further experiments made by Crookes, the projected particle theory of the rays was not at first universally accepted, and some physicists maintained that the rays were an undulatory motion of the ether. This question was decided by Perrin in 1895. He showed by direct experiment that the rays carried a negative charge, but thus far the origin of the rays, their velocity, and the mass and charge of each particle were unknown.

The question of the ratio of the charge to the mass was studied by Schuster in 1890, and he concluded that in gases it was of the same order as in liquids, but for negative ions it was larger than for positive. This was the first indication of the characteristic difference between positive and negative ions in gases.

A direct method of finding the ratio of the charge e to the mass m of the cathode particles, and the velocity of the particles, was devised by Wiechert, and in 1897 he described the experiments which showed that in some cases the velocity of the rays was about one-tenth of the velocity of light, and that the ratio e/m for the cathode rays was between 4000 and 2000 times as great as the corresponding quantity for a hydrogen atom. Thus, assuming the charges to be the same in the two cases, the experiments showed that the mass of a cathode particle is very small compared with the mass of an atom of hydrogen. This small cathode particle has been called the electron. Further experiments show that currents of negative electricity obtained from metal surfaces by other methods also consist of streams of electrons. Thus Sir J. J. Thomson investigated the charged particles set free from hot wires or from a metallic surface by the action of ultraviolet light, and found that in both cases the ratio e/m was the same as for cathode rays. The values of e/m afterwards found by various methods show that the ratio of the mass of the electron to the mass of an atom of hydrogen is 1 : 1830. This value of e/m is constant provided the velocity is small compared with the velocity of light, but with velocities of this order the effective mass of the electron increases, and Kaufmann found that the value of e/m diminishes in accordance with Lorentz's theory as the velocity approaches the velocity of light.

During the earlier part of this period some investigations were made of the currents that can be obtained with forces smaller than those required to produce discharges. The positive and negative ions produced in air at atmospheric pressure at the surface of incandescent metals, the conductivity of flames, and the charges obtained in newly prepared gases, or by bubbling air through water, were examined. In these cases the mass associated with the ions is comparatively large, and varies rather irregularly over wide ranges, so that it was difficult to formulate precise theories from the results of the experiments. These large ions have the property of condensing water vapour, and in a moist atmosphere small drops are easily obtained which form a visible cloud. This phenomenon led to the method of estimating the charge on each particle. The number of particles in a given volume was found by dividing the weight of the cloud by the weight of each particle estimated from the rate of fall of the cloud. The charge on each particle was then obtained by dividing the total charge by this number. Various corrections and improvements were later introduced by Millikan, and the charge on an ion in a gas has been found to be 4.7×10^{-10} electrostatic unit.

The remarkable discoveries made by Röntgen and Becquerel, which have led to so many advances in the knowledge of molecular physics, were of invaluable assistance in providing means of studying the properties of ions in gases. It was found that X-rays and the rays from radioactive substances made gases conduct, and it was possible to obtain ionisation at a uniform rate in gases under various conditions, with the advantage that the mass associated with the ions was not liable to irregular change.

Special experiments were devised to determine the rate of recombination of positive and negative ions, the velocity of the ions under electric forces and their rate of diffusion; and various properties of ions in gases were discovered.

The experiments on diffusion, for instance, led to a method of finding the number of molecules per cubic centimetre of a gas and of comparing the charges on ions in liquids and in gases. If N be the number of molecules per cubic centimetre of a gas at atmospheric pressure and 15° C., and e the charge on an ion in a gas, a direct determination of the product $N \times e$ is given by observing the lateral diffusion of a narrow stream of ions. The value of $N \times e$ thus found is 1.23×10^{10}, and as the charge e was also found by other experiments, the value of N is seen to be 2.6×10^{19}.

If E be the charge on a hydrogen ion in a liquid, the total charge $2N \times E$ carried by all the atoms in a cubic centimetre of the gas is equal to the quantity of electricity required to evolve that volume. When expressed in electrostatic units, the latter quantity is 2.46×10^{10}. Thus the two charges E and e are the same.

Another line of investigation was undertaken in order to discover how ions are generated in large numbers, as when small changes of force convert a gas from an insulator to a conductor. It was found that when ions are generated by Röntgen rays or by ultra-violet light a maximum current composed of ions generated by the rays was obtained with small forces, but as the force increased beyond a certain point new ions are generated in the gas by the motion of those produced initially by the rays. At first the new ions are produced by the collisions of negative ions, or electrons, with molecules of the gas, and as the force increases and approaches the value required to produce a discharge, the positive ions also acquire the property of generating others by collision.

The theory of ionisation by collision was found to be in accurate agreement with the experimental determinations of the forces required to produce spark discharges, brush discharges, and the corona discharge which is accompanied by a glow over the surface of a wire or cylinder.

Thus the various properties of ions which have been discovered in the last fifty years have already explained many phenomena connected with electric currents.

SPECTROSCOPIC ASTRONOMY.

By Prof. A. Fowler, F.R.S.

The science of celestial chemistry and physics was brought into existence in 1859, when Kirchhoff's famous experiment on the reversal of spectral lines furnished the key to the interpretation of the dark lines of the solar spectrum, and thence to the determination of the composition of the sun and stars. The new science developed with extraordinary rapidity, and within ten years the spectra of all the different classes of celestial bodies had been carefully observed. The gaseous nature of some of the nebulæ had been discovered by Huggins, and a spectroscopic classification of stars had been made on such sure foundations by Secchi that it still survives as one of the most convenient modes of describing the main features of stellar spectra. The memorable discovery by Lockyer and Janssen of the method of observing solar prominences without waiting for an eclipse of the sun was also made during this fruitful period, and the possible determination of the radial motions of stars by displacements of the spectral lines had been put to a practical test by Huggins. The demonstration that the immensely distant celestial bodies were composed, in part at least, of the same kinds of matter as the earth may well take rank among the greatest triumphs of science.

The half-century which has elapsed since the first issue of this journal has witnessed a progress which must far exceed the highest hopes of the earlier workers. Some of the advances have followed from the increased apertures of the telescopes which collect the light for spectroscopic examination, but many more are to be attributed to the substitution of photographic for visual methods of observation which was made practicable by the introduction of the gelatine dry plate.

Great observatories dedicated to astrophysics have been erected, notably in America, and observational methods have reached a high degree of refinement. In solar investigations, where the great intensity of the light allows of the use of instruments of high resolving power, velocities on the sun's surface can now be measured with a probable error of only a few metres per second; and even more remarkable is Hale's determination of the general magnetic field of the sun by observations of Zeeman effects involving displacements usually amounting to less than one-thousandth of an Ångström unit. Stellar spectroscopes have been improved by the provision of temperature control and other aids to efficiency, so that radial velocities are now measurable in the case of the brighter stars to within a quarter of a kilometre per second. With the exceptional resources of the Mount Wilson observatory, stellar spectra have even been photographed on a scale comparable with that of Rowland's great map of the solar spectrum, providing data for deductions, among other things, on such a delicate matter as that of the pressure in the atmosphere of a star.

Not less important has been the development of experimental researches bearing upon the interpretation of celestial spectra. The study of enhanced lines initiated by Lockyer has been especially productive, not only in relation to stellar temperatures, but also in leading to a satisfactory explanation of most of the lines which are met with in the spectra of the hotter stars, where we might well have expected that the reproduction of the conditions would be outside the range of our laboratory resources. The application to sun-spots of Zeeman's discovery of the effect upon spectrum lines of a strong magnetic field, and Ramsay's discovery of terrestrial helium following its previous detection in the sun's chromosphere, are familiar examples of the close bonds which unite astronomy with other sciences to their mutual advantage.

The spectrum of the sun has naturally been the subject of an immense amount of detailed study, and as the work has progressed it has become less and less probable that there are any substances in the sun which do not also exist on the earth. The spectra of sun-spots and of the chromosphere have also been minutely recorded, and most of their peculiarities have been satisfactorily accounted for. The bright lines of the coronal spectrum, however, have not yet been matched in any terrestrial source, but the precise knowledge of this spectrum which has been obtained during total eclipses has stimulated theoretical investigations, and some extremely suggestive relations have been deduced by Nicholson in his calculations of the spectra of atoms of assumed simple structure. Similar considerations have also been extended to the unidentified lines which occur in nebulæ.

As regards the stars, many of them have been photographed in great detail for minute analysis, and a multitude more for purposes of classification. Secchi's classification, at first merely empirical, soon came to be regarded as indicating the actual sequence of forms assumed by a star in the process of cooling, and the same idea is embodied in the Harvard system of classification, which has been most widely adopted by astronomers in recent years. Lockyer, however, has based a classification on the supposition that there must be stars which are becoming hotter as well as stars which are cooling down, in accordance with the theory of condensing masses of gas or meteorites, and this view has lately been greatly strengthened by the work of H. N. Russell on the densities of stars. In either case the impressive result is that the different types of stars are not to be looked upon as arising from fundamental differences of composition, but as representing successive stages in an orderly evolutionary progression.

The spectroscopic determination of the velocities of stars in the line-of-sight, irrespective of distance, has united the old and the new astronomy in the great task of deciphering the intricacies of structure of the sidereal universe. Besides contributing the velocities and spectral classes of individual stars, the spectroscope has revealed the existence of a large number of close binary systems, and has provided the most trustworthy means of investigating the sun's motion in space, the effect of which is to be eliminated in deducing the movements of the stars themselves.

An entirely new field for the spectroscope has been opened up by the remarkable discovery by Adams of a method of estimating the absolute brightnesses, and thence the distances, of the stars by mere inspection of photographs of their spectra. This novel method is full of promise, and encourages the hope that other equally unexpected applications of the spectroscope may yet be discovered.

Lack of space forbids even the enumeration of many other remarkable achievements, but sufficient may have been said to convey some impression of the enormous extension of the scope of astronomical research which has been brought about by the introduction of the spectroscope. It cannot be doubted that the spectroscope will continue to play a leading part in the advancement of our knowledge of the universe of which we form a part.

X-RAYS IN PHYSICAL SCIENCE.

By Prof. W. H. Bragg, F.R.S.

It is twenty-four years since Röntgen made the famous discovery which at once excited such immense and widespread interest. Everyone felt the fascination of the photograph which actually showed the bones of a living human hand. Surgeons seized on its obvious application to their craft; students of physical science realised that a new and most powerful means of investigation had been placed in their hands. And at the present day we see that the first expectations have been more than realised. We stand only at the beginning of what the Röntgen rays promise to accomplish for us.

Knowledge of the main properties of the X-rays grew rapidly under the labours of Röntgen himself and the many investigators who were attracted to the new field. Much was discovered respecting the power of penetrating various substances, the existence of different qualities, hard or penetrating, soft or less penetrating, the dependence of quality on the degree of evacuation, the construction and the applied potential of the X-ray bulb, the action on the photographic plate and on the fluorescent screen, and the power of producing ions in a gas. At the same time, the technique improved rapidly; bulbs, plates and screens, coils and interruptors were all designed afresh to meet the demands of an experiment which grew into an industry.

Notable advances were made by Barkla when he proved the existence of a polarisation which was to be expected on the hypothesis that the rays were ethereal waves or pulses, and when he showed that every element emitted its own special and characteristic X-rays under proper stimulus. The properties of characteristic radiation are most remarkable and instructive. The radiation of any element can excite the corresponding characteristic radiation in elements lighter than itself, but never in any element which is heavier. For example, "zinc rays" can excite the characteristic radiation of magnesium, potassium, or nickel, but not the characteristic radiation of bromine or silver, nor, indeed, of zinc itself. Since energy is necessarily spent in the excitation of radiations, the absorption coefficients of zinc rays by the various elements show a marked discontinuity; they increase steadily from magnesium upwards, but there is a sudden drop at zinc, the coefficient falling to about one-eighth of its previous value. After that the coefficient increases steadily with the atomic weight as before.

X-rays can excite an electron radiation in any substance on which they fall, and this effect has also been the subject of much investigation. The more penetrating the X-rays, the higher the velocity of the electron which it can cause to be emitted. This effect is carried to an extreme in the corresponding emission of very high-speed electrons under the stimulus of the γ-rays of radium, for the parallelism between all the properties of X-rays and γ-rays is an obvious indication of the similarity of their nature. There is a striking correspondence in the two processes—that of the excitation of X-rays by the moving electrons of the X-ray bulb, and that of the emission of electrons under the stimulus of X-rays. The quality of an X-ray depends on the velocity of the electron that excited it, and not at all on the number of electrons in the exciting stream; conversely, the velocity of an electron due to X-rays depends only on the quality of the rays, and not at all on their intensity. Some kind of matter is required to bring about either of the energy transformations, but the atomic weight of it has no influence on the principle just stated. Anomalies may appear when characteristic radiations are excited, but they can be explained as apparent only.

Many other remarkable properties, which cannot be described in so brief a notice as this, were discovered in the first period of X-ray investigation. All of them were examined with the greatest interest, because it was recognised that if X- and γ-rays were essentially of the same nature as light, their study must contribute to any true theory of light radiation, and, indeed, must be necessary thereto.

A new period of investigation began when von Laue and his collaborators demonstrated in 1912 that X-rays could be diffracted by the ordered array of the atoms of a crystal. From a simple interpretation of von Laue's principle, and from the results of its application to the study of crystals of sodium and potassium chloride, W. Laurence Bragg was able to discover the actual arrangement of the atoms of those crystals and the distances separating the atom-bearing planes. It thus became possible to find the actual length of an X-ray. The older and vaguer methods of defining the quality of an X-ray were at once replaced by a method of great precision. Previous work can now be revised under infinitely better conditions, and much has already been accomplished in that direction.

Moseley, making a careful survey of the wave-lengths of the radiations of all the elements available, showed that the wave-length of the characteristic radiation marched in perfectly even step with the increase of the atomic number, and, therefore, that the atomic number of an element defined it more fundamentally than its atomic weight. So all the elements were drawn together by a common tie as they had never been before; anomalies of position in the periodic table were explained, and the number and places of missing elements were made clear.

The examination of the interchange of energy between X-radiation and electron movement can now be made so effectively that it has been possible to use the experimental results for one of the best determinations of Planck's constant.

In another direction the new discoveries have opened out a wide road of advance into crystallography. In the first place, it is possible to determine the crystal lattice—that is to say, to measure the sides and angles of the rhomboid cell which contains the unit pattern of atomic assemblage and is repeated throughout the crystal without change of form or orientation. This is a comparatively easy task. It is a second and more difficult task to determine the arrangement of the atoms within the cell; it has been accomplished in a few single cases only. Lastly, the new researches will give us information concerning the position of the electrons or the diffracting centres within the atoms and about their normal movements. Something has already been done in this direction also.

Moreover, the new knowledge reacts on older information, shaping it for interpretation and making it more valuable. From a knowledge, for example, of the elastic constants of crystals, the forces between the atoms themselves may be calculated as soon as the architecture of the crystal is known. It will be possible to make use of facts concerning cleavage planes, occurrence of certain natural faces and not of others, etching figures, and the like. Light will be thrown on the meaning of valency and on all that lies at the root of chemical action. If the atomic forces can be calculated, an explanation of the form of the wave-surface of light within a crystal will be at hand.

X-rays have been applied with ever-increasing success to medicine and surgery; their extraordinary power of revealing the interior of a body without disturbing its exterior are beginning to be recognised as a trustworthy aid to industry, as, for example, in the detection of flaws of construction otherwise invisible; and their use in observing the crystalline state is already being considered as a probable and welcome aid to metallurgical problems. But still the richest mode of their employment is by the indirect methods of pure science. Their unique properties help as nothing else can to a knowledge of the relations between radiation and matter, ether-waves and electrons, atoms and the forces that bind them together, which are among the greatest of the fundamental problems of physics.

X-RAYS IN MEDICAL SCIENCE.

By A. C. Jordan, M.D., M.R.C.P.

The discovery of X-rays in 1895 was justly hailed as one of the greatest scientific marvels of any age. Medical men eagerly grasped the possibilities of these rays, which enabled them to see the internal organs of their patients actually at work, hitherto impossible even to surgeons, who in the course of their operations had the organs exposed to view, but only under conditions of anæsthesia.

The first practical uses to which X-rays were applied were: (1) In the detection and localisation of metallic foreign bodies, such as needles and bullets; (2) in the detection and localisation of metallic or other foreign bodies that had been swallowed; (3) in the diagnosis of fractures of bones: this branch of radiology has made enormous strides during the war, and has led to a vast improvement in the treatment of fractures and to the saving of countless limbs; (4) in the diagnosis of calculi in the urinary tract and elsewhere: these foreign bodies throw shadows which have to be distinguished from concretions in the bowel and calcareous deposits: many pitfalls lie in wait for the unwary observer, and the right interpretation of these shadows, even at the present time, calls for skill, patience, and discrimination; (5) in the diagnosis of diseases of the chest: the appearance of the normal movements of respiration and of the beating heart was closely observed, and as a result of these observations upon healthy subjects this branch of physiology has had, to a large extent, to be rewritten. The position of the heart and vessels in the chest—in the midst of the air-filled lungs—rendered accurate diagnosis difficult by the older methods of physical examination, but by means of X-ray examinations with the fluorescent screen the mechanism of the heart has been closely studied and its diseases accurately diagnosed.

In regard to diseases of the lungs, pneumonia, pleurisy, abscess of the lung, tumours, enlarged glands in the chest, and many other conditions produce characteristic shadows on the fluorescent screen, and enable the site, nature, and extent of the disease to be determined. In pulmonary tuberculosis the aid which X-rays have brought to its early diagnosis, and in defining its extent, has proved of such value that this means of diagnosing phthisis is playing an essential part in the campaign in progress for dealing with this scourge. X-ray study has shown that the first changes which occur in the lung in this disease lie so deeply buried in the chest—under cover of a thick layer of healthy lung—that they are quite beyond the reach of the older methods of detection by percussion and auscultation. By the time the stethoscope is able to discover the signs of consumption, the disease is probably so far advanced that the prospects of a cure are remote. The diagnostic utility of X-rays has increased steadily with the continued improvement in the apparatus and the increased skill and experience of those engaged in this branch of science.

The correct estimation of fractures and other injuries to bone and joints necessitated an accurate study of the form and texture of normal bones, as well as the individual variations that occur in the conformation of bones and their joint surfaces. This knowledge led at once to a most important extension of the diagnostic powers of X-rays—the recognition of disease in bone and the differential diagnosis of many diseases of bones and joints.

So far we have considered radio-diagnosis as dependent on differences of density among the tissues. Bone, with its lime salts, is far more opaque to X-rays than muscle: consolidated lung is more opaque than healthy, air-filled lung. At first sight this precludes from the range of radio-diagnosis a very important part of the body—the hollow viscera constituting the digestive tract. Very little information is to be gained from an ordinary X-ray inspection of the stomach and bowels, but the introduction of opaque substances into hollow organs with the object of determining their outlines and of observing abnormalities of size, shape, or function has opened up an entirely new extension of the science of radio-diagnosis.

An "opaque meal" consisting of a heavy insoluble salt, such as carbonate of bismuth, is given in a dose of 2–4 oz. Its progress is observed through the œsophagus into the stomach and duodenum, and observations are continued at intervals to note the position and behaviour of each part of the small and large intestine as the bismuth passes through. By this means much new information is being gained concerning the physiology and the diseases of the alimentary tract. Our views regarding the causation and nature of many of the affections of the digestive system have had to be reconsidered and modified.

Medical and surgical text-books of a few years ago contained separate chapters devoted to individual diseases, such as gastric ulcer, duodenal ulcer, gall-stones, and appendicitis, but when radiologists were called upon to aid in the diagnosis of these various diseases they tendered evidence that showed conclusively that these diseases were not isolated morbid affections of the organs concerned, but "end-results" of a more general derangement of the digestive system. In other words, the stomach or appendix does not "go wrong" by reason of any intrinsic vice, but because it is in an environment which has become vitiated or unhealthy.

An entirely different aspect of our subject is the application of X-rays to the treatment of disease. From observations upon the far-reaching consequences of undue exposure to the action of X-rays, radiologists were led to explore their possibilities for therapeutic purposes.

It is well known that the first workers in the field of radiology were destined to pay a heavy price for their devotion. The repeated exposure of the skin to the action of the new rays set up a disease in skin known as X-ray dermatitis. Gradually the skin and even the deeper tissues of the hands and other parts that had been exposed to the action of the rays were destroyed. Extensive and painful sores appeared which penetrated deeply and resisted all attempts to induce healing, and in some cases cancerous change set in, necessitating the loss of a limb, and unfortunately, in a few cases, leading to a fatal termination. It was natural to surmise that an agent with such terrible powers for evil as X-rays possess might, in suitable small doses, be converted into a means of salvation, in the same way as many deadly poisons—strychnine, opium, digitalis, and mercury—have become the physician's most potent and useful remedies when rightly administered.

It was found that certain diseases of the skin yielded very readily to carefully administered applications of X-rays; and to-day ringworm, so difficult to eradicate by ordinary methods of treatment, is almost universally treated by X-rays. Prior to this treatment primary schools were deprived of numbers of their pupils for long periods, averaging two years for each child, but now the disease is usually eradicated in three months.

Other diseases which have been treated with a large degree of success by irradiation are: Tuberculous glands; other gland enlargements, such as occur in lymphadenoma (Hodgkin's disease); uterine fibroids; exophthalmic goitre (Graves's disease); blood diseases, such as leukæmia; and some forms of gout, rheumatism, and neuritis: in these painful disorders X-ray treatment relieves pain even when it cannot achieve a cure.

In view of the successful application of X-rays in dispelling enlarged glands, the question naturally arose: Have we here a therapeutic agent which can cure that most dreaded of all diseases—cancer? The answer to this important question was sought with diligence, and at first with much promise. But its limitations soon became apparent, and to this day the results of X-ray treatment of cancer have not fulfilled our greatest hopes. True, many cancerous masses can be destroyed and made to disappear by this treatment, yet a genuine cure does not always follow. Other growths may appear in inaccessible places, or general dissemination of cancer may set in. Early removal by operation is still the safest method of dealing with a cancerous growth. The removal may, however, be advantageously followed by the systematic irradiation of the operation area, so as to destroy any cancerous cells that may have been left behind. We must not (nay, we dare not) despair of the successful treatment of cancer. Recent researches, however, lead to the conclusion that the road to salvation is in the prevention rather than in the cure of the disease. In these researches X-ray observations of the digestive system occupy a prominent place. They have taught us that particular sections or points in the gastro-intestinal tract become so altered from their healthy state as to be specially liable to take on a cancerous change. We have learnt that toxic products, absorbed from the intestinal canal into the general circulation, give rise to deterioration of the tissues and render them liable to become cancerous as the result of some slight source of continued irritation such as would do no harm to healthy tissues.

The effects of X-ray exposures on white blood corpuscles are receiving increased attention, and to-day results are being obtained which are of great interest. We know, for instance, that the white cells of the blood play a leading part in the struggle with invading microbes. If particular kinds of white cells can be increased in numbers and in activity, we shall have gained a notable step in treatment. Already there are reports from more than one part of the world of promising results from treatment on these lines in cases of pulmonary consumption.

It will be seen from the foregoing brief account that important developments in the functions of X-rays in the direction both of diagnosis and of therapeutic application can be hopefully awaited.

Every day we are learning more of the nature and properties of the various kinds of X-rays, the soft and hard primary rays, the homogeneous and other secondary rays; and knowledge is increasing regarding their action on the surface and within the body tissues.

It is safe to predict that in the coming years X-rays will play an increasingly important part in attaining the end and aim of all medical study—the prevention of disease and the maintenance of a high standard of health and efficiency in the community.

PROGRESS OF ELECTRICAL INVENTION.

By Prof. J. A. Fleming, F.R.S.

THE progress of electrical discovery and invention, and especially of electric lighting, telegraphy, and telephony, in the last fifty years is the theme on which the Editor of NATURE has asked me to make a short contribution to this jubilee issue. The chief difficulty, however, is in selecting from the enormous stores of accumulated knowledge the topics most worthy of notice in a space all too brief for any adequate treatment.

Casting our glances backward to 1869, we can, however, say that on the theoretical side electrical science was then beginning to emerge from the stage of a chiefly qualitative study of phenomena into an era of quantitative measurement, on which progress so much depends. The initial attempts to lay deep-sea submarine cables and the engineering aspects of land telegraphy had compelled attention to the exact measurement of electrical quantities. Advanced physicists had already appreciated the advantages of an absolute system of measurement based on the fundamental units of space, time, and mass; but practical electricians still employed vague phrases such as "quantity currents" and "intensity currents," and precise ideas on the subjects of potential, capacity, inductance, electric energy, and power were not widely diffused. Lord Kelvin (then Prof. W. Thomson) had, indeed, started into existence some years previously (in 1861) the famous British Association Committee on Electrical Units, and Maxwell, Balfour Stewart, and Fleeming Jenkin had commenced experiments on the practical determination of the ohm, or British Association unit of electric resistance, for which work Faraday, W. Thomson, and Maxwell in Great Britain, and Gauss, Weber, and Helmholtz in Germany had laid the foundations.

A new era began in 1873 with the publication of Maxwell's stimulating work on electricity and magnetism. Up to that time students of the subject for the most part obtained their knowledge from such descriptive non-mathematical works as de la Rive's great treatise on electricity and magnetism. When Maxwell was appointed professor of experimental physics at Cambridge in 1871, and the Cavendish Laboratory was opened for work about 1873, quantitative researches at once commenced with Hicks, Gordon, Chrystal, Fleming, Schuster, Glazebrook, and Shaw as early workers. After Maxwell's lamented death in 1879, the late Lord Rayleigh accepted the position as his successor and directed his attention and great abilities at once to the exact determination of practical electric units, in which he did magnificent service, a work very ably continued by Glazebrook, J. J. Thomson, Searle, and others. After the introduction of public electric lighting, the measurement of electric quantities became a commercial matter. In 1885 the writer of this article read a paper to the Institution of Electrical Engineers in London advocating "the necessity for a standardising laboratory for electrical testing instruments." Soon after, the Board of Trade established such a laboratory, later on the Germans started their "Reichsanstalt," and at a still later stage the National Physical Laboratory in England was organised and equipped.

The Cambridge physicists have always maintained the high standard of research which marked that of Kelvin, Maxwell, and Rayleigh, and much valuable quantitative electrical work has been done there, too extensive for detailed reference. When Sir J. J. Thomson succeeded Lord Rayleigh at the Cavendish Laboratory he began the epoch-making researches on the nature of electricity and matter which have revolutionised scientific concepts. His identification of the cathode-ray particle with the electron of Larmor and Johnstone Stoney, and his measurement of its charge and mass, are amongst the most brilliant achievements of experimental science, and opened up an entirely new era in electrical research. J. J. Thomson gathered round him a band of experimental investigators whose researches, coupled with his own, threw light on innumerable obscure phenomena. The discovery of X-rays by Röntgen in 1895 and of the Becquerel rays, and the discovery of radium by Mme. and Prof. Curie, stimulated the work of Rutherford, C. T. R. Wilson, Townsend, and others, which has resulted in immense accessions to our knowledge of the nature of electricity and atoms.

Side by side with this progress in pure scientific knowledge fruitful advances were made in electrotechnics. Faraday's great discovery of magneto-electric induction had been long before applied in the construction of machines with permanent magnets for generating, by rotation of coils of wire, an electric current. Henry Wilde had suggested the use of electromagnets for producing the magnetic field, and he, as well as Werner, Siemens, and Wheatstone, had discovered the self-exciting principle and applied it in machines, to which the term "dynamo" was later on applied. In 1870 Z. Gramme, a French electrician, re-invented a special form of armature construction, first suggested by Pacinotti, which enabled a dynamo to give a very uniform direct electric current; and Hefner Alteneck, in Germany in 1873, had patented another type of armature winding, now called the drum winding. The way was then opened for the production of electric currents by mechanical power on a large scale and for the solution of the problem of public electric lighting.

Paul Jablochkov invented in 1876 his "electric candle" and initiated public street electric lighting in Paris. C. F. Brush, in America, invented a simple form of arc lamp adapted for working in series with others and a type of series arc-lamp dynamo. This Brush system soon after 1878 was largely in operation for street lighting.

In the following year Edison, in America, and Swan, in England, solved the problem of the production of a practical carbon filament incandescent electric lamp and thus rendered domestic electric lighting possible on a large scale.

In the same year the writer of this article exhibited some of Edison's early carbon filament lamps in operation in Queen Victoria Street, London, though it was not until the Crystal Palace Electrical Exhibition of 1882 that the public saw the new illuminant used on a large scale. The invention of the metallic filament lamp about 1904 made an immense improvement in economy in electric illumination, and more recently the "half watt" gas-filled lamp threatens to displace arc lighting entirely from streets and buildings.

The utilisation of this lamp, however, required a public electric supply, and Edison was one of the first to work out all the practical details and provide a complete system. This was put into operation in New York and in London in 1882. Improvements in the dynamo rapidly followed, and in the hands of J. Hopkinson, Crompton, Siemens, and others it became a highly efficient machine. About 1883 attention began to be directed to alternating currents, and alternators and transformers were designed by Ferranti, Mordey, and Parker.

In or before 1890 or 1891 polyphase alternators were first produced by Ferraris, Tesla, and C. E. L. Brown. Large electric supply stations were then built, and a lively contest took place on the relative merits of direct and alternating currents. The polyphase alternating system has, however, enabled electric power transmission to be conducted over great distances, and in the last twenty-five years an immense utilisation of natural water-power has taken place by this means, beginning with the Niagara Falls Power Station in 1893. Electrification of urban tram lines and short-distance inter-urban railways has made enormous progress in the last quarter of a century.

Meanwhile, between 1876 and 1879 Graham Bell, Edison, and Elisha Gray, in the United States, had given us the speaking telephone, and D. E. Hughes, in England, had produced the microphone, which is the basis of all modern telephone transmitters. In 1876 Lord Kelvin astonished the British Association at Glasgow by the information that he had heard articulate speech transmitted over a wire by one of Bell's early telephones. In 1879 the first rudimentary telephone exchange was established in London.

When once the commercial possibilities of telephone exchanges and of domestic electric lighting had been realised, progress was assured, although that of the latter was retarded by the unwise Electric Lighting Act of 1882, not repealed until 1888, and telephonic improvements were hindered by the Government control of it established by the legal interpretation of the term "telegraph" to include "telephone," under the Telegraph Purchase Acts.

Limiting consideration, then, to improvements in telegraphy and telephony, we note very briefly the following stages of invention. In 1869 the British Government passed an Act for the acquirement of the electric telegraph companies, and made the transmission of paid messages a public service. This "nationalisation" has, however, put a burden on the taxpayer, although it resulted in great extension of the facilities. Improved methods of transmission, such as the Wheatstone automatic system, capable of sending 400 words a minute, were soon introduced for Press purposes.

So far back as 1855 D. E. Hughes had invented an ingenious printing telegraph, but immense improvements afterwards introduced by Baudot, Creed, and Murray now enable twelve messages to be sent simultaneously on a single wire, each being printed down on paper at the receiving end, the sending being done by a typist on a special typewriter at the rate of thirty to forty words a minute.

Most long telegraph lines are now worked multiplex, meaning that several messages can be sent in the same or opposite directions on the same wire simultaneously.

In submarine cable work Great Britain has always been pre-eminent. The first submarine cable was laid in 1851 by the Brothers Brett across the English Channel, and the first permanently successful Atlantic cable by Sir Charles Bright and Sir James Anderson in 1866 from the s.s. *Great Eastern*. Lord Kelvin, who had previously given to the world his mirror galvanometer, invented also in 1867 the syphon recorder which receives and records the feeble arrival currents, and later improvements have given to it its present form. Very sensitive relays and repeaters have been invented by Muirhead, Heurtley, S. G. Brown, and Axel Orling, which have vastly increased the speed of transmission. Lord Kelvin laid the firm foundations for the theory of the telegraph cable so far back as 1855. There are at present about 300,000 miles of working submarine cable in the world, most of which has been made and laid by British electricians. In connection with telephony, enormous inventive thought has been given since 1880 to perfecting the mechanism of telephone exchanges, and the difficulties of automatic exchanges, which require no telephone girls or operators to effect the connection between subscribers, have now been finally overcome. Another very great advance has been in the "loading" of telephone lines. In 1887 Oliver Heaviside first showed the importance of inductance in the line as a remedy for "distortion" in the wave form of the speech currents, but it was not until Pupin, in the United States in 1899, suggested the insertion of inductance or "loading" coils at certain proper intervals in the line that practical success was obtained. A Danish engineer, Krarup, introduced a system of uniform loading for submarine telephone lines. The Pupin type of loading has made telephony possible over very great distances, such as New York to San Francisco, and Berlin to Rome. The difficulties of loading submarine cables up to 100 miles or so in length have been overcome. The theory of the subject has been treated by Heaviside, Kennelly, and Fleming.

Wireless telegraphy has attracted the attention of electricians since 1842, but no important invention was made until Marconi in 1896 first showed how to employ electromagnetic waves for this purpose, generated by a special form of Hertzian oscillator, and detected by an improved form of Branly metallic filings coherer. Lodge then demonstrated the importance of syntony in connection with the subject, and it soon took very practical shape. Inventors all over the world were attracted to this new field, with the result that in a few years, chiefly by the work of Marconi and his co-workers, electric wave telegraphy between ships and shore became established as an indispensable aid to navigation. The construction of long-distance wireless stations, the first of which was erected at Poldhu, in Cornwall, in 1901, brought to notice many remarkable facts in connection with the propagation of long electric waves round the earth and through the atmosphere.

A very important factor in the recent developments of wireless telegraphy and telephony has been the invention of the thermionic detector and oscillator. The pioneer invention, according to judicial decisions, was made by the writer of this article in 1904 in applying for the first time an incandescent electric lamp with a metal plate sealed into the bulb as a detector of high-frequency electric oscillations. The "Fleming valve" led to the invention of the three-electrode amplifier and thermionic generator of oscillations. This has given us an instrument of marvellous sensibility for detecting electric waves, and made wireless telephony a success and wireless telegraphy half round the world an achievement. The importance of wireless telegraphy and telephony in the European War of 1914–18 has been the cause of wonderful developments of the subject owing to the number of able minds brought to bear upon it.

Turning, then, from the present and the past and directing our gaze upon the future, we can certainly see many achievements looming before us. The world will be covered with long-distance wireless stations which will effect instantaneous communication over thousands of miles. Long-distance wireless telephony will enable speech to be transmitted over great distances, and it is quite within the bounds of possibility that the business man of the near future in London may hold a five-minutes' conversation with a friend in New York or even South Africa with as much ease as we now telephone to Glasgow or Liverpool. Directional wireless telegraphy will be used to steer passenger-carrying aeroplanes through cloud or fog. The steam locomotive and engine will gradually be replaced by the electric motor, and the water-power of the world will be utilised by its means. There are large possibilities still latent in connection with electro-chemistry and electro-metallurgy, and one great problem of the future is to tap the illimitable stores of energy latent in every chemical atom for the use and benefit of man. As coal becomes exhausted or coal power is made too expensive by labour difficulties, the question of new sources of energy becomes pressing. The engine of the future may be an improved form of internal-combustion engine in which the combustible is not coal gas or oil vapour, but some form of explosive compound in which atomic energy is suddenly released and expended in heating air or other gas in a cylinder.

Of one thing we may be perfectly certain, namely, that it is only through the avenue of pure scientific research sedulously and disinterestedly pursued that we shall reach the solution of these technical problems of supreme importance to mankind. The last fifty years has been a period of extraordinary technical applications of ever-increasing electrical knowledge, and no one can see reason to think that we have yet reached finality in the possible utilisation of this physical agent for ameliorating the conditions of human life.

DEVELOPMENTS OF MECHANICAL SCIENCE.

By Dr. W. C. Unwin, F.R.S.

THE attempt here made to give a sketch of the mechanical side of progress in the last fifty years is necessarily slight. The year 1869 was the centenary of that in which Boulton and Watt took out their first patent for the steam engine. It is due to the application of steam-power to industrial operations, more than to anything else, that there has been so great an increase of population, of wealth, and of social prosperity, and indirectly also of scientific knowledge, during the last 150 years. Perhaps a review of some of the earlier advances already slipping out of knowledge, as well as of more recent and familiar discoveries, will be interesting.

Eighty years ago Dr. Lardner said it was due to the steam engine that reason had taken the place of force, the pen had superseded the sword, and that war had almost ceased on the earth. History does not confirm the prescience of this. The last war, largely an engineering war, owes its vast range and frightful devastation to means placed in the hands of armies and navies by mechanical science. To take one point, success in war depends chiefly on the rapidity with which large masses of men can be moved and served with ammunition and food. This must be accomplished by railways and motor trucks. At Verdun sixty million shells containing three million tons of steel were expended in thirty weeks.

During the last fifty years there has been a wide extension of research in mechanical science. Most large engineering works have their laboratory for testing materials, and the problems investigated are largely those suggested by industrial operations. This was specially important during the war, and it is now necessary to make permanent the more intelligent and active spirit thus aroused.

Hydraulics is a very old subject of research. Its problems are generally too complex for purely rational solution. Hence the need of continued experiment. A remarkable series of measurements of flow over weirs of different forms, under different conditions, with varying velocities of approach, and an investigation of the peculiar change of form of the water nappe on the weir crest at low discharges, was communicated by Bazin to the Ann. des Ponts et Chaussées in 1888–98.

In 1885 Froude gave the first direct determination of the frictional resistance of surfaces of different roughness in water (Brit. Assoc. Report). The most novel result was that the average friction per square foot depended on the length of the surface in the direction of motion. The friction of rotating discs was investigated by Unwin in 1880, and by Gibson in 1910. A research by Stanton and Pannell (Trans. R.S., 1914) has shown the conditions of similarity of motion in fluids, and extended the results to water and air and to high velocities. These results have been of service in discussing the resistance of aeroplanes as tested in wind channels. Osborne Reynolds's experiments in 1882 showed that in flow-in pipes there was a critical velocity below which the resistance varied as the velocity, and above nearly as the square of the velocity.

Froude applied his results to the extremely important subject of the calculation of the resistance of ships. The greater part of the resistance is due to skin friction, and can be calculated on the assumption that the wetted surface is equivalent to a plane of equal area and length in the direction of motion and equal roughness. The remainder of the resistance, due to waves and eddies, can be found by model experiments. There is an exact relation between wave and eddy resistance of the model and ship at corresponding speeds. The method of model tests of ships as a guide to design is now fully established. Sir Alfred Yarrow has generously established an admirable ship model tank at the National Physical Laboratory.

Water-power is one of the oldest sources of mechanical energy for industrial purposes. Its importance, looking to the fact of the limitations of coal supply and that in favourable circumstances it is cheaper than steam-power, can scarcely be over-estimated. Its use has greatly helped processes such as the fixation of atmospheric nitrogen, and the production of aluminium, calcic carbide, carborundum, caustic soda, etc., besides being an essential auxiliary in many great electric lighting installations. Thirty years ago no water turbine existed of 1000 h.p.; now turbines up to 20,000 h.p. have been made. The harnessing of Niagara, commenced in 1890, gave rise to a movement for utilising water-power on a great scale. The possibility of transmitting energy electrically to distances up to 200 miles, with little loss and commercial success, has greatly enhanced the availability of water-power. In the U.S.A. some seven million horse-power are utilised, in Norway more than one million, in Canada two millions, and in Italy one million. There are great possibilities in the British Dominions. In Canada and some other countries a Government survey of the water-power resources is in progress.

In 1869 the steam engine differed little from what it was as Watt left it, except in detail, size, and variety of application. One important modification since may be noted. Rankine and Clausius drew up a complete rational theory based on the mechanical equivalent of heat. But it appeared that actual engines used 40 to 60 per cent. more steam than was accounted for by the theory. In the late 'fifties Hirn, of Colmar, traced the discrepancy to the conductivity of the cylinder wall, which was cooled by evaporation to the condenser during exhaust, and then condensed part of the steam on admission. To remedy this he introduced superheated steam, used to some extent in the 'sixties with economical results, but not widely adopted until the 'nineties. Watt aimed at getting a dry, hot cylinder, but only partly succeeded. Superheating is a further step, only second in importance to the separate condenser.

The greatest change in the generation of power is due to the perfecting of the steam turbine by Sir Charles Parsons. The principle of the steam turbine is old, but it involved great scientific tenacity and courage and large, unremunerative expenditure before practical success was achieved. The first condensing turbine of 100 h.p. was made in 1892. Now in the latest cruiser, the *Raleigh*, there are turbines of 70,000 h.p. For large electric installations and for large and speedy ships the steam turbine has superseded the reciprocating engine. Lately Sir Charles Parsons has introduced gear for reducing the necessarily high turbine speed to one more suitable for the propeller, and this will much extend the use of the turbine in marine engineering.

The development of the internal-combustion engine belongs almost entirely to the last half-century. On it has depended all aircraft and submarines, and most mechanical road transport. The first satisfactory gas engine was that of Dr. Otto in 1876. Dowson, in 1878, introduced producer gas, emancipating the engine from dependence on illuminating or town gas; and Benier soon after invented the suction producer. The Germans developed the large-cylinder, high-powered gas engine chiefly for utilising blast-furnace and coke-oven gas—a waste product. Sir Dugald Clerk, who has led the way in this country in developing the gas engine, and especially in studying its theory, estimates that there were gas engines of $5\frac{3}{4}$ million h.p. at work in 1909.

The first paraffin engine was that of Priestman in 1885. The Diesel oil engine, introduced in 1893, has perhaps the greatest thermal efficiency of any heat engine.

The petrol engine, which has made the conquest of the air possible, was greatly improved during the war, and is the lightest of heat motors. An aeroplane engine of 850 h.p. is stated to weigh only 1·63 lb. per h.p.

The future of air transport has very great promise, but it looks as if for commercial purposes the airship has advantages over the aeroplane. In coastal patrol and anti-submarine work naval airships carried out 9000 patrols covering $1\frac{1}{2}$ million miles. Engineers interested believe that an airship capable of carrying 1000 persons at 80 miles an hour is in reach of present practice. Attempts are being made to produce helium to replace hydrogen in the envelope, removing one source of danger.

Mr. Lanchester has reminded us that, with Government help largely withdrawn, the aeronautical industry is in the position of a youth luxuriously brought up who finds himself face to face with the fact that he has to earn his own livelihood.

Structures and machines should be designed with adequate strength and at the same time with the least necessary material. In the old view the strength limit was the statical breaking weight, and the ratio of this to the working stress was termed the factor of safety. Wöhler's research in 1871 proved that, in ordinary conditions of continual variation of stress, fracture occurred with much less than the statical breaking weight, and depended on the range of variation of stress. Bauschinger showed that the position of the elastic limit changed with repetition of straining action, and that the range of elasticity appeared to be the same as the range of stress, which could be sustained indefinitely. Bairstow and Stanton have confirmed this. Osborne Reynolds constructed a machine in which continuous changes of stress in a test bar could be produced by the inertia of reciprocating weights.

In the period under consideration there has been a great extension of public and private mechanical testing laboratories. The National Physical Laboratory and the Bureau of Standards, Washington, are now Government institutions. In the U.S.A. very large testing machines have been constructed, several of 600 tons capacity, and one of 5000 tons at Pittsburgh. For testing full-size members such as bridge ties, reinforced concrete columns, etc., such machines are necessary. Though new tests of materials must be adopted with great caution, tests of hardness and tests of brittleness have been found useful. Guest, Scoble, and others have investigated compound stress, and found that in ductile materials the limit of resistance is the greatest shear stress. A very great advance has been made in the delicacy and accuracy of strain measuring instruments.

THE TREND OF MODERN METALLURGY.

By Prof. H. C. H. Carpenter, F.R.S.

METALLURGY is the art of extracting metals from their ores, refining them, and working them up into finished products for the use of mankind *at a profit*. The inevitable corollary of this is that the economic factor is always decisive as to the applicability or otherwise of any new scientific discovery which bears upon the industry. The art is one of the oldest in the world, but in spite of its highly diversified character and the profound influence that scientific methods have had upon its scope and technique, it does not differ to-day in essence from the ancient art except in the fact that to an ever-increasing extent the applications of science are found to be payable.

In attempting a survey of the present position and tendencies of the great metallurgical industries, only the broadest treatment is possible. Accordingly, no account will be taken of the usual subdivision of the subject into ferrous and non-ferrous metallurgy. Rather does there appear to be an advantage in omitting this distinction which has no scientific basis, but is purely one of custom.

The first stage in the passage from the mineral as mined to the manufactured metal is "ore-dressing," and here a very notable advance, made in the last few years, has to be recorded. The old method of "gravity" concentration, whereby the ore after being crushed was suspended in water and treated in a variety of machines for the concentration of the metallic contents, which, being specifically heavier, tended to sink, while the lighter gangue floated, never, at its best, gave an extraction of more than 82 per cent. In the "flotation" process of to-day the sulphide ore particles are made to float on a froth produced by the agitation of the pulp with the addition of a small amount of oil and acid, while the gangue, although specifically lighter, sinks. The flotative agent is air, the froth being stabilised by the particular oil mixture used. Surface tension and not gravity is the principle utilised in the separation. The method has been principally applied to the concentration of copper sulphide and mixed lead and zinc sulphide ores. Its largest application has been in copper reduction work in America, where many millions of tons of ore are being treated to-day. At Anaconda the total recoveries in the concentration process have been raised from 76 per cent. to as much as about 95 per cent. There can scarcely be any doubt that flotation has a great future as a concentrator of metal values. At the present, however, it is limited to sulphide materials. For that reason it has had no effect on the metallurgy of iron, where the mineral is either an oxide or a carbonate; but it seems likely to have a very wide application to the principal economic minerals of copper, lead, zinc, gold, and silver, especially when the two latter contain base metal values.

Thus far the concentration has been mechanical—*i.e.* there has been no change in the chemical composition of the mineral itself. In the next stage, in the great majority of cases, "smelting" or "reduction" begins, which has for its object the conversion of the ore into a metal, usually unrefined. Hitherto the shaft or blast furnace has held its own, with coke as the fuel. This furnace has had its principal recent development along the lines of better charge distribution, and, in the iron industry, more efficient hot blast stoves and more economical power plants. Fifteen years ago many furnacemen were satisfied with almost any distribution of charge they happened to get from the apparatus installed, but this most important operation cannot be ignored without causing low output and high coke consumption. Distributors are now in use which give the charge a columnar structure with alternate columns of coarse and fine ore, instead of uniform layers produced by most systems of filling. Highly beneficial results are claimed for this improvement.

Hitherto the reverberatory furnace has been markedly inferior to the shaft furnace from the point of view of thermal efficiency. For this reason only the ore which was in too fine a state of division for treatment in a shaft furnace was smelted in a reverberatory. The very extensive application of gravity and flotation concentration, particularly to copper ores, with the fine grinding which these processes involve, has, however, necessitated the smelting concentration of such materials in these furnaces. Until comparatively recently the best practice in the reverberatory furnace concentration of copper ores was about 4·8 tons of charge per ton of coal, against about 8 tons of charge per ton of coke in the blast furnace. Here, too, a remarkable improvement during the last five years has taken place. This is due, in the main, to three factors:—

(1) To the increased efficiency of burning coal in the form of dust as compared with burning it on a grate.

(2) To maintaining a very large mass of the charge piled along each side of the furnace, which increases the speed of heat absorption.

(3) To the augmented size of the hearth, which has now reached a length of about 143 ft. and a width of 30 ft.

For successful practice, the coal, before pulverising, must be dried to a maximum of 1 per cent. of moisture. It must be finely pulverised, since the increased surface thus obtained has a direct bearing on the efficiency. Upwards of 80 per cent. should be capable of passing through a 200-mesh sieve. The delivery of coal and air must be controlled so that the proper proportion between them is maintained, and the coal itself must contain enough volatile combustible matter to give the required combustion. Only a few years ago it used to be reckoned that to smelt from 230 to 270 tons of charge per 24 hours was good work. The current practice to-day in the new furnaces is to smelt between 600 and 700 tons, and the ratio of charge to fuel has been brought up to about 7 : 1, which raises the reverberatory furnace almost to a level with the blast furnace from the thermal efficiency point of view. Certain of these large reverberatories are fired with oil, and very satisfactory results, as regards both economy in fuel consumption and weight of charge smelted, have been obtained.

Passing next to the refining of the metal, it is here that "electric heat" is tending in some cases to supplement, in others to supplant, fuel heat. An instance is furnished by the refining of steel on a large scale in the so-called triplex process, in the second stage of which fuel heat, in the form of producer gas, is used (the charge being worked first in a converter and afterwards in an open-hearth furnace), while in the third stage an electric resistance furnace is utilised which permits the refining of the steel to a considerably further degree. It is widely held that the quality of steel which can be produced in this way is superior to that obtained in the open-hearth furnace. This is due to the fact that, owing to the high temperature employed, more refractory basic fluxes can be used which permit of a greater removal of sulphur and phosphorus, with a consequent improvement in the properties of the refined steel. Moreover, in the electric furnace the charge is decidedly less contaminated with gases. For high-grade materials, such as high-speed cutting tools, where quality is of paramount importance, the electric furnace seems to have a field all its own, and, owing to the fact that, under special conditions, current for it can be bought from public service companies during "off peak" periods, its installation cost is not necessarily high. This permits of its use in plants smaller than otherwise would be justified in making their own steel. The rapid growth of the electric furnace is shown by the fact that the total number in operation in March, 1910, was 114, and in January, 1917, 471.

As an alternative to flotation concentration and smelting operations, which, as mentioned, are particularly suitable for sulphide ores, the achievements of hydrometallurgy have also to be considered. The cyanide process, which has long been established as the most suitable method of extracting gold and silver from low-grade ores, depends on the fact that the dilute solutions employed exercise a selective solvent action on the precious metals, and is the best-known instance of the application of leaching on a large scale.

Recently the extraction and refining of copper by hydrometallurgical and electrolytic methods direct from the ore has become a commercial process. Many of the low-grade ores of copper, particularly the vast porphyry deposits in the highly mineralised mountainous country in the south-west of U.S.A. and Mexico, are oxidised and not amenable to flotation concentration. For their beneficiation leaching is the most suitable method. A famous example of this kind is the treatment of the ore obtained from the mine of the Chile Exploration Co. situated at Chuquicamata, which, as regards tonnage and contents of valuable metal, is one of the greatest known copper deposits in the world. The high point of the mine lies at an altitude of 9890 ft., while the extraction plant is situated at 9023 ft. on a plateau of the Andes, 160 miles north-east of Antofagasta. Here a plant of 10,000 tons daily capacity has been designed and erected in a desert 5000 miles away from the base of supplies. The ore, which carries about 2 per cent. of copper, is an oxysulphate known as "brochantite."

The process chosen utilises its sulphuric acid ion for the solution of the copper, and allows a percentage discard of the liquid after each operation, thus avoiding its fouling by continual use. The ore is crushed to about half-an-inch mesh and leached with sulphuric acid. The greater part of the chlorine is eliminated in tube mills by treatment with metallic copper. The remaining copper is precipitated from solution by electrolysis and the cathodes are melted and cast into commercial wire bars. In this way a high-grade commercial metal is produced direct from the ore in three operations, in only the last of which is a furnace treatment necessary. Against this the ordinary concentrating, smelting, and refining operations involve no fewer than seven stages. The output of refined copper from this plant is at the rate of 200 tons per day.

The refining of metals by electrolysis, of which the previous process is an illustration, is one of the most important features of the industry of to-day. It derives its importance from two considerations which are inter-related: first, that it permits the production of the commercial metal in a highly purified form; secondly, arising out of this, it allows the complete recovery of the precious metal values from base metal ores, which thus increases their commercial value. To-day, iron, copper, zinc, lead, aluminium, sodium, magnesium, nickel, gold, and silver are obtained in a marketable form by such methods. To take one instance only, upwards of 90 per cent. of the world's annual production of copper, which in 1913 was about a million tons, was refined by electrolysis within 20 miles of New York City. The cathode copper thus produced did not contain more than 2–3 parts of impurities in 10,000. As a by-product of this refining, there was obtained nearly 20 per cent. of the world's entire output of silver, a substantial amount of gold, small amounts of platinum and palladium, together with notable quantities of nickel, selenium, and tellurium.

Viewing the industry to-day, it is manifest that there is a notable trend towards the substitution of furnace- or pyro-metallurgy by hydro- and electro-metallurgy. Even where furnace operations still hold the field, attempts are being continually made towards the substitution of fuel heat by electric heat. Iron is being produced commercially in Sweden, Canada, and the U.S.A. by electric smelting and refining. There is a clear trend of a similar character in the metallurgy of certain ores of copper which are not amenable to direct flotation or leaching. Metals such as aluminium, sodium, and magnesium are produced direct by electrolysis. The great importance of this tendency, as already suggested, is that it permits of a more complete beneficiation of any given ore, and, indeed, brings a far wider range of raw materials within the scope of economic exploitation than otherwise would be the case. How clearly this is so may be seen from the following instances:—

Previous to the introduction of the cyanide process, it did not pay to extract gold from any sulphide ore unless it contained at least 0·5 oz. of this metal. By means of this process, however, the limit of such payable ores has been brought down to about .1 dwt. per ton, and in the case of clean gravel containing native gold to as low as 3 grains—*i.e.* 0·006 of an oz. of gold per ton. Similarly in the case of the sulphide ores of silver, the previous limit of 20 oz. has been lowered to about 2 oz. per ton by the same process. As regards copper, the economic percentage was about 5 per cent. down to the year 1890. By the introduction of leaching processes this figure was quickly reduced to about 2 per cent. Progress has been continuous in lowering the limit, and to-day tailings from concentrating tables containing only 0·5 per cent. of copper are being treated for extraction at Cananea (Mexico) and Anaconda (U.S.A.). In regard to such materials it is more than possible that the flotation process will lower the limit still further.

Limits of space prevent any reference to the trend of current practice in the mechanical and thermal treatment of metals and alloys and the ever-deepening influence of metallography on this great branch of the metallurgical industry.

POSITION AND PROSPECTS OF AVIATION.

By L. Bairstow, F.R.S.

The present phase of scientific development of aviation may be said to date from the period 1890–1900, and to have its most definite form given by the researches of Langley and Maxim. From Langley's book were taken the early data on which pioneer designs were prepared, and a protracted controversy arose between Blériot and Farman as to the relative merits of the biplane or the monoplane as a result of a statement by Langley which has since proved to need considerable modification.

The first notable flight in public appears to have been that of Santos Dumont in 1906, for which he was granted the Deutsch de la Meurthe prize; this was little more than a long hop, and for the next two years it was clear that one of the larger difficulties of flight was the control of aircraft in the air.

Flying with reasonable certainty dates from the exhibition flights of the Wright Brothers in France during 1908, and may fairly be ascribed to the introduction by them of wing warping for the purposes of lateral control. Since then progress, both scientifically and industrially, has been very rapid.

In 1909 the Advisory Committee for Aeronautics was formed by the then Prime Minister, Mr. Asquith, with the late Lord Rayleigh as its president. The Committee controlled the activities of the Aeronautical Research Departments of the National Physical Laboratory, and was closely informed of the full-scale research work carried on at the Royal Aircraft Factory.

The development of the best shape of aeroplane had approached finality somewhat closely in the years 1913–14; on the other hand, owing to the death in an aeroplane accident of Mr. E. Busk, preliminary experiments on the industrial application of the theory of stability came to a premature end. During the war the attention of scientific workers in aeronautics was devoted to the many applications of existing knowledge rather than to its extension, and it was pointed out by them that the performances of aeroplanes could be predicted approximately with little effort, and that these predictions could be made the basis for an appeal for new designs to meet the increasing exigencies connected with fighting in the air.

On the other hand, no such simple generalisation has been found possible for dealing with stability, with the unfortunate result that designs made to give the necessary speed and rate of climb have been put into use before their condition as to stability was fully understood. Defects of stability made themselves felt by a series of accidents peculiar to each type. The analysis of these accidents and suggestions as to remedies came from the existing scientific work on stability. Examination of the categories into which accidents fall gives, perhaps, the clearest idea as to the technical development possible in the next decade. Some 80 per cent. of the total accidents during training are due to loss of speed of the aeroplane and an attempt on the part of the pilot to turn his aeroplane towards suitable alighting ground. The remaining 20 per cent. are in large part accounted for by failure of the engine to continue to develop power and so to compel descent on unsuitable landing ground. The latter point scarcely needs more than passing comment, for the general history of development in machinery shows that many years are necessary after main ideas have been established before details are satisfactory. Progress made in understanding the phenomenon connected with fatigue suggests that a moderate reduction of the power expected from existing aeroplane engine designs would lead to an enormous increase in the length of their life. It may therefore be expected that the ordinary precautions taken in the development of an engine will lead to the practical elimination of accidents under the heading of forced landings; here, again, progress will be accelerated by use of the known scientific data.

The larger group of accidents mentioned above needs a consideration of design intimately associated with the pilot's power of control of the aeroplane and its inherent stability. It should not be forgotten that the relation between these two quantities in an aeroplane designed for fighting in the air may have little or no connection with the corresponding relation of the properties desirable for civil aeroplanes. This field is as yet comparatively unexplored, and there are strong grounds for believing that an aeroplane can be so designed that the dangerous consequences of error of control by the pilot are greatly reduced; it is not improbable that the accidents on the score of loss of flying speed can be reduced to some 5 or 10 per cent. of their present magnitude when the necessary skill in design has been acquired.

The most important of the many difficulties which make it impossible to forecast the future of aviation are not technical, but commercial. Development under the stress of a great war has left an industry capable of producing an enormous number of aircraft. Attention has been given solely to military uses, and aeroplanes are therefore not specifically designed for civil purposes. At the same time, the civil uses are not clear; how far aviation will be good for the purposes of carrying mails, passengers, or merchandise is at present almost wholly a matter for conjecture.

Pre-war experience was gained in the development of aircraft which could be flown with a moderate degree of ease and safety, and no lines of commercial communication had been inaugurated. The main asset of both the aeroplane and the airship is speed, and here the importance of long distances will be evident on little consideration. In a country like England, with well-organised railway trunk lines and journeys of the order of 500 miles, the saving of time in the carriage of mails is small, particularly since the mail trains travel by night, whereas aeroplanes wait for the dawn before commencing the journey.

Where the route includes a sea passage the advantages are much greater, and the enterprise of our two leading transport companies has shown the possibility of a remarkable degree of certainty in the service between London and Paris. It is, however, on much longer journeys than these that the saving of time by aerial transport presents its most attractive possibilities.

On the other hand, the initial outlay and running expenses are roughly proportional to the length of journey, and the inception therefore represents a formidable undertaking. The returns are problematical, and from the nature of the case it will be obvious that until the special facilities have existed for some time no estimate of value can be made as to the charges which will prove remunerative to an operating company and sufficiently attractive to the users of the new form of transport.

Civil aerial transport is therefore still in its infancy as an addition to our industrial life.

THE LIQUEFACTION OF GASES.

By Prof. C. H. Lees, F.R.S.

In 1869, when the first number of Nature appeared, Andrews had just completed his experiments on carbonic acid, and established the fact that for each gas there is a critical temperature above which it is impossible to liquefy the gas by pressure. Faraday, by using low temperatures and considerable pressures, had liquefied chlorine, sulphurous and hydrochloric acids, cyanogen, and ammonia in 1823, by 1844 had added eight other gases to the list, and had solidified sulphuretted hydrogen, ammonia, and nitrous oxide. Cailletet, in 1878, by suddenly reducing the pressure on oxygen, nitrogen, and carbonic oxide compressed to 300 atmospheres, obtained mists which he ascribed to fine drops of the liquefied gas. Pictet, about the same time, by employing greater pressures and cooling his apparatus with other liquefied gases, succeeded in obtaining a small quantity of liquid oxygen which was of a slightly blue colour.

In 1883, at Cracow, Wroblewski and Olszewski succeeded in obtaining small quantities of liquid oxygen, nitrogen, and air, which evaporated in a few seconds. By 1887 Olszewski could obtain a few c.c., and by 1900 100 c.c., of liquid oxygen before an audience of his students. Dewar had been able to produce quantities exceeding 20 c.c. since 1886, and had already made determinations of the properties of substances at the low temperatures thus attainable. In 1892 he introduced the double-walled vacuum vessels with a little mercury within to convert the internal surfaces into mirrors, now known as Dewar flasks. These reduced the rate of evaporation of a liquid gas stored in them to about a thirtieth of the rate for ordinary vessels. The utilisation of the Joule-Kelvin cooling effect by Linde and by Hampson in 1895 enabled each to produce a machine capable of liquefying air, oxygen, and nitrogen on a commercial scale. In 1898 Dewar produced for the first time liquid hydrogen, using the Joule-Kelvin effect in the gas pre-cooled to 68° A. by a bath of liquid air evaporating *in vacuo*. Next year he solidified it, and determined its melting point to be 14° A. In 1908, at Leyden, Kamerlingh Onnes liquefied helium and determined its boiling point to be 4° A. In the meantime, Olszewski had liquefied and solidified argon in 1895, and Ramsay and Travers had by 1900 liquefied krypton and xenon.

The commercial production of liquefied gases gave facilities for the examination of the physical properties of substances at low temperatures, and in this work Dewar and Kamerlingh Onnes and his pupils have played prominent parts. It is to the Leyden professor we owe the discovery of the disappearance of the electrical resistances of many metals at temperatures a few degrees above absolute zero attained by the use of liquid helium.

PROGRESS OF METEOROLOGY.

By W. H. Dines, F.R.S

The progress of meteorology during the last fifty years has been very marked, as may be seen by a casual reference to the current meteorological literature of the period 1865–75; to a great extent, it resembles the emergence of astronomy as an exact science from the old astrology, but it must be confessed that the Newton of meteorology has not yet appeared.

Fifty years back the student of meteorology spent much of his time in a vain hunt for weather sequences, and the principle of *post hoc propter hoc* held full sway; the laws of motion and the more recently discovered laws of thermodynamics were in most cases completely ignored, or at least considered as not being applicable to meteorology. This has been largely changed for the better, and one does not now expect to find a cold area explained as being due to the descent of air in an anticyclone from a higher and colder region. Perhaps the pendulum has swung too far the other way, and mathematical analysis may sometimes be used when it is not applicable. On the assumption that air is a perfect fluid, it follows from a strict mathematical analysis that a sphere exposed to a steady current of wind will offer no resistance to that wind—a result obviously inconsistent with the facts. The assumption made cannot be justified, and one cannot help feeling that great caution should be used in making assumptions if the result of a complex mathematical investigation into a meteorological question is to be trustworthy. Mathematics, however, afford a most useful and often indispensable aid to meteorology, and of late years especially, although far from exclusively, by their means many useful deductions have been drawn.

It is impossible in a brief article to give any full statement of the present position of meteorology, but a short account of the great access of knowledge that has come to us in the last fifteen years or so by means of observations in the upper air may be of interest, the more so because the great central problem of meteorologists who live in temperate latitudes has always been the genesis and motion of cyclones and anticyclones which bring us our various types of weather, and this problem is most intimately interwoven with the upper-air observations.

A mass of detail remains to be filled in, but the salient facts of the distribution of temperature in the upper air are well established, and, at least for Europe, where some 1500 observations are available, are beyond dispute. We have also observations from Canada, the United States, and Batavia, and a few from Central Africa and the tropical Atlantic.

It has been found that the atmosphere is divided into two parts: a lower part, the troposphere, in which there is a lapse rate—that is, a fall of temperature with height—of about 6° C. per kilometre (17° F. per mile); and an upper part, the stratosphere, in which there is no appreciable change of temperature with height. The boundary between the two parts is in these latitudes quite sharp and distinct, but is not so well defined in the tropics. Its height varies with the latitude: for the South of England the mean is 10·6 km.; for Scotland it is 9·8 km.; and for the equatorial regions it reaches 16 km. It has also for temperate latitudes an annual variation, rising in the summer, falling in the winter. It should be added that the usual lapse rate is less than 6° per kilometre in the first three or four kilometres, is more than 6° above that height, and in regions of excessive cold, such as Canada or Siberia in the winter, may be absent or reversed in the lower strata. With regard to temperature, over the equator the stratosphere may be as cold as −80° C.; over Europe it has about −54° C. for its mean, but may vary from −40° to −70° C.

Confining, now, our attention to Europe, there is very little or no correlation between the temperature and the barometric pressure of the air at the surface, but a totally different set of conditions is met with as soon as the very lowest stratum—the first 2000 ft., say—is passed. From 1 km. and upwards there is a very high correlation indeed between temperature and pressure; between 4 and 8 km. the correlation coefficients are more than 0·85; they then fall off rapidly, so that there is again no correlation at the boundary between the troposphere and stratosphere. Above this, in the lower part of the stratosphere, the correlation is negative and reaches −0·30, but falls off with increasing height. Also the correlation between the pressure at 9 km. and the temperature at any height excepting the surface and the common boundary is very high, being positive for the troposphere and negative above 12 km. Since a low-pressure area at the surface remains so up to nearly 20 km., the correlation defined above leads to the following rules. In a cyclone the troposphere is relatively cold and the stratosphere warm, and, it may be added, the boundary between the two is much lower than usual. In an anticyclone the troposphere is warm and the stratosphere cold; also the common boundary is raised. The actual differences of temperature between a well-marked cyclone and anticyclone in the British Isles are about 10° C., the cyclone being 10° cooler from 3 to 8 km., and the anticyclone 10° cooler from 12 km. height and upwards. In the cyclone the common boundary is 3 to 4 km. lower than in the anticyclone.

The cause of these differences is still more or less a matter of conjecture and controversy. In my opinion the changes of pressure at heights of 8 or 9 km. are in some way brought about by the accumulated momentum of the general circulation, and the temperature changes that follow are easily explained by the laws of mechanics and thermodynamics. Thus I think that temperature changes in the upper air are the results, and not the causes, of cyclones and anticyclones.

In addition to the results obtained by observations of temperature and humidity by means of registering balloons, much work in the last fifteen years has been done by means of pilot balloons. A large portion of this remains to be worked up. Also a considerable advance has been made from the theoretical side in our knowledge of the motion of the air particles near the centre of a cyclone, and meteorologists have good cause for congratulation in the steady progress that is taking place.

PROGRESS OF GEOGRAPHY.

By Sir John Scott Keltie.

During the past half-century marked advances have been made in all the departments now included under the head of Geography, which has to deal with certain problems dependent on the constitution, configuration, and distribution of the surface features of the earth. In attempting to take stock of the results of the exploration of the unknown and little-known regions of the globe during this period, I think it is safe to say that we have to go back to the half-century which followed 1492 (when Columbus stumbled upon a New World) before we find a period so prolific. The two Poles have been reached and large additions made to our knowledge of the deep island-girt ocean which covers the Arctic basin, and to the vast ice-bound, mountainous continent near the centre of which the South Pole is located. The unknown two-thirds of the no longer "Dark Continent" have been more or less provisionally charted, and all but an insignificant fraction partitioned among the Powers of Europe. Great areas of North America have been surveyed, charted, and occupied, while much has been done for the exploration of Central and South America. The map of Asia has, to a large extent, been reconstructed, while the vast unknown interior of Australia has been traversed in all directions. Even much of Europe has been re-surveyed. A new department essentially geographical—oceanography—has been created as the result of the *Challenger* and other oceanic surveys.

Survey work not only in the official surveys, but also among explorers, has become more and more accurate, while methods and instruments have been greatly improved. These improvements, combined with the more thorough training available at the Royal Geographical Society and certain of the universities by would-be explorers, have greatly enhanced the scientific value of the results of exploring expeditions. Many of these in recent years have been accompanied by specialists, not only in strictly geographical subjects, but also in other departments of science—geology, biology, meteorology, anthropology, etc.—certain of the data of which are required in working out some of the problems with which it is the business of geography to deal. For, to quote from the presidential address of Sir Richard Strachey to the Royal Geographical Society in May, 1887:—

> There is no greater difficulty in recognising the legitimate place of geography as one of the sciences of observation, because of the close relation that subsists between the matters with which it deals, and those that fall within the scope of other branches of science, such as geology or biology, than there is in assigning the like character to chemistry and electricity, because of the interaction of the forces with which they specially deal, with those that constitute the principal subject of inquiry in other specialised fields of human knowledge.

Of course, apart from the gains to geography as an observational science, the other departments of science represented on these expeditions have greatly profited by the opportunity thus afforded.

The results of all this activity have been vast additions to our knowledge of the great features of the earth's surface, their constitution, their morphology, their distribution, their mutual relations, their influence on the distribution of all that the surface sustains, mineral, vegetable, animal, and, most important of all, man, of whom all the other factors form the environment. If we compare the maps of to-day with those of fifty years ago, they will afford striking evidence of the great additions which have been made to our knowledge of the face of the earth. The entirely unmapped has been enormously decreased, while marked progress towards accuracy has been made on the imperfectly mapped features. Great improvements have been made, especially in the British Islands, in cartography, both in the symbols adopted for indicating the physical features and in execution and workmanship. At the International Geographical Congress of Geneva in 1891, a great scheme was initiated for an international map of the world on the scale of 1/1,000,000. At subsequent conferences a series of regulations was drawn up to be followed by each country in producing a map of its territories, and a certain amount of progress has been made, though it is feared that the war has been a serious interruption. On the other hand, one important result of the war has been the production by the Royal Geographical Society, under the direction of the Geographical Section of the General Staff, of a map of Europe and the Near East on the lines of the international map which not only has proved of great service in connection with the war, but also will be of permanent value as the standard map of the extensive region dealt with. In general, it may be said that the maps and atlases of the present day reflect the marked advance which has been made in geography generally during the past half-century.

In recent years considerable progress has been made in geodesy. In 1899–1902 an arc was measured in Spitsbergen, while under the direction of the late Sir David Gill there was initiated the measurement of a great arc in Africa along the meridian of 30° E. If these arcs are connected through Asia Minor and Europe, a continuous measured arc of 105° would be obtained. The arc of Quito (Peru) has been re-measured under the direction of the French Academy of

Sciences, and it is hoped may be connected with the great arc in 98° W. which has been undertaken by the U.S. Coast and Geodetic Survey. Other arcs of special importance have been measured in Europe and Asia.

One of the great problems with which geography has to deal is that of distribution. It is obvious, on the face of it, that the many types of features which are distributed over the surface of the earth must have a potent influence on the distribution and activities of humanity, which lives and moves and has its being among them. There can be no doubt as to the influence of geographical conditions on history and other human activities, and perhaps even on race; but, as Ellsworth Huntington points out, the claims in this respect are often too vague to convince the sceptical historian. What we want is a more precise statement as to the nature and amount, the quantity and quality, in each case in this environmental influence compared with various other elements. Several attempts have been made to deal with the problem in recent years; definite areas should be selected and the problem worked out in detail on the spot.

In what precedes we have dealt mainly with the geosphere; but the hydrosphere is an important section of geography, both in itself and in its influence on the former. Hydrography is a convenient term to include the various forms in which water is distributed over the face of the earth—rivers, lakes, and the ocean itself. Potamology, or the study of rivers and their *régime*, has attracted much attention in recent years. Limnology, the study of lakes—depth, movement of their waters, distribution of life, physical nature of their basins—initiated by Forel in the 'eighties and 'nineties on the Lake of Geneva, has been continued in the Scottish lochs with voluminous results of high scientific value. But it is in oceanography that the greatest advances have been made during the half-century. A certain amount of work on a limited scale had been done in oceanic research, but it remained for the great *Challenger* Expedition during its 1872–76 cruise over the oceans of the world to create a new department of science under the name of Oceanography. This was followed by other similar expeditions in the *Siboga*, the *Planet*, and the *Michael Sars*, the result being a vast accumulation of data on the ocean in all its aspects—its depths, the nature of its bed, distribution of life at all depths, saltness, temperature, its surface and under-currents, and other features.

As the result of a movement initiated by the Royal Geographical Society in 1884, geography has obtained a place in education in Great Britain which it had never held before, while the standard of the subject has been raised to a much higher level. The subject has at last received ample recognition at Oxford and Cambridge and other universities in the kingdom, while radical reforms have been made in schools of all grades. On the university programme we have such heads as the Principles of Geography; Survey of the Natural Regions of the Globe; Land Forms and Morphology of the Continents; Meteorology, Climatology, and Oceanography; Human Geography in its Various Phases; Geographical Methods of Notation, and so on. This will show how high is the standard and how wide the field of the subject compared with the position even thirty or forty years ago.

Such, briefly, is a review of the progress of geography during the past half-century and its present position in this country. It has made vast advances in all directions and risen far above the lowly position assigned to it fifty years ago. Still it has by no means reached the position claimed for it by the late Sir Joseph Hooker; "it must permeate," he said, "the whole of education to the termination of the university career, every subject taught having a geographical aspect." Notwithstanding all that has been accomplished in the more or less scientific exploration of the face of the earth, much still remains to be done before our knowledge of its features is adequate. The great blanks which disfigured the map of Africa fifty years ago have, no doubt, been filled up, but it is doubtful if more than one-tenth of its surface has been mapped with anything like accuracy. Of Australia, large areas have only been provisionally mapped, and the same may be said of Asia. Even in the case of Canada and the United States much remains to be accomplished before these countries are as thoroughly mapped as the United Kingdom, India, and even Japan. Of South America, only fragments have been adequately mapped, and probably a million square miles are entirely unexplored.

Oceanography has by no means completed its task, though when Amundsen returns in four or five years' time he may be able to tell us all we want to know about the Arctic basin. While there is no need for a network of mapping on the Antarctic continent, still we desire further additions to our knowledge of its great features, its geology, its meteorology, as well as its resources, if there are any of value accessible. There remains ample room for work by trained explorers in many of the islands of the ocean. It is thus evident that plenty of work still remains to be done in exploration, in survey, in mapping, and in collecting the varied material which will enable the trained geographer to work out those problems which bear on the relations between man and his geographical environment. Happily, the marked educational advance during the last thirty years in the status of geography, and the great improvement in geographical education, have resulted in producing an increasing number of young geographers capable of dealing on scientific lines with the problems presented; in this respect we are rapidly approaching the standard which has for long been almost a monopoly of Germany.

PROGRESS OF PHOTOGRAPHY.

By Chapman Jones.

To most people fifty years ago, photography was represented by the "carte-de-visite" which they exchanged with their friends, and a few "views" which they bought now and then as mementoes. Some who were rather better-to-do preferred the larger "cabinets" which had been fashionable for two or three years. But there were also, as there had been for the previous thirty years or more, an increasing number of those who were really interested in the art and the science of photography. The Royal Photographic Society, then the Photographic Society of London, was sixteen years old, and there had been journals devoted to photography for about as long. The rapid rectilinear lens, which has enjoyed a greater popularity than any other lens, had just been introduced. The carbon process had already been practised commercially, but in that very year it received its final simplification by the elimination of the use of a cement to hold the exposed tissue on to its support during development. Large photographs had been made, one, 12 ft. by 7 ft., having been recorded in 1868. Photography in natural colours had had its history written, the principles of three-colour photography were understood, the nature of the developable image had been much discussed, and an electrical theory had been proposed. Actinometers had been devised. The kinematograph was represented by the zoetrope, or "wheel of life," a mere toy.

Thus it is obvious that when NATURE first saw the light photography had made very considerable progress, but its applications were hampered by its limitations. There was no plate sensitive enough for a photographic zoetrope, and the three-colour method of colour photography was not practical, because the plates available were insensitive to red and nearly insensitive to green. But the keys to the removal of these two great barriers to progress were soon to be found. Vogel's fundamental discovery that silver haloids might be made sensitive to red and to green by treating them with certain colouring matters was made within four years, and within eight years, during which gelatine had been coming to the front as a medium to replace collodion, Bennett found that by keeping gelatine emulsion warm for a few days the general sensitiveness of the plates coated with it was increased very many times. It remained, of course, to develop the possibilities thus demonstrated, and, equally of course, they were developed. During the 'seventies there were other notable matters. Printing in platinum was introduced, the replacement of glass by films received attention, and the photographic zoetrope became an accomplished fact in the work of Mr. Muybridge, of California.

In the 'eighties hand-cameras began to appear, isochromatic plates (that is, plates sensitised for green) were commercially produced, films were made practical, plates and films were coated by machines instead of by hand, and developing agents, which had hitherto been restricted to two or three, began to increase in number.

In the next decade, the 'nineties, Carl Zeiss issued the first anastigmat, which was soon followed by the products of other firms, and the mechanical, photographic, and optical difficulties of kinematography were largely overcome. Many new developing agents were introduced, and the chemical constitution apparently necessary to confer the power of development was elucidated.

In the early years of the present century much superior colour sensitisers for gelatine plates were found, and panchromatic plates became practically a new power in dealing with colour. The autochrome plate provided the first commercially practical method of photography in natural colours on a single plate and by one series of operations.

This brief sketch of some of the chief items of the history of photography for the period under review is necessarily very incomplete, but it gives landmarks that may help to picture the general progress. The applications to scientific and pictorial work, as well as to matters of immediate commercial importance, followed close upon each step that increased the scope of photographic methods, until in many cases these took the first place instead of a very subordinate position. We have examples of this in astronomy, in surveying, and especially in photo-engraving and block-making, for in this last case the hand methods have been rendered commercially obsolete. With the increase of facility the popularity of photography increased until now one regards any person who can say that he has never taken a photograph as something akin to a person who is unable to write.

The Editor asks me to say something as to the "promise of future advance." Photography in its essence is a pictorial method of recording, and may therefore be fitly associated with writing, though photography has the great advantage of being automatic. Besides this it has so many advantages that it will form a necessary part of the training of every well-educated person. Whether it will be a college or a secondary-school subject the educationists must decide, but it will form a necessary adjunct to the study of almost all college subjects. In the professional and commercial world its importance will be increasingly recognised as a means of rapidly getting unbiased records. The kinematograph is a photographic method of recording movement whether slow or rapid, and will therefore be increasingly appreciated both for scientific purposes and as a means of education.

As to pure photography—that is, the study of photography itself—we do not know what change takes place in silver salts when they are rendered developable. Of late this matter seems to have passed into the domain of atomic or molecular physics. We know little enough about gelatine, and want to know a great deal more. Gelatine has proved to be a better medium than collodion, but there seems no reason to suppose that a better than gelatine may not be found. We seem to have realised the maximum aperture (or rapidity) in lenses, but there is no such absolute boundary to the sensitiveness of photographic plates, and here we look for continued progress. One fundamental question: Why should silver occupy such a unique position among all the elements with regard to the sensitiveness of its salts?

REPRODUCTION OF ILLUSTRATIONS, 1869–1919.

By EMERY WALKER.

FIFTY years ago illustrations for books or periodicals were printed either from engraved wood blocks, steel plates, or were lithographs. In the earliest numbers of NATURE examples may be seen of the first method—in that of January 20, 1870, we find a diagram of a section of the tube by which it was proposed to construct the Channel tunnel; and in that of February 17 an illustration of the Newall telescope at Gateshead: these could scarcely be bettered now. The map illustrating the main drainage of London, in the issue of March 31, is an example of the inadequacy of wood for such a purpose.

Two years later Mr. Alfred Dawson patented a method of engraving designed to supersede wood, and though his object was not attained in subjects requiring tone, diagrams and simple maps were found at once to be better and more cheaply engraved by his process.

Dawson's typographic etching, as he named it, is produced thus: A metal plate is coated with a ground of wax composition; the drawing is made upon the plate through the ground down to the surface of the plate with steel points, similar to those used in etching, but they are faceted to different dimensions at the points. If lettering is wanted, as for a map or a diagram, the letters are stamped in the wax with ordinary printer's type. The spaces between the lines and letters are then raised upon the plate by the addition of melted wax, which unites with the ground and runs up to the line, and in the hands of a skilful operator stops there, thus forming a mould. This is then blackleaded, and upon it copper is deposited by a galvanic battery. When the copper is about the thickness of fairly stout brown paper it is taken off the mould and the outer surface tinned and "backed up" with antimonial lead. The leaden surface is turned in a facing lathe and mounted upon wood or metal, which brings the printing surface of the block to the height of type. It is then practically a piece of type and can be "set up" and printed with the text of the page.

This process was a development, with some refinements, of a method patented by Edward Palmer about 1840, and called by him "glyphography"; it was used to a limited extent for book illustration.

Dawson's typographic etching is still in use, and it may be interesting to note that the line blocks for the maps in Fortescue's "History of the British Army," and the greater part of those for the last edition of the "Encyclopædia Britannica," were engraved in this way.

In France a method called, after its inventor, "Gillotage" had been in use a few years earlier than this, by which blocks for the cheaper kinds of newspapers were made by transferring to zinc drawings made in reverse upon lithographic transfer paper, and the "whites" bitten away with dilute nitric acid. This process was introduced into England after the suppression of the Commune in 1871. The application of photography to this process was the beginning of a revolution in book illustration. For though wood-engraving held its own for many years after this for subjects in which chiaroscuro was required, it was gradually disused for drawings made in line, and the art of pen-and-ink drawing for reproduction began.

Artists soon got used to the new method, and there was a general demand for a process which would reproduce not only drawings in line, but also those made in washes or body colour, and would be suitable for the direct reproduction in the printing press of a photograph from nature. This was met simultaneously by F. E. Ives, an American of great photographic distinction, and by a German inventor, Meisenbach. Ives's process, though beautiful results were obtained, was too complicated for general use, and Meisenbach's process, called in English "half-tone," held the field. The negative of the drawing to be reproduced was made by photographing through a screen of parallel lines placed close to, but not touching, the sensitive surface of the photographic plate, and when the exposure was half-completed the lens was covered and the screen turned round so that the lines ran in the opposite direction to that in which the screen was first placed, and the exposure completed.

This was in 1882. The result was rather crude and deficient in variety of tone. The real advance was made by the invention, by Max Levy, of Philadelphia, of a new screen composed of two ruled glasses placed in contact at right angles. Max Levy's screens were imported largely, and from this time England, which had been, in the earlier stages of the invention, dependent upon Vienna, and to a smaller extent upon Paris, for half-tone blocks, went ahead, and now half-tone work made here is not second to that of any country in the world. It is used, not only in books, but also for the illustration of daily papers.

The most important invention since Meisenbach's is the three-colour half-tone process. This was based upon James Clerk Maxwell's researches made so long ago as 1861. The drawing or object is photographed successively through three colour filters: for the red negative a green filter is used; for the blue, a red; and for the yellow, a violet or blue filter.

A half-tone block is made from each colour negative, an operation requiring the utmost accuracy to get register, and the screen is placed at different angles to get white into the interstices of the grain and to prevent an effect like that of "watered silk."

In all these processes intended for the letterpress machine, the metal plate, for rough work of zinc, and for more delicate work of copper, is mounted "type-high" in the manner described above.

A more recent invention obviates the use of the objectionable but necessary shiny coated paper: An impression is made from a half-tone plate upon an india-rubber roller and transferred to the paper, which may have an ordinary or even a slightly rough surface. Excellent work has been done with some subjects by the application of this method to the three-colour process, but so far the average results are not equal to those obtained by the use of blocks upon glossy paper. This is called "Off-set."

A very important photographic process, used until lately more on the Continent than in England, where it was first introduced in 1870, is collotype; or, as it was known in earlier days here, "heliotype." Mungo Ponton, in 1839, used bichromate of potassium, and Fox Talbot, in 1851, discovered the action of this chemical in making a gelatine film sensitive to light. When a negative is printed upon a film of gelatine so sensitised, it absorbs moisture in inverse ratio to the amount of light it has received, and when by means of a roller a greasy ink is applied to it, it takes the ink in the ratio of its dryness, and so gradation in the print is obtained. The advantage of this method of reproduction is that it is not necessary to use the glossy coated paper, which is essential if one is to obtain the best result from either a half-tone block in black or from a set printed in three colours. The disadvantage is that it cannot be printed on a letterpress machine in the same way as a block.

This process is unrivalled for facsimiles of documents and early manuscripts. But for the reproduction of pictures and illustrations requiring a greater depth of tone, photogravure remains without a rival at present. It is interesting to note that Niepce de Saint-Victor, in 1847, had produced a photogravure plate. He coated a copperplate with bitumen of Judea and exposed it to the action of the sun under a line engraving, which acted as a photographic positive, afterwards biting the protected lines into the copper, and etched a plate which could be printed on a copperplate press.

Since that time many modifications have been made, the more important being the process invented by Rousillon based upon a beautiful invention of Walter Bentley Woodbury, patented in 1866, and introduced by Messrs. Goupil, of Paris, early in the 'seventies, which was an electrotype from a gelatine mould in relief; and that by Klic, of Vienna, who invented the method now most generally used: A copperplate is covered with an aquatint ground made by dusting powdered resin or bitumen of Judea on it and then melting it with a gentle heat. This causes the particles to run together in little "hills," leaving minute "valleys" between them. Upon this plate an ordinary carbon positive made from a reversed negative is squeegeed down and developed. When it is dry it is placed in a bath of perchloride of iron. This acid bites through the gelatine of the carbon positive and into the copper, the depth being graduated by the varying thickness of the gelatine of the carbon positive. When the biting is completed the gelatine is cleaned off, the copperplate inked by filling the interstices or pits and the excess of ink wiped off, first with canvas and fine muslin, and, finally, with the printer's hand, and an impression taken upon damped paper in the same way as from a copperplate engraved by hand.

An adaptation of photogravure to machinery was made at Lancaster about twenty years ago. It consists in applying Klic's method to a copper cylinder by the use of a half-tone screen instead of a grain produced by bitumen or resin. After inking the surface of the cylinder it is wiped to remove the superfluous ink and impressions on paper are made by a rotary motion at a great rate. The process is now largely used for illustrations for weekly illustrated newspapers and magazines.

PROGRESS IN SCIENCE TEACHING.

By Sir William A. Tilden, F.R.S.

A MAN who remembers clearly the first Great International Exhibition in 1851, and was at school through the period of the Crimean War, can no longer claim to be ranked among young men or even the middle-aged. But, with all the disadvantages of age, there is something to be said for the satisfaction and practical use of personal reminiscence. The days of school life which I can recall were practically pre-scientific, for, though one or two schools, such as the Quaker School at Ackworth, included elementary science in their programme, the utmost attempted, as a rule, was a visit from a peripatetic teacher, who came, like the dancing-master and the drawing-master, once a week or a fortnight. This was the practice at a school in Norfolk at which

I was a pupil in 1856. It was kept by a kindly old clergyman, who would, in the occasional absence of the lecturer, quack a bit himself and sometimes show experiments, not always well chosen. I remember seeing the cruel operation of putting a mouse under the receiver of the air-pump and extracting the air. And though Stockhardt's "Experimental Chemistry" was the text-book, the boys made no experiments for themselves, but were required to commit to memory passages from the book, such as "iodine has a violet vapour." There were no school laboratories in those days, even in the great public schools, neither was natural science so much as mentioned in the great majority of the schools in the country.

There can be no doubt that the Great Exhibition in 1851 set many people thinking, for in 1853 the Department of Science and Art was created with the object of assisting in the establishment of local science schools and classes. Many of the first created schools failed, and in 1859 the only classes in actual operation under the Department were at Aberdeen, Birmingham, Bristol, and Wigan.

The difficulty at that time arose chiefly from the scarcity of competent teachers willing to undertake the work, and a system was therefore inaugurated by which persons who passed the examinations held by the Department were considered qualified to teach and to earn payment on results. The system, with modifications, grew to gigantic proportions, and, whatever may have been said in later years in the way of criticism by those who object to all kinds of examinations, there can be no doubt that the existence of these classes served to spread an elementary knowledge of physical and natural science very widely through the country, and especially among the industrial classes, who would otherwise never have found their way into any place of higher instruction.

With regard to the introduction of systematic teaching of science into public schools and others of similar rank, there is the evidence of the Rev. W. Tuckwell, headmaster of Taunton School, who, in a paper contributed to the British Association at Exeter in 1869, stated that science had been taught at Taunton "for the last five years" and at the rate of not less than three hours a week. This was, however, a marked exception, for from the first report of the Duke of Devonshire's Commission it appears that in 1864 science did not exist in the programme of the largest and most famous schools. Very soon after this, however, systematic teaching, associated with practical work, began at Clifton, Rugby, and the Manchester Grammar School, and this example was soon followed elsewhere. Nevertheless, the Commissioners reported that in 1875, of 128 endowed schools examined, not one half had even attempted to introduce it, while only thirteen had a laboratory, and only ten gave so much as four hours a week. It was uphill work. Obstruction was rampant, not only among the headmasters, but also in the old universities to which the schools passed on their boys. The distribution of scholarships at that time was most unfair, and mischief was done by the procedure of the Oxford and Cambridge Schools Examination Board, which sent down examiners, sometimes ill-qualified for their office, who set unsuitable questions from the text-books with very little reference to the teaching.

At the present day all the great schools are provided with spacious laboratories and an equipment generally superior to that which was to be found in many British universities fifty years ago. Moreover, there is now a large body of highly efficient and enthusiastic teachers, not only in the schools for boys, but also in the high schools for girls, which have sprung up since that day. The science masters have formed an association which includes representatives of all the great public schools and many others—in all, upwards of three hundred members. The science mistresses have a separate association of their own, and as the problems they have before them are very nearly the same as those which interest the masters, it seems a pity that the two associations are not amalgamated. The existence of these associations and the position of influence to which the Association of Science Masters has attained show the changed position of physical and natural science as a school subject. There are, however, schools still where the headmaster stands in the way of the development of science teaching; there is the persistent, ignorant demand on the part of the public for those subjects only which are supposed to lead immediately to remunerative business; there is the almost total ignorance in Whitehall, in Parliament, and in the Ministry of the commonplaces of physical science; there are the indifferent methods still employed in classical teaching whereby an enormous waste of time is incurred: all these are circumstances which operate perennially against that kind of recognition of physical science in education which is essential to national progress, and must continue to be the subject of conflict until a state of balance between the advocates of the old and of the new has been established.

From the schools we may now turn to see what has been accomplished at the universities. In the early sixties of the nineteenth century the position of science at Oxford is indicated by the fact that Dr. C. G. B. Daubeny occupied down to 1867 the chair of chemistry simultaneously with that of botany. An undergraduate who chose to "go in for stinks" could attain a degree, but it was B.A. Daubeny's successor, Sir Benjamin Brodie, was a distinguished chemist, and in his evidence before the Royal Commission in 1873 he plainly stated his view that Oxford did nothing to extend scientific knowledge—that is to say, that research was not encouraged. At Cambridge things were in much the same position. There were some distinguished scientific professors, of whom Stokes was one of the most eminent, but there was no university laboratory, though one had been opened at St. John's College. At this time and for many years afterwards serious students of chemistry and some other branches of science resorted to the German universities for the instruction which they could not obtain in their own country in the higher parts of their subjects and in research, usually returning with the Ph.D. degree. In London the only chemical laboratories for the reception of students were at the Pharmaceutical Society (opened in 1844), at the Royal College of Chemistry (opened in 1845), at University College, at King's College, and at the Royal School of Mines in Jermyn Street. But a great step forward was taken when in 1860 the University of London founded for the first time in England a Faculty of Science and began to hold examinations for the degrees of Bachelor and Doctor in that faculty. The effect was immediate and extensive. The programme put forth appeared formidable, but it provided at once a stimulus and a guide to all the numerous casual students scattered throughout the kingdom, some attending classes of the Science and Art Department or mechanics' institutes, some engaged privately in evening study after business. As a simple matter of autobiography, my case was one of the latter kind. I was then a young demonstrator in the laboratory of the Pharmaceutical Society, but I was fairly well up in the physics and chemistry of that day. I also held a Science and Art certificate as a teacher of botany. The matriculation was the chief obstacle, as I had practically learned no Greek at school. This, however, diligence enabled me to surmount, and by 1868 I got my B.Sc. with First Class Honours in chemistry.

My case must have been very similar to that of dozens of young men at that time to whom came the opportunity of getting a stamp or brand without the necessity of throwing up the occupation by which they were getting a living. But it did more than that, for the syllabus of subjects comprised the whole circle of the sciences, including, besides the various departments of natural and experimental science, logic and moral philosophy, so that candidates were required to show at least a rudimentary knowledge of the subject-matter of various branches of human knowledge of which they would otherwise have remained totally ignorant. My own experience leads me to think that this "little knowledge," which, according to Pope's mistaken aphorism, is "a dangerous thing," is of great value even to the specialist. A *Doctor* of Science ought, and is supposed, to be an expert in some direction or other, but not long ago I met a London D.Sc. who had never heard of Bishop Berkeley. This curious fact revealed a state of ignorance of all philosophy and much more which he would have escaped had the old regulations been retained. This is, of course, now past praying for, and research, which implies specialism, is the order of the day. It is only consolatory to reflect that anything which induces concentrated thought has an educative effect on the young mind.

One of the greatest movements for the promotion of education in general, and conspicuously in the encouragement given to scientific teaching and research, was the foundation of the university colleges and new universities distributed over the country. In Manchester the college which became the nucleus of the present Victoria University had been founded by John Owens in 1851, while in London University College (the original University of London), King's College, and Bedford College were already in existence. But in 1871 the first step was taken towards the extension of similar benefits to other parts of the country. In the first instance these institutions subsisted on endowments provided by private benefactors, supplemented by aid from local subscribers or such bodies as the Guilds of London. But in a very few years these were found to be insufficient, and serious financial embarrassment had to be faced. After repeated applications to the Government for assistance, and a long struggle, the battle was won, and in 1889 State aid was granted in the form of the very modest amount of 15,000*l.* per annum, to be divided among the English colleges. Sir William Ramsay was one of the most active promoters of the movement, and the full story is recorded in his "Life" (Macmillan).

As to the future of scientific discovery, who can tell? The wonders which have been successively revealed during the last fifty years should teach us not to be surprised at anything. Co-operation among workers and organisation may do something in the way of gathering up knowledge of Nature, but whatever is done by Governments, institutions, or individuals, one consideration should ever be kept in view, and that is that genius will find its own way, and it would be worse than useless to prescribe subjects, or methods, or opportunities to the man who has been gifted by the gods.

ASPECTS OF SCIENCE AT UNIVERSITIES.

BY DR. ALEX HILL.

DOUBTLESS the provision made by the universities of the United Kingdom for the teaching of science and for research is still inadequate. It always will be. The occupation of the field and its extension is a single process, not a process and its result; since the farther man explores, the wider is his vision of the unexplored. The improvement which has marked the past fifty years is roughly proportionate to the growth of knowledge and to the investigator's success in utilising it for the meeting of human needs.

Oxford, Cambridge, the four Scottish universities, Trinity College, Dublin, Durham (with no Newcastle College of Science), and London were the only universities in 1869. To these must be added Owens College, still in the house in Quay Street "to which a chemical laboratory and a large lecture-room had been added." In science Cambridge led the van with, possibly, University College, London, as her nearest rival. It is unsafe to adopt an order of merit. Much depends upon the point of view. Edinburgh, for example, in the biological aspect, might lay claim to precedence. We may take Cambridge and University College as examples of the provision made for science, then and now, seeing that space will not allow of a fuller treatment of the subject.

Science attained to the status of a department of knowledge when the Natural Sciences Tripos was established. The first examination was held in 1851. Yet for many years the various branches of natural science were regarded as possible substitutes for the humanities in the education of a gentleman, rather than as vehicles of a grim and strenuous discipline for the work of life. Science was Whewell's *forte,* omniscience his foible. The Tripos was reminiscent of his influence. All branches of science ranked alike. A candidate's place depended upon his aggregate of marks. To secure a first class he must show that his knowledge, like that of the stupendous Master of Trinity, ranged from zoology to mineralogy.

The institution of the Tripos was a powerful stimulus to scientific study. New buildings were erected in 1864 and 1865, yet the contrast between the accommodation and equipment of the various departments, in 1869 and to-day, is so marked as to be amusing. Salvin's building was a palace as compared with the hovel in the south-east corner of the old Botanic Garden, erected in 1786 by Mr. Bradwell, bricklayer, and Mr. Kaye, carpenter, both of Cambridge, in which, until 1864, all departments, with the exception of geology, had been lodged; a building which for several years after that date was shared by the professor of chemistry and the professor of anatomy (including comparative anatomy and comparative physiology). The lecture-room on the upper floor of this building was well lighted, but the metallurgical laboratory on the ground floor, and the cabinet in which, if possible, a body was dissected every year, were dark and inconvenient in such degree as seemed appropriate to the evil-smelling and repulsive rites to which they were devoted.

Salvin's building, which was enlarged later by the addition of an upper story, provided accommodation for mineralogy, botany, zoology, and natural philosophy. For long the block was known as the "New Museums," since the greater part of its space was given up to the housing of the herbarium and the collections of minerals and of zoological specimens. Museums, be it noted, were considered, in those days, as of far more importance than laboratories for the teaching of science. The geological collection was stored—it would be misleading to write "exhibited"—in Cockerell's building, now given up to the university library.

To-day the whole of the old Botanic Garden, with much surrounding property from which houses have been cleared, together with about six acres on the opposite side of Downing Street, is covered with noble buildings. Fortunately, they are not too noble. For the most part, they look as if they were intended for the purposes for which they are used. Cambridge is happier than some modern universities in this respect. The dignity of science is not enhanced by Gothic or Palladian architecture. Science looks to the future, not to the past. Steel girders and sheets of glass can be rearranged to meet new needs. The cotton-mill style is the only style appropriate to museums and laboratories. Proportion, light, ventilation, and convenience of access of the building as a whole and of its several parts are the only merits for which the man who designs them can lay claim to renown.

Excluding the professors of mathematics and astronomy, the scientific staff of the university comprised the professors of chemistry, anatomy, botany, geology, natural philosophy, and zoology, each of whom received a yearly stipend of 300*l.*, together with a demonstrator of anatomy, who received 100*l.*, and an attendant at the chemical laboratory. These officers alone were paid out of the University Chest. Additional assistants, lecturers, and demonstrators were to be found in some departments, but their employment was the professor's private affair. To the university staff must be added a lecturer in natural science at Trinity, two lecturers at St. John's, a medical lecturer at Caius, the superintendent of the laboratory at Sidney, and two lecturers in medicine and natural science at Downing. To-day we find nineteen professors of natural science and seventy-three readers, lecturers, and demonstrators on the university staff, and forty-three college lecturers.

The lures set in the gates of science were scarce likely to beguile a student from the broader ways. "Three-quarters of all university prizes and more than one-half of all college prizes are awarded for classics and English," the Calendar boasted in 1869. English might as well have been omitted. It could not stand alone. The only prize for natural science was the Sedgwick. Thirteen names appeared in the Natural Sciences Tripos, against 111 in the Mathematical and 73 in the Classical class-lists. In 1914, 153 men and women took honours in the Natural Sciences Tripos, against 121 in the Mathematical, 113 in the Classical, and 352 in the various other Triposes which have come into existence in recent years.

At University College, London, the laboratory accommodation was singularly modest, as, indeed, it remained until quite recent times. The steady flow of discovery which has issued from the cramped, dark, inconvenient chemical laboratory is testimony to the genius of the men who have successively occupied the chair. Students were not expected, in 1869, to do practical work, as understood to-day. The writer recalls sitting in a row of other students, in 1872, pulling petals from flowers and filling his notebook with floral diagrams; attending demonstrations in the physical laboratory; dissecting, when it came to his turn, a rabbit to be inspected by the class, whilst Prof. Grant, in the dress-coat, brocaded vest, and white cravat of the Georgian period, discoursed philosophy, with occasional reference to the rabbit. In the chemical laboratory students worked in relays, but so limited was its space that the lecture-theatre had to be fitted for the examination in practical chemistry by clamping a tray for each student on to the sloping board on which, during lectures, the notebooks rested. A similar description would apply to the laboratories at Edinburgh, Glasgow, Dublin.

Provision for teaching and research has kept step with the uses to which scientific knowledge has been turned. The distinction drawn between pure science and applied science is essentially unsound and wholly mischievous, as if the purity of science were sullied whenever the problem to be solved is suggested by an immediate human need. The discoveries made by an investigator who has a practical application in view are as truly additions to the sum of human knowledge as those which reward a worker who is following a line of research which can never, so far as he is aware, contribute to man's comfort. In most cases the practical man also advances the grasp of pure science by directing attention to gaps in theory, and by asking the professors questions which they cannot answer. The universities have been slow in realising their duty to the crafts and manufactures. It is greatly to be hoped that, in the near future, we shall cease to hear of independent bodies set up for the purpose of carrying out either "scientific" or "industrial" research. There is but one Science, and the universities are the instruments for extending its range.

FIFTY YEARS OF TECHNICAL EDUCATION.

BY J. H. REYNOLDS, M.Sc.

JUST fifty years ago there appeared a remarkable book, the fruit of much thought, experience, and wide travel, entitled "Systematic Technical Education for the English People." Its author was Mr. J. Scott Russell, F.R.S., the designer of the *Great Eastern*, the largest vessel of that time, which rendered singular service in the laying of the first Atlantic cable. The volume was dedicated to the Queen, and the purpose of the dedication was declared to be "to entreat her Majesty graciously to consider the case of the uneducated English folk who are now suffering great misfortune in their trade, commerce, and manufactures, as well as in their social, moral, and intellectual condition, through having been neglected and allowed to fall behind other nations better cared for by the men whose duty it was to lead as well as to govern the people." The Queen was urged "to issue her Most Gracious Majesty's commands to her Majesty's Ministers to see to it that for the future the dexterous, energetic, willing working people of England receive at the hands of the Government a practical education for useful life as thorough and systematic as the best-educated nation in Europe."

Mr. Scott Russell declared that the condition of English education, both general and scientific, compared very unfavourably with that prevailing in Continental countries, notably in Prussia, Saxony, Württemberg, and Switzerland, whilst no provision worthy of the name existed for technical education and training, which were abundantly provided for all grades of workers in industry and commerce in all the countries named. He called in evidence the lessons taught by the Great Exhibition of 1851, which owed its origin to the enlightened views of the Prince Consort, and in which the civilised nations of Europe received their first lessons in technical education. Our superiority in machinery and its products was manifest, whilst in articles demanding beauty and grace of design we were plainly lamentably far behind some Continental nations. Mr. J. Scott Russell concludes his book by pleading for the appointment "of a powerful statesman to be Minister of Public Education with a strong will; a complete organised plan of a people's teaching; a determination that, at whatever cost, the English people shall become in one generation the best-educated nation in Europe—and it will be done." We have at last such a man in the present President of the Board of Education, and it is to be hoped that he may so remain and be given the means to carry out the essential reforms embodied in the great Act of 1918.

The enormous progress made by the several important nations as a result of the object-lesson of 1851 was made clearly evident at the exhibition held at Paris in 1855. England was no longer, in consequence of the establishment of schools of design and the circulation of the best models in the areas affected, outstripped in pottery and glass, whilst, on the other hand, foreign nations, such as France and Germany, recognising the advantage which England enjoyed in the possession of abundant raw material, such as coal, iron, and steel, together with skill in adapting them to the purposes of industry, and realising that the only effective way of meeting it was to apply higher science and research in their treatment and application, had already, with this aim in view, established schools for the education and training of both masters and workmen, with the result that their engineering exhibits made a remarkable display.

The International Exhibition of 1862 held in London showed a further striking advance on the part of foreign nations: Switzerland with her aniline colours, Prussia with her ingots of Krupp steel, France with her steam-engines, and the United States with ingenious machinery for economising labour. But it was the Exhibition of 1867, held in Paris, which offered conclusive and disturbing evidence of the successful efforts of foreign nations in the application of organised scientific and technical education to manufactures, especially in the production of well-designed steam-engines, boilers, ships' armour, and artillery.

In the great ironworks at Creusot, in France, there was established a systematic organisation of technical schools such as could be found nowhere in England. It was the considered judgment of skilled observers and of representative workmen in various trades who visited the exhibition that England no longer held the preeminence in industry which was surely hers in 1851, due, as was declared, entirely to the absence of sufficient facilities of training in pure and applied science. The Science and Art Department, founded in its entirety in 1853, had encouraged the establishment of evening classes in science and art, but they reached only a fraction of the workers, and except in a few instances they had little bearing upon the technology of industry. It may safely be said that in 1869 out of 1,250,000 youths engaged in industry not more than 5 per cent. were receiving any training in applied science in the day and evening institutions of the kingdom.

The period of trade depression that followed after the year 1869 and the awakening of the nation to the serious industrial competition of certain foreign nations, largely due to better educational provision, notably of scientific education, especially for the leaders of industry, gave rise to earnest efforts to provide the means of scientific and technical training in this country. The Livery Companies of the City of London joined with the City in the creation of the City and Guilds of London Institute in 1879, the purpose of which it was to provide a day and evening technical college at Finsbury (opened in 1883) for boys purposing to enter upon industrial pursuits, together with a central college at South Kensington, opened in 1884, for the training of future industrial leaders and teachers of technology. In addition, the aim of the institute was to encourage the establishment of technological classes throughout the kingdom and to set up a system of examinations in the subjects. Large annual sums were subscribed in support of these objects, and certificates, prizes, and medals were awarded to successful students.

Considerable annual grants were given in aid of the establishment of technical schools in Manchester, Sheffield, and other places, and the Company of Clothworkers made itself responsible for the establishment and support of a textile department at the Yorkshire College, Leeds, whilst the Company of Drapers founded and supported the People's Palace, now the East London College. The interest aroused in the subject of technical education and the rising competition of Continental nations led the Government to appoint in July, 1881, a Royal Commission "to inquire into the instruction of the industrial classes of certain foreign countries in technical and other subjects for the purpose of comparison with that of the corresponding classes in this country, and into the influence of such instruction in manufacturing and other industries at home and abroad." The Commission presented in 1884 an exhaustive and highly informing and stimulating report after nearly three years' inquiry not only in Europe, but also in the United States, which had a profound effect upon public opinion, and led to the passing of the Technical Instruction Act of 1889, which empowered local authorities to rate themselves for the support of technical schools. This was followed by the Act of 1890, whereby nearly 800,000*l.* annually derived from the customs and excise duties was placed at the disposal of local authorities for purposes similar to those of the former Act.

This resulted in the establishment, chiefly by the local authorities, of technical schools and colleges throughout the kingdom, a few of which were effectively equipped and staffed for the training of qualified day students intended for leading positions in the various industries, and some of these schools, like those of certain London polytechnics, Manchester, Glasgow, Sheffield, Bristol, and Belfast, came into intimate relations with their respective universities. The Education Act of 1902, which placed all grades of education, exclusive of the university, under the control of the local authority, had a unifying effect which made it possible to correlate the various forms of education and to bring the opportunity of secondary and technical training within reach of the poor but capable scholar.

Meanwhile, many important industries, notably those producing scientific instruments, chemical ware, fine chemicals, and especially artificial dyestuffs, had passed largely into the hands of German and Swiss firms, as witness their exhibits in the Paris Exhibition of 1900, due entirely to the command on their part of an effective supply of efficient scientific workers, so that they held the "key" of our textile trades so far as printed and coloured goods were concerned. The course of the great war has made clear, however, the innate capacity and resource of the English manufacturer in these and other products of foreign origin, as well as in the fertility of his invention and in the success with which he has met and solved many technical problems arising during its course. Striking evidence of this was displayed in the exhibitions of British scientific products held in London and Manchester in 1918, and in London in 1919, under the auspices of the British Science Guild—an organisation established to further the cause of scientific and technical education and promote attention to scientific method in all national affairs.

Another fruit of the war is the awakened interest in the subject of education on the part of large employers, and especially of the importance of scientific training and research. A Committee of the Privy Council has been instituted for the purpose of encouraging scientific and industrial research, with numerous sub-committees dealing with various sections of industry and with special products. Ten research associations have been formed in respect of the chief industries, and twenty-eight important researches have been undertaken and aided from the fund of 1,000,000*l.* placed at the disposal of the Committee by Parliament.

The Education Act of 1918, which should be made operative without delay, will, when it comes into full effect, supply a far higher type of student for our arts and industries. As showing the advance within the last fifty years, there were at the beginning of that period only four universities which granted degrees in England and Wales, one of which (London) was merely an examining body. Now there are eleven duly incorporated, with numerous colleges attached to them, many of them chiefly concerned with technical training and education. These universities are all well equipped and staffed for the teaching of science and its applications, in the encouragement of which this journal has borne no small share since its foundation in 1869.

Yet we have still far to go if we would keep ourselves abreast of foreign educational enterprise. There were in 1914 twenty-one universities in Germany, with 68,000 students, against eighteen in the United Kingdom, with 27,000 students. There were also eleven technical high schools in Germany, and sixteen other special high schools for agriculture, mining, etc., with 21,000 students, as against 5000 in ours, and in both age and standard of education at entrance their students rank much higher than ours. The State grants to universities and colleges in the United Kingdom were about 500,000*l.*, in Germany nearly 2,000,000*l.*, and in the United States 7,000,000*l.*, but in addition there was given nearly 4,000,000*l.* in private benefactions, as compared with 200,000*l.* in the United Kingdom. To maintain our position as a leading nation in industry and commerce, we need to increase the potentiality of our manhood, to secure which will require a much larger expenditure of money and effort. We want accomplished leaders and a well-educated and highly trained rank and file.

THE PROMOTION OF RESEARCH.

By SIR RICHARD A. GREGORY.

The great inventions of former ages were made in countries where practical life, industry, and commerce were most advanced; but the great inventions of the last fifty years in chemistry and electricity and the science of heat have been made in the scientific laboratory: the former were stimulated by practical wants, the latter themselves produced new practical requirements, and created new spheres of labour, industry, and commerce.—J. T. MERZ.

THE recognition of the value of scientific research as a determining factor of progressive development has been a common note of many public utterances in recent years. Ministers and labour leaders, manufacturers and men of letters, are impressed with the results of experimental inquiry and do homage to those who devote their lives to it. Rarely, however, is the spirit which prompts most scientific investigations understood. "The quickening power of science, only he can know from whose soul it gushes free." It seeks not to use, but to know: its aim is not an engine of war or a profitable invention, but the discovery of new knowledge and the creation of new ideas for all mankind. Researches which have practical applications as their proximate or ultimate ends are not likely in these days to need much advocacy for their support, but those which have no such aims must, like virtue, carry their own reward with them. The standard of value to-day, more than ever it was, is worldly riches, and if all research had to be measured by it science might gain the whole world, but it would lose its own soul by so doing.

When the State or the manufacturer makes provision for research, tangible results are expected, and freedom to explore what, from a practical point of view, seem to be unpromising by-paths is discouraged. To a certain extent Mr. Gladstone was right when in 1872 he termed the intervention of the State as "interference" with science, calculated to discourage individual exertion and so obstruct discovery and progress. The view then taken was that the more science was left to itself the better for it. We are far from accepting this *laissez faire* principle entirely, but there is some truth in it so far as purely scientific research is concerned. Creative genius never has been, and never will be, willing to submit to bureaucratic control or industrial needs, yet it discovers the new lands in which rich fruits are afterwards cultivated for the benefit of the world. While, therefore, we acknowledge with much satisfaction the growing appreciation of research as a means of promoting industrial advance, we trust that the apparently useless and unpractical pursuits of purely scientific workers will be regarded as equally worthy of encouragement.

When the publication of NATURE was begun fifty years ago, experimental research received little or no support from the State. Astronomical work was carried on at the Royal Observatory, Greenwich, and natural history objects were displayed at the British Museum, but there was absolutely no provision in this country for the support of experimental investigation of a modern type. It was pointed out in these columns in 1872 that great laboratories had been erected in Berlin, Leipzig, Bonn, Aix-la-Chapelle, Karlsruhe, Stuttgart, Griefswald, and other places, at the expense of the State, and special provision had been made in them for original scientific research, but no like developments had taken place here. When a deputation of the Council of the British Association waited upon Earl Grey, Lord President of the Council, in 1870, to urge on the Government the issuing of a Royal Commission to inquire into the state of science in England, Lord Grey thought that the whole inquiry was fraught with difficulties, but the object was worthy of a statesman's ambition. The Commission was appointed in the same year, with the seventh Duke of Devonshire as president and Sir Norman Lockyer as secretary; and the volumes of its reports issued from 1871 to 1875 are filled with convincing evidence and far-seeing suggestions.

The terms of reference of the Commission were "to make inquiry with regard to scientific instruction and the advancement of science, and to inquire what aid thereto is derived from grants voted by Parliament, or from endowments belonging to the several universities in Great Britain and Ireland, and the colleges thereof, and whether such aid could be rendered in a manner more effectual for the purpose." The whole position of science in the United Kingdom was surveyed in the volumes of the report of the Commission; and had the recommendations of the Commissioners been acted upon, we should easily have been in advance of all other countries in the applications of science to industry, and have been strongly equipped for all eventualities of peace or of war. Our statesmen had not sufficient knowledge of science to understand its relation to national advancement, or sufficient faith in scientific discovery to believe that provision for it would ultimately benefit the community industrially and politically; and we lost ground in consequence of their neglect.

One of the recommendations of the Commission was that a special department of science should be entrusted with the duty of promoting the scientific interests of the country. It was proposed that a Ministry of Science should be constituted, with a permanent and well-paid scientific council to advise the Government on scientific questions, consider inventions tendered for the use of the State, and conduct or superintend experimental investigations relating to such matters. The Department of Research and Information outlined in the Report on the Machinery of Government issued by the Ministry of Reconstruction a few months ago is intended to serve much the same purposes as were contemplated by the Duke of Devonshire's Commission. It is permissible in this connection to recall a communication to NATURE of June 15, 1871, in which Lt.-Col. A. Strange described the work which a Ministry of Science could undertake, and added, in words which are as apt to-day as they were when they were written:

> When we have all scientific national institutions under one Minister of State, advised by a permanent, independent, and highly-qualified consultative body—when we have a similar body to advise the Ministers of War and Marine in strategical science—then the fact that, in accordance with our marvellous constitution, these ministers must almost necessarily be men without pretension to a knowledge of the affairs which they administer, need cause us no alarm. When these combinations have been, as they assuredly will be, sooner or later, effected, the wealth, resources, and intelligence of the nation, having due scope, will render us unapproachable in the arts of peace and unconquerable in war—but not till then.

Though the Ministry of Science advocated fifty years ago has not been realised, the Department of Scientific and Industrial Research established in 1916 fulfils many of its functions and is likely to undertake further work for the co-ordination and development of national scientific activities if the recommendations of the Report on the Machinery of Government are ever carried out. The Department has a fund of one million pounds voted by Parliament as a block grant to be expended over a period of five or six years. This fund is being used to make grants towards the foundation and maintenance of approved associations for research on a co-operative basis. In addition, the Department has at its disposal an annual Parliamentary vote to cover the cost of researches not undertaken by the research associations, to provide grants to research workers, and for administration. The Department also now administers the National Physical Laboratory, which was founded in 1899, and to which the sum of 155,000*l.* is allocated in the Civil Service Estimates for the current financial year.

National provision for scientific work has thus been considerably extended in recent years. The official attitude of earlier days was represented by a reply which the Lords Commissioners of H.M. Treasury made to an application from the British Association in 1872 for a grant of 150*l.* to secure the continuance of some important tidal observations. The reply was:

> I am to state that their Lordships have given their anxious attention to the memorial, and that they are fully sensible of the interesting nature of such investigations, but that they feel that if they acceded to this request it would be impossible to refuse to contribute towards the numerous other objects which men of eminence may desire to treat scientifically. Their Lordships must, therefore, though with regret, decline to make a promise of assistance towards the present object out of public funds.

It will be evident from this example of the position of State support for science in England in 1872 that much remained to be done in order to change the official mind which after "anxious attention" had to express "regret" that the Government of these islands could not provide the sum of 150*l.* for tidal observations because further demands might be made for the support of other investigations. It is not too much to say that NATURE has been largely responsible for bringing about a more encouraging attitude towards scientific research on the part both of statesmen and the public generally. Throughout its existence this journal has consistently and persistently advocated increased attention by the State to scientific investigation and the need for liberal endowment of all work by which natural knowledge is increased. It is gratifying to know that the principle of national responsibility for the fostering of these research activities has in recent years been officially accepted.

Fifty years ago the provision made by Parliament for the promotion of science in the United Kingdom was an annual grant of 1000*l*., which was administered by the Royal Society. In 1876 a further grant of 4000*l*. was voted for "the payment of personal allowances to gentlemen during the time they are engaged in their investigations." In 1882 the grant of 1000*l*. was discontinued, and that of 4000*l*. has been included since then in the Civil Service Estimates without increase. The Royal Society, which administers the grant, derives no pecuniary benefit from it, and it only shares to the extent of a few hundred pounds annually in the additional annual grant of 1000*l*. made to assist in defraying the expenses of scientific publication. If this grant were increased to ten times the amount it could be effectively used by scientific societies, for the costs of publication are now very heavy and the output of papers or other works worthy of publication is much greater than when the grant was originally made in 1894.

In the Estimates for 1869–70 a grant of 1000*l*. to the Royal Society, 500*l*. to the Royal Geographical Society, and 300*l*. to the Royal Society of Edinburgh, together with other grants for scientific investigation, were classified together as votes for learned societies, with a total of 12,300*l*. The total amount for scientific and other institutions in the Estimates for 1919–20 is about 114,000*l*., but this includes 47,000*l*. for the Meteorological Office, and 20,000*l*. for the National Museum of Wales. In addition, the grants for investigation and research under the Department of Scientific and Industrial Research are estimated at 93,570*l*., and there is a grant of 12,775*l*. for the Fuel Research Station.

State grants to Colleges of London and Manchester were recommended by the Devonshire Commission in 1874, but the first direct assistance of this kind from the National Exchequer was a grant of 4000*l*. to the University College of Wales in 1883. In 1889–90 a vote of 15,000*l*. was included in the Estimates for University Colleges in England, in addition to 12,000*l*. for the three University Colleges of Wales. The total grant under that vote was then 44,785*l*., and now—thirty years later—the total amount of the grants to be paid out of the Exchequer for the maintenance of university institutions in the United Kingdom during the year 1919–20 is 1,000,000*l*. Though the increase is substantial, there are more institutions to participate in the grant, and much larger staffs and more elaborate equipment are necessary, so that it cannot be said even now that adequate provision has been made by the State for university education.

In university grants and gifts, as in those for research, the tendency is to promote the applied sciences and to overlook the needs of departments concerned particularly with knowledge of no apparent practical value. It is forgotten that the great advances in the industrial sciences of modern times, those which have raised the industrial and commercial life of the community, and so enormously increased its wealth, have had their origin in university laboratories and like places of what may be termed academic study. Investigations and discoveries on the borderlands of science, and leading to no immediately useful results for mankind, are often in the end the most valuable. It is the duty of universities to provide encouragement and training for men and women who possess special capacities for carrying on work of this kind; and a wise State will see that these workers are provided with full facilities for the cultivation of their abilities, as well as freedom to follow what seem to them the most promising paths of investigation. A scientific research laboratory cannot be conducted on the lines of a business house in which each department has to justify its existence by profitable returns. It must be independent of its patron, whether this be represented by a State department or by a governing body of commercial men. Unless this is so, our university laboratories and our research workers in fields of pure science may be reduced to the condition of some of the universities in the United States, amusingly illustrated by President Maclaurin, of the Massachusetts Institute of Technology, as follows:

The superintendent of buildings and grounds, or other competent authority, calls upon Mr. Newton.

Superintendent: Your theory of gravitation is hanging fire unduly. The director insists upon a finished report, filed in his office by 9 a.m. Monday next; summarised on one page; typewritten, and the main points underlined. Also a careful estimate of the cost of research per student-hour.

Newton: But there is one difficulty which has been puzzling me for fourteen years, and I am not quite . . .

Superintendent (with snap and vigour). Guess you had better overcome that difficulty by Monday morning or quit.

The absurdity of the picture is manifest; yet there is a tendency to regard research as more or less routine work in which results can be ordered and measured as they can by methods of scientific efficiency in industry. This is the present danger, and it is the duty of all who cherish increase of knowledge to see that such inhibitory conditions are excluded in our laboratories of creative science.

RESEARCH AND ITS APPLICATION.[1]

RESEARCH in the distant past was the privilege of the few. In chemistry, during the Middle Ages, the alchemists were practically the only men pursuing it, and they in secret, and not always from the highest of motives. Working by themselves as they did, they had not the great advantage of meeting and discussing with others similarly engaged, and using their progress and mistakes to intensify their own increase in knowledge. Thus it has come about that the science of chemistry is little more than a century old, and its tremendous advances only a few decades.

As the foundation of all these advances research is firmly embedded. Without it the structure could not have arisen or the glowing anticipations of the future been even imagined. Twenty centuries ago we were told, "Seek, and ye shall find; knock, and it shall be opened unto you." No one can deny that there have been accidental discoveries, some of great moment; but this has not been, and will not be, a safe dependence. Accidental discoveries are not to be relied on, although they are not to be scorned. In chemistry the accidental good fortunes have usually come to those who were really seeking, although possibly for something far different; but, note this, they were usually made by men qualified to recognise an important discovery when it flashed across their vision.

Research, of course, is not of necessity to result in invention. It may in that respect terminate in a *cul-de-sac* from which with present knowledge there is no egress; or, what more frequently happens, it may lead to a line of reasoning which in time leads to another, and so on, until suddenly a bright light illumines the way and a goal of the greatest importance is attained. Many instances illustrative of this could be mentioned. One only need here be cited, and that because of the importance it has assumed in the light of recent developments.

As early as 1882 men of science rigidly established by chemical research what chemists call the "constitution" of the blue vegetable dye indigo, and clinched that scientific conclusion by preparing the identical material in the laboratory. This particular important addition to human knowledge has remained a discovery merely, yet it so stimulated the search for practicable methods of applying that discovery to human needs that voluminous researches in a number of European countries were undertaken almost at once for that purpose. It remained for a college professor, working in quite a different field, to hit upon the central idea of the successful indigo method of 1897, and to clinch it by appropriate laboratory methods. In 1901, however, one of the so-called "inorganic" chemists, in searching for new worlds to conquer, evolved an idea which he thought would make one of the discarded and discredited methods of making indigo a worthy rival of the only commercially successful indigo method of that day. And he was right! The owners of the 1897 method were forced to look to their laurels.

The chemical knowledge and research that enter into the synthetic production of indigo, as we know it to-day, come from more than three generations of chemists, scattered all over the globe, speaking many languages, researching on many different and separate problems which touch almost every phase of human endeavour; and the end is not yet.

True research must be intentional and intensive. We must really seek if we would find. We must really knock at the doors of the secret chambers of knowledge if they are to be opened to us. We must have imagination, it is true, but we must have more than that. There must be the foundation of sound education and the ability to extend it to embrace new and unexpected knowledge, and apply this in its turn as we progress upwards.

The importance of research is being more and more recognised and understood by the public. One of the most encouraging evidences of this is shown in the preamble and resolution adopted recently by the American Federation of Labour at Atlantic City, indicating as these do a clear appreciation by that great association of how much we all depend on what science will disclose to ameliorate the conditions of the future.

But let our friends of the federation not be content with what the Government can do in the line of their resolution, good as it has been and will be. Let them start a carefully planned series of researches themselves, and follow them up until the truth stands revealed. Employers of labour have been doing this for years. The shining goal of all research is the truth, the whole truth, and nothing but the truth. Thus, starting from different angles, with fairness and thoroughness, the various so-called interests will arrive at the same truth, for there can only be one truth concerning any question. Thus will it come to pass that capital and labour will discover that the true interest of one is the true interest of all, and instead of bickerings and suspicions we shall have that cordial co-operation which is absolutely essential if we are to get the best out of this world of ours.

Scientific discovery is really not a haphazard matter. The art of making it can be cultivated, and definite rules of research can be laid down. Many elements enter into the problem, and these have been very well tabulated by the late Dr. G. Gore in his book, "The Art of Scientific Discovery." He defines the difference between discovery and invention as follows:—"Discovery consists in finding new truths of Nature, whilst invention consists in applying those truths to some desired purpose"; and that definition is sufficiently accurate. Research does not always lead to discovery or discovery to invention, but the sequence is logical.

The application of research has always required a high order of talent. In the future a still higher order of talent will be necessary, but in addition this talent must be prepared by education to do this very thing. How can we produce the leaders who shall adequately combine both the scientific and the practical qualifications that are necessary? This is one of the greatest and most interesting problems awaiting solution by our educators, and on its correct solution depends, in a larger degree than many imagine, the future of successful and contented industry in this country.

The candidate for leadership should have a healthy body, good habits (which involves good character), and a good mind educated to the highest degree attainable. This education should be specialised in the desired direction, while good all round. He should have a thorough knowledge of human nature. To play on the "harp of a thousand strings" requires an unusual acquaintance with the instrument. How many men, otherwise great, have broken down here, sometimes because they have given too much confidence, sometimes not enough, sometimes because they did not know how to select assistants.

Let us proceed to fill our high places of every kind with the men and women specifically prepared to fill them, being assured that the effort to do so will produce an army of those not quite qualified for the top, but of the greatest value to assist those who are. Let us educate for living, certainly; but let us also educate for leadership—that superlative leadership of which civilisation will stand more and more in need as it increases in complexity and reaches higher and higher planes.

[1] Abstract of an address delivered by the President of the American Chemical Society, Dr. W. H. Nichols, at Philadelphia, September 4.

BRITISH BOTANIC GARDENS AND STATIONS.

A MARKED feature of the scientific activities of the past fifty years has been the extensive establishment throughout the British Empire of botanic gardens and botanic stations. The history of such institutions is a long one; it takes us back to the time of the Pharaohs. It is also wide; the Spaniards found, in the Mexico they devastated, establishments of this nature conducted with as much enlightenment and on as elaborate a scale as any then to be met with in Europe.

The motives underlying the creation of such gardens have varied at different times and in different countries. Up to the middle of the sixteenth century the scope of European botanical gardens was mainly confined to the technical task of illustrating as fully as possible what were believed to be the sources of classical simples. During the next hundred years this was extended so as to include such æsthetic and economic novelties as could be made to grow. But by the middle of the eighteenth century, when the Royal Garden at Kew (1759), and the Botanic Garden at St. Vincent in the West Indies (1764), were founded, the purpose of botanical collections had become largely limited to the assemblage of plants interesting because of their rarity.

Presently a healthy reaction against this rather narrow outlook arose, for we find the historical memorandum by Lt.-Col. Kyd, to which the establishment of the famous institution at Calcutta was due (1786), advocating "the propriety of establishing a botanical garden, not for the purpose of collecting rare plants (although they also have their uses) as things of mere curiosity or furnishing articles for the gratification of luxury, but for establishing a stock for disseminating such articles as may prove beneficial to the inhabitants as well as to the natives of Great Britain, and which ultimately may tend to the extension of the national commerce and riches." Already Sir Joseph Banks, with his practical mind, had made representations to the same effect with regard to Kew, urging the utilisation of the Royal Garden as a central institution where information regarding the vegetation of the globe and its economic uses could be accumulated; where useful plants from all quarters could be raised; and whence such plants could be distributed to the overseas possessions of the Crown. Before the close of the first generation of the nineteenth century, many important establishments of the kind had been provided; among these we may note the gardens at Peradeniya in Ceylon, Saharunpur in North-West India, Singapore and Penang in Malaya, Buitenzorg in Java (during the brief occupation of that island by the English), Trinidad in the West Indies, and Sydney in Australia.

The conversion of Kew into the national botanic garden for this country (1841) gave a new impetus to this salutary activity, and under the active guidance of three eminent directors—Sir W. J. Hooker (1841–65), Sir J. D. Hooker (1865–85), and Sir W. T. Thiselton-Dyer (1885–1905)—the tradition established by Banks was vigorously sustained. To this impetus we may attribute the establishment of the famous gardens of Melbourne (1846), Durban (1850), Adelaide (1855), Brisbane (1855); and Jamaica (1857), though in the last case the inability of the local legislature to appreciate the value of science ensured for the garden the fate which had befallen that founded a century earlier in St. Vincent. The great services rendered by Kew to all forms of botanical enterprise have been nowhere more manifest than in the training of those who have proceeded to every quarter of the globe to take charge of the botanic gardens and stations throughout the Empire.

Since 1869, when NATURE was founded, the activities in this direction have continued unimpaired. In 1870 the botanic garden at Wellington in New Zealand was founded. In 1871 the abandoned Jamaica garden was re-established and another was created in Bermuda. In 1879 an important botanic garden was founded at Georgetown, in British Guiana.

Between 1886 and 1890 the botanic garden at St. Vincent, which had long been allowed to lie in abeyance, was restored, and new botanic stations were opened in the islands of Barbados, Dominica, Grenada, St. Lucia, and the smaller islands. The last station to be established in this region was that of British Honduras (1892). Profiting by the experience gained in the West Indies, attention was directed to Africa, and Kew has been instrumental in the establishment of botanic stations in our West African Colonies at Lagos (1887), Aburi in the Gold Coast (1890), Old Calabar (1893), Sierra Leone (1895), and Kaduna in Northern Nigeria (1914). In East Africa the need for a botanic station in Nyasaland was urged by the authorities at Kew, and as a result that at Zomba was founded in 1891. This was followed by the establishment of the botanic garden at Entebbe in Uganda in 1898. The urgency of the need for such an institution in the East Africa Protectorate it has, for some reason, been more difficult to persuade the authorities concerned to realise. But at last (1918) the beginnings of such an institution as has long been called for have been created at Nairobi. The Government of the Sudan, with a keener appreciation of the value of science, lost no time in establishing a botanic garden at Khartum and a botanic station at Jebelin.

Notable additions to the list of botanic gardens were those founded at Hong Kong in 1871, and at Aberdeen in 1897. But the most important of the creations of recent years is that of a great national botanic garden at Kirstenbosch, Cape Town, in 1913. This science owes to the enlightened action of the Government of the Union of South Africa, and to the untiring advocacy and exertions of the late Prof. Pearson. This institution bids fair to become in time the "Kew" of South Africa, and gives promise to be one of the most interesting and valuable scientific gardens in the world.

THE SCIENTIFIC AND TECHNICAL DEPARTMENT OF THE IMPERIAL INSTITUTE.

IN furtherance of its principal object of promoting the utilisation of the resources of the Empire, and in order to supplement its other activities in this direction, the Imperial Institute established in 1896 a scientific and technical department under the direction of Prof. Wyndham Dunstan. The history of the formation of that department and of its work in early years was told by the late Sir Frederick Abel, at that time Director of the Imperial Institute, in the preface to a volume of technical reports and scientific papers published by the institute in 1903. From that account it will be seen that the inception of scientific work at the institute received strong support from his Majesty King Edward and from the Royal Commission of the 1851 Exhibition, whilst the late Lord Playfair was one of its most active supporters.

The principal purpose of the department was to investigate by laboratory researches and technical trials raw materials, and especially those derived from the Empire overseas, as the first step in their commercial utilisation. The work of the department rapidly increased in amount and importance, and the laboratories and staff have been greatly extended in recent years. It is obvious that in the wide sense the scientific investigation of raw materials provides an enormous field, and it was necessary to limit the work of the department to those materials which are considered to be of most importance from a commercial point of view and are best dealt with in this country, and also to a large extent to limit the scientific investigation of these selected materials to the subjects requiring elucidation from the commercial viewpoint. Even with these necessary limitations a large number of scientific papers have been communicated by the staff of the department to the Royal Society, Chemical Society, Society of Chemical Industry, and other societies, whilst a number of materials of promise in scientific research have been passed for investigation to workers in other institutions, including the Universities of Manchester, Liverpool, Leeds, Aberdeen, and London.

To the research laboratories, which are provided with the proper equipment for experimental research, have been added testing plant and machinery for enabling small-scale technical trials of certain raw materials to be carried out. Arrangements have also been made with manufacturers for trials on a commercial scale of materials which appear to be suitable for commercial employment, and the department is now utilised not only for such investigations as have been indicated, but by manufacturers and merchants in this country for obtaining information as to supplies of raw materials, their nature and composition, and also as to their uses and the means of overcoming technical difficulties in regard to their industrial employment.

The scientific results of investigation conducted by members of the staff are, as a rule, communicated to the special societies concerned, whilst records of some of the principal results obtained in their commercial bearings are printed in the quarterly Bulletin of the Imperial Institute.

THE LISTER INSTITUTE OF PREVENTIVE MEDICINE.

THE institute originated from a public meeting summoned by the Lord Mayor in July, 1889, to hear statements from scientific men as to the efficacy of Pasteur's treatment for hydrophobia. The lack of any institute in this country with objects similar to those of the Institut Pasteur in Paris was discussed, and it was pointed out that England should continue to take her share in the discovery of means to control disease and not be dependent upon the national laboratories of France and Germany.

A committee was formed, of which Lister became chairman, and in 1891 the British Institute of Preventive Medicine was founded.

During the first nine years of its existence the permanent income of the institute was hopelessly inadequate to the requirements, but in 1900 it received a gift of 250,000*l.* from Lord Iveagh, which for the first time placed it in possession of an assured income. In 1903 the title of Lister Institute was adopted.

The central institute is situated on the banks of the Thames at Chelsea. It contains laboratories equipped for the study of bacteriology, biochemistry, protozoology, experimental pathology, entomology, etc., and a library and theatre. These accommodate, in addition to the staff, 20–30 graduates who are engaged in researches in some subject pertaining to preventive medicine under the guidance of the staff. The institute is a school of the University of London, and graduates of any university may proceed to the degree of doctor of science after having satisfactorily conducted during two years a research under the direction of a member of the staff who is a recognised teacher in the University.

In addition to its central laboratories in London the institute has a branch where antitoxic sera, bacterial vaccines, and calf-vaccine lymph are manufactured, and where investigations into the improvement of these curative and prophylactic agents, their standardisation, etc., are carried out.

The institute is administered by a governing body of seven, upon which the Earl of Iveagh has three representatives and the Royal Society one. The remaining three are elected by the members.

The income of the institute is derived from two sources, about one-third from endowment and the remainder partly from the sale of antitoxins, etc., and partly from moneys received from Government Departments and municipal authorities as remuneration for investigations and diagnoses carried out at their request.

THE NATIONAL PHYSICAL LABORATORY.

IF fifty years ago a Government had proposed to allocate 150,000*l.* per annum for the furtherance of scientific research, it would have met with an unsympathetic response in Parliament, and in all probability would have been turned out of office as too visionary and unpractical. The growth of the belief in the influence of research on industry and commerce was slow in this country, and was due, perhaps, more to the successful application to the production of electricity and of light of the laws of electromagnetic induction discovered by Faraday than to any other fact. When Dr. (now Sir Oliver) Lodge urged the necessity of a National Physical Laboratory in his address to the Mathematical and Physical Section of the British Association in 1891, Berlin and Paris had already taken action. A committee of the association, under the chairmanship of Sir Douglas Galton, drew up a scheme for the foundation of such a laboratory, and, after a favourable report by a Treasury Committee under Lord Rayleigh appointed to consider the matter, the laboratory was founded in 1901, with Dr. (now Sir Richard) Glazebrook as director and an annual income of 5000*l.* The control was vested in the council of the Royal Society, who appointed an executive committee. Owing to the rapid growth of the work of the laboratory, the financial responsibility became too great for the Royal Society, and the financial control was taken over by the Government in 1918. So well has the laboratory justified its foundation that the Government is prepared not only to make the annual grant mentioned in the opening sentence, but also to support a Department of Scientific and Industrial Research, and National Chemical and Engineering Laboratories are not outside the bounds of possibility.

THE DAVY FARADAY RESEARCH LABORATORY OF THE ROYAL INSTITUTION.

THE Davy Faraday Research Laboratory of the Royal Institution was founded and endowed by the late Dr. Ludwig Mond, F.R.S., with the object of providing opportunity for original investigation to extend knowledge in the domain of pure chemical and physical science by persons (men and women of any nationality) who could satisfy the authorities of the laboratory of their scientific training and qualifications to conduct original research.

The laboratory was opened on December 22, 1896, by his Majesty King Edward VII., who took occasion to point out that "Dr. Mond's foundation was a most important accession to the resources which had been placed at the command of the institution for the advancement of chemical and physical science. The Royal Institution has long enjoyed a world-wide reputation, thanks to the marvellous work of the succession of illustrious men whose researches carried on within its walls have very largely contributed to secure and maintain for this country a foremost position as a source of great discoveries and important advances in science and its applications."

Mr. Robert Mond was nominated in the deed of trust honorary secretary for life.

The managers appointed the late Lord Rayleigh and Sir James Dewar the directors without remuneration.

The following is a selection of inquiries executed in the Davy-Faraday Research Laboratory communicated to scientific societies by fellows of the Royal Society:—Dr. H. Debus, "Contributions to the History of Glyoxalic Acid"; Hugo Muller, "Quercitol, Cocositol, Inositol, Flavon"; Horace T. Brown, "Starch: Its Transformations and Derivatives"; J. Y. Buchanan, "The Specific Gravity of Soluble Salts"; J. Emerson Reynolds, "Silicon Researches"; J. E. Petavel, "Standards of Light" and "Gaseous Explosive Mixtures"; A. Scott, "Atomic Weight of Carbon, etc."; W. J. Russell, "Action of Wood on Photographic Plates in the Dark, etc."

The following papers have been published:—A. Croft Hill, "Reversibility of Enzyme or Ferment Action, etc."; W. Wahl, "Optical Investigations of Solidified Gases, etc."; W. Gluud, "Derivatives of Allylamine, Phenylglycine, etc."; Sir J. C. Bose, "The Response of Inorganic Matter to Stimulus, etc."; Miss Ida Smedley, "Colour Derivatives of Fluorene"; and Miss A. Everett, "Colour Photometry."

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

THE International Catalogue of Scientific Literature was constituted in 1900 at an International Conference held in London under the auspices of the Royal Society. It is a unique attempt to secure an accurate and exhaustive bibliography of pure science by international co-operation, each country being responsible for the indexing of its own literature. Each volume contains an author index and a subject index. An annual issue is composed of seventeen volumes indexing the seventeen branches into which science is divided for convenience of reference. The books and papers catalogued are those published since January 1, 1901, papers published before that date being indexed in the Royal Society's Catalogue of Scientific Papers.

The control of the catalogue is in the hands of an international council composed of one representative from each country taking part in the work. This council appoints an executive committee, which meets in London, but each of the countries co-operating has its own regional bureau to prepare index cards and send them to a central bureau in London for publication. Since the foundation of the catalogue about three million such cards have been received from the bureaux. More than two hundred volumes have been published.

Until the outbreak of the war in 1914 more than thirty countries were taking part in preparing the catalogue, and the harmony with which they worked together is one of the most remarkable features of the enterprise. Even the Russo-Japanese War did not hinder the delegates of Russia and Japan from meeting at the conferences.

Although the recent war and the present condition of Europe create a difficult position for all international undertakings, it is much to be hoped that means may be found for continuing the work of the catalogue on an international basis, and without sacrificing those distinctive features which have met with such widespread appreciation.

THE TROPICAL DISEASES BUREAU.

THE Tropical Diseases Bureau came into existence in July, 1912, as a development of the Sleeping Sickness Bureau founded in 1908. The main function of the bureau has been to review current papers on tropical diseases, *i.e.* exotic diseases occurring in the tropics and sub-tropics. The medium of publication is the *Tropical Diseases Bulletin*, now in its fourteenth volume. The *Bulletin*, which appears monthly, contains classified summaries of all papers within its scope which come under notice. Each subject is in charge of a "sectional editor," whose initials are appended to his summaries. Thus the results of the most recent researches on tropical disease in every country, new methods of treatment, and improved means of prevention quickly become available for the remote worker in the tropics. Critical reviews of books are also published.

The bureau issues also the *Tropical Veterinary Bulletin* quarterly, the object of which is to deal with the diseases of domestic animals in the tropics in the same way as the *Tropical Diseases Bulletin* does with the diseases of man.

The bureau maintains a library under the charge of Capt. R. L. Sheppard, which contains complete or nearly complete files of all the tropical medical journals, in addition to others, some two hundred series in all, and a large number of reports and reprints. Though the library is mainly intended for the use of the sectional editors, it is open to any inquirer without formality.

The bureau is under the management of a committee appointed by the Secretary of State for the Colonies, the expert members of which are Sir John Rose Bradford, Sir David Bruce, Sir Havelock Charles, Sir Wm. Leishman, Sir Patrick Manson, and, representing veterinary medicine, Sir John M'Fadyean and Sir Stewart Stockman. Dr. A. G. Bagshawe is the director. It is maintained by a grant in aid from the Imperial Treasury and by contributions from the Governments of India, the Sudan, the Union of South Africa, and certain colonies and protectorates, to which copies of its publications are supplied gratis. By the general public the *Tropical Diseases Bulletin* can be obtained at an annual subscription of a guinea, and the *Tropical Veterinary Bulletin* at 10s.

The offices of the bureau are at present situated at the Imperial Institute, South Kensington.

WOMEN AT CAMBRIDGE.

IN February, 1896, the council of the Senate reported the receipt of four memorials relating to the admission of women to degrees. A syndicate was appointed to consider the question, and in February, 1897, the majority reported recommending that degrees should be conferred on women by diploma, but not that they should become members of the University on the same terms as men. The liveliest interest in and opposition to these proposals were occasioned, and a discussion lasting three days took place in the Senate House. Finally, in May, 1897, the report was rejected by the Senate, amid scenes of enthusiasm and disorder, by a majority of 1707 to 661.

In May, 1919, the council reported the receipt of two memorials relating to the same subject, and proposed the appointment of a syndicate to consider it. The first memorial stated:—"We believe that the time has passed for the adoption of half-measures, and that women should be admitted to full membership of the University." In the second, objection was taken to the "attempt to force a hasty conclusion on a prejudged issue," and the suggestion made that a solution might be found by allowing women to obtain degrees without becoming full members of the University. This suggestion—which is made now by those who in 1897 opposed the granting of degrees to women at all—is practically the same as that which was rejected by a large majority then, and illustrates how far the attitude towards women has changed in twenty-two years. There are few now who would dare openly to advocate the exclusion of women from the recognition rightly due to their study and their services to learning.

On Thursday, October 30, a discussion on the subject was held in the Senate House. It is clear that a large progressive body of opinion is in favour of removing all restrictions on the studies of women and on their just recognition by the University. It is also clear, however, that there is still an underlying opposition to the idea of a mixed university, which will manifest itself in proposals designed to shelve the question temporarily by the adoption of half-measures. There can be little doubt that in the end all restrictions will be removed; and there are many who believe that it will be wiser and more generous for the University now to allow women the full membership they demand than to have the change forced upon it by outside influence, *e.g.* through the coming Royal Commission.

NOTES.

ANNOUNCEMENT of the approaching fiftieth anniversary of the foundation of NATURE was made in a letter sent a few weeks ago to the presidents of a number of scientific societies, official heads of British universities, and other representatives of progressive knowledge, most of whom are among the contributors to the columns of this journal. The result of this communication has been that we have received numerous cordial messages of congratulation, many of them containing interesting reminiscences associated with NATURE, and all most appreciative of the services it affords to scientific workers. It was hoped that space could have been found to publish these messages this week, but this has proved impracticable. We believe, however, that these testimonies to the close attention paid to the contents of NATURE will interest a wide scientific public, and therefore propose to place a selection from them before our readers in next week's issue.

THE general arrangement of Notes in these columns follows the principle of from man to machine; early paragraphs are concerned with current topics and events, and these are followed successively by Notes on subjects relating to biological, physical, and engineering sciences. The articles on scientific progress which we have been fortunate enough to secure for this issue are arranged in much the same order, so that each has a relationship to the contributions which precede and follow it. In addition to the descriptive articles concerned with different fields of scientific activity, short accounts are given of a few important British institutions established for research purposes since NATURE was first published. These articles will, we think, serve to increase the value of this jubilee number as an epitome of outstanding developments of scientific work during the past fifty years.

ON Wednesday, October 29, Mr. Balfour was inaugurated Chancellor of Cambridge University. In a letter to the Vice-Chancellor dated October 25 he had written:—"In so far as lifelong devotion to the University, unceasing interest in its welfare, and pride in its great services to learning be sufficient qualifications for that high post, I am not unfitted to fill it." His election was unopposed. In presenting the Letters Patent the Vice-Chancellor dwelt upon the needs of the University and upon the possibility of utilising the learning available in the University more fully in the service of the Empire. The new Chancellor agreed that it is the business of the community to make easier the path of those who have shown what the sound learning and scientific training of a university can do for a national cause, but at the same time he felt that, in the main, Cambridge would have to trust, and could well trust, its own powers in the coming arduous days of peace. In all departments of national activity, but especially in the scientific study of the mechanical, economic, chemical, medical, or physical problems of the last five years, our universities—and not least Cambridge—have earned a position in the national estimation which they have never held before. This position carries great opportunities and great obligations with it. The interest of the next few years and their influence on the future history of education and human knowledge are immense. There will undoubtedly be a strong tendency towards the adoption of a more technical education and towards the teaching of "practical" subjects in a university course; this tendency cannot, and must not, be opposed, but at the same time it is most earnestly to be desired that our universities should keep before the eyes of their students the three chief motives for the acquisition and improvement of knowledge: a pleasure in knowledge for its own sake, a sure faith that no attempt to acquire and improve knowledge is vain, and a reasoned belief in the power of knowledge to help and elevate mankind. Cambridge has chosen wisely in electing a Chancellor in whom these motives are so strong, and who possesses in a high degree the power and opportunity of keeping them before the eyes of the best of his countrymen.

MEMORIAL tablets to Lord Lister to be erected at University College, London, will be unveiled on Tuesday, November 11, by Sir George Makins, president of the Royal College of Surgeons, and Sir J. J. Thomson, president of the Royal Society. The Duke of Bedford, president of the Lister Memorial Committee, will preside.

THE VERY REV. W. R. INGE, Dean of St. Paul's, has been appointed Romanes lecturer for 1920 at the University of Oxford. The date and subject of his lecture will be announced later. The late Camden professor of ancient history, Mr. F. J. Haverfield, has bequeathed the residue of his estate, subject to certain charges, in trust to the University for the advancement of the study of Romano-British antiquities.

MR. W. R. COOPER has just retired from the editorial chair of the *Electrician*, having decided to devote the whole of his time to his consulting practice. He was appointed editor of our contemporary in 1906, and under his editorship the journal has represented electrical science at its best, as well as progressive practice. He will be succeeded by Mr. F. H. Masters, who was chief assistant editor at the outbreak of war in 1914.

AT the annual general meeting of the Cambridge Philosophical Society, held on October 27, the following were elected officers of the society for the ensuing session, 1919–20:—*President:* Mr. C. T. R. Wilson. *Vice-Presidents:* Sir W. J. Pope and Sir E. Rutherford. *Treasurer:* Prof. Hobson. *Secretaries:* Mr. A. Wood, Mr. G. H. Hardy, and Mr. H. H. Brindley. *New Members of the Council:* Prof. Inglis, Prof. Seward, Dr. Rivers, Dr. E. H. Griffiths, and Mr. F. A. Potts.

DR. O. L. BRADY, president of the National Union of Scientific Workers, took the chair at a meeting held on October 30 to inaugurate a London branch. He pointed out that the organisation of the union is by branches. Although there are already branches in South Kensington, the Board of Agriculture, the London County Council, and at Woolwich, it was felt that a more central branch should be formed to meet the needs of workers engaged in the City and in the central district of London. A resolution that a London branch of the National Union of Scientific Workers be forthwith formed was passed unanimously, and Dr. H. M. Atkinson and Mr. W. E. King were elected chairman and secretary respectively of the branch.

THE *Times* of November 4 publishes the following message from its New York correspondent, dated November 3:—"The gift of a further 2,000,000*l.* to the Rockefeller Institute by the founder, Mr. John D. Rockefeller, is announced to-day. The institute, which was founded in 1901, has become the largest endowed establishment in the world for medical research. It had already received from Mr. Rockefeller successive gifts to the amount of 5,500,000*l.* and real estate valued at 500,000*l.* The scientific staff numbers sixty-five, and in addition there are 310 persons employed in technical and general services. The latest gift will enable research to be conducted in new fields in biology, chemistry, and physics, as well as in medicine itself, and the study of practical problems relating to disease in men and animals."

AT the Philosophical Congress, held at Bedford College last July, particular interest centred round the physiological researches of Dr. Head and his fellow-workers into the nature of the function of the cortex cerebri. This work has been going on for the last eighteen years. It started with the now classical experiment performed by Dr. Head, with the aid of Dr. Rivers, on the innervation of his own forearm. Following the clue which that experiment afforded, the function of the cerebral cortex in regard to sensation has been more and more clearly elaborated. Injuries due to the war have afforded means of immediately testing theories such as we might have had to wait long for under other conditions. Some of our readers are anxious to know where they can obtain an account of this work. Unfortunately, it is not at present available in the form of a treatise or monograph; it exists only in articles in medical journals. A very clear epitome of the whole theory, however, with illustrative cases, and free from technical terms, is the article by Dr. Head himself on "Sensation and the Cerebral Cortex," which fills the whole number of *Brain*, vol. xli., part ii., issued in 1918. The philosophical interest in the theory was due to the complete scientific refutation it offers of all psychological theories which build up knowledge out of original sense-material. Sensations depend neither for their existence nor for their psychical quality on the cortex cerebri, which has a purely interpretative function in regard to them.

LAST July Sir Robert Hadfield invited a large party of his Sheffield workmen to London to visit the British Scientific Products Exhibition, and also the Science Museum at South Kensington. Included in the party were a number of apprentices, some from the Hadfield works in Sheffield and others from similar establishments in London. Prizes were offered to the boys for the best essays descriptive of the visit. The winning essays, which are now printed for private circulation, are a striking commentary on the interest taken in the visit. To many of the Sheffield boys, who were in London for the first time, the day was a red-letter one. Their keen powers of observation were not confined to the exhibitions only; one at least showed a truly surprising knowledge of the significance of the historical statues he saw on his way from and to the station. More human, perhaps, was the boy lost in admiration for the London 'bus drivers. It is no mean feat of endurance to visit two exhibitions in one day and carry off any sort of coherent idea of what has been seen. The novelty of the event must have given these boys added enthusiasm, for they describe with great clearness machinery and processes which interested them. The essays show the immense educational value of visits of this character, and they are, too, a real tribute to the work of the evening technical schools, where the boys study hard after a day's work.

PROF. FERNANDO SANFORD discusses in the *Scientific Monthly* for October the *ignis fatuus*, one of those "meteoric appearances which have puzzled man since he began to inquire into the relations of phenomena, and which are still unexplainable." He reviews the various theories which have been formulated to explain these appearances. His final suggestion is that "they are little swarms of luminous bacteria which are carried up from the bottom of the marsh by rising bubbles of gas. Many kinds of luminous bacteria are known, and the marshes from which these lights arise are known to be the favoured habitat of some of these kinds. Some at least of these bacteria do not become luminous until exposed to the oxygen of the air. This seems to be true of the bacteria which cause the luminosity of rotten wood, the 'foxfire' of our boyhood."

IN the *Scientific Monthly* for October Prof. J. H. Breasted, the eminent Egyptian scholar, publishes the first part of a lecture on the origin of civilisation, with special reference to the Nile Valley. Following the guidance of Blanckenhorn, he classifies the geology of the Nile Valley, in so far as it bears on the age of man there, into four chief periods:—(1) The Lacustrine Terraces, Pliocene and First Glacial; (2) the Upper River Terrace, Second Glacial; (3) the Lower River Terrace, Third Glacial; and (4) the Alluvium, Lower Fourth Glacial, Upper Post-Glacial. Far back in the European Glacial age the North African plateau was the home of early hunters, who have left signs of their presence not only in flint weapons, but also in a remarkable rock temple in the western desert. From this point he deals with burials and artefacts, including the marvellous ripple-flaked flint implements which are a mystery to craftsmen of the present day. Prof. Breasted leaves the later developments of the culture of prehistoric man in this region to a second article, which will complete a study of unusual interest.

UNDER the title of "The Linguistic Survey of India and the Census of 1911" Sir George Grierson has published a short summary of the great work which he has now brought to a successful termination. The Survey deals with a population amounting to 290,000,000, as compared with 312,000,000 recorded in the census of 1911, the difference being due to the fact that the census covered the whole of India, while large tracts, like Burma, were excluded from the operations of the Survey. In all, 872 different languages and dialects are recorded. The sub-family which contains the greatest number of languages, thirty-two in all, is the Tibeto-Burman, where the population is split up into numerous sections owing to their special environment in a mountainous region. On the other hand, there are only seventeen Indo-Aryan languages spoken by 226,000,000 in the wide northern plains, where facilities of intercommunication promoted fusion of races. If, as an example of similarly circumstanced Aryan groups, we take the Eranian languages spoken in and near India and the Dardic languages, we find that these two branches, like the Tibeto-Burman languages, are spoken in inhospitable mountain tracts, but that, unlike the Tibeto-Burman group, they have a power of persistence. If they do subdivide, the division is not into mutually unintelligible languages, but into mutually intelligible dialects, held together by a common grammatical basis. This summary of the work of a great scientific philologist may be warmly commended to the notice of all students of language.

IN the course of his presidential address to the North-East Coast Institution of Engineers and Shipbuilders on October 24, Mr. A. Ernest Doxford made strong references to the present economic position of the country, and said that much too little publicity has been given to this important matter. This has afforded the extremist his opportunity to inflame the minds of the uninformed, and lead the country perilously near to anarchy. Two great evils have to be fought—greed and ignorance—and both of these can be overcome by education. The first and most important point to consider in education is the qualification of the teacher. He must be sound in first principles, in his facts, and in his reasoning, and must be capable and willing to impart his knowledge to others. One would have thought that a common-sense nation, such as we certainly are, would have seen the absolute necessity of paying well for such qualities; but, instead, we find that the teaching profession is one of the worst paid, with the natural result that we get either inferior or discontented teachers. This discontent is bound to be reflected, to a greater or less extent, in the mind of the pupil, and is the source of a great deal of our social unrest. The brain-power of the teacher is often superior to that of many in other walks of life who are being better paid than he, and the injustice, in many cases, forces him into the band of extremists, where he thinks that a social upheaval may remedy his grievances. Mr. Doxford feels sure that if, in our reconstruction, we put education foremost, we shall remedy not only many of the evils that existed prior to the war, but also the more virulent types that have arisen since.

DR. MURRAY STUART describes, in the Records of the Geological Survey of India (vol. l., p. 28, 1919), the deposits of potash salts in the Punjab Salt Range and Kohat, and adds a paper on the probable origin and history of the rock-salt deposits in this region. The author believes that the salts were originally laid down from an evaporating saline solution, but that their present banded structure, of which a good illustration is given, is due to subsequent flow under pressure. The salt, in fact, is now not a sediment, but a schist. Included iron pyrites, liberating sulphuric acid, has led to the formation of gypsum as a product of contact with limestone, and is also responsible for the presence of mirabilite. The potash salts, whatever their original position in the series, now appear as patches and lenticles in the rearranged foliated mass, and no continuous bed can be expected. "The prospects of obtaining potash from the salt of the Salt Range are not promising."

ONE of the most definite tendencies in British agriculture is towards greater use of mechanical power, though the most satisfactory source of power remains to be ascertained. In the Journal of the Royal Society of Arts for September 26 and October 3 and 10, Dr. J. F. Crowley discusses the use of electricity in agriculture, with special reference to its development in Germany. Farm conditions make portability essential, and a limit is set to the power obtainable from steam or oil engines by their weight. These considerations led to the development of electrical power, which has been so notable a feature of German agriculture in recent years. By far the greater amount of power used on German farms is distributed from central stations by high-tension overhead lines. The transformers and motors may be either fixed or portable, and may be separated by considerable distances. Illustrated descriptions are given of the motors and their use in ordinary agricultural operations. Thinly populated rural districts in Germany secured the advantage of cheap electricity through the growth of numerous rural co-operative societies, which either produced electricity themselves or secured a cheap supply by guaranteeing a certain consumption. The author believes that considerable progress could be made if steps were taken to promote such co-operative movements in the rural districts of this country.

A SERIES of illustrated articles descriptive of the Hell Gate Bridge at New York has been appearing in recent issues of *Engineering*. The article in the issue for October 17 contains an interesting account of the span measurements. It was impossible to secure a satisfactory direct measurement, since no previous structure crossed the river at the site, and the distance between the skewbacks was determined by triangulation. To obtain a check a special steel tape about 1100 ft. long was made, and repeated measurements were taken, making calculated allowances for tension, deflection, and temperature. Difficulty was experienced in making the corrected measurements agree precisely on account of the unequal temperatures of different portions of the tape. There was, however, substantial agreement with the triangulation measurements. The day before the erection of the last panel of the arch-trusses was commenced, careful measurements showed a clearance of 1·75 in. between the extremities of the semi-trusses. A rise in temperature during the night produced a diminished clearance of 0·75 in. next morning. Work was therefore accelerated in order to have the lower chord inserted before the rising temperature eliminated the whole of the clearance. The first chord piece had to be lifted vertically into position rather than revolved from an oblique position in a vertical plane as is customary. The following day was rainy and cloudy, affording more favourable weather conditions.

AN interesting survey of the general position of chemical industries in the chief countries of the world, and especially in France, is contributed by M. René P. Duchemin to the *Revue Scientifique* for October 4. Due to war demands, there has been a considerable over-production of important "heavy" chemicals such as sulphuric acid, nitrogen compounds, chlorine, and bromine; and this not only by the belligerent nations, but by neutral countries also. Factories have been developed and extended, so that they now have much greater productive capacity than heretofore; and, moreover, large stocks were necessarily accumulated by the various Governments to provide for unforeseen contingencies during the progress of hostilities. In some branches of manufacture these stocks represent several years' normal output. Hence the position of the industry as regards the foregoing products is just now a difficult one. For France in particular, unless the industry is to dwindle and vanish, it will be necessary to devise measures for preventing destructive competition by indiscriminate admission of certain chemicals from other countries. The plan adopted by Great Britain, namely, limited importation, to prevent either undue lowering of prices by "dumping" or excessive charges by manufacturers here, is considered by the writer named to be the best for France to follow until something like normal conditions are again reached.

HARDNESS is an extremely important quality, but no satisfactory definition of it has yet been given. The geologist has his scale of hardness, and the engineer has his instruments for measuring the elusive quality. The tests employed by the engineer are good in their way, but they do not, as a rule, measure directly what the manufacturer wishes to obtain in the finished article. A manufacturer of cutlery, for example, is not directly interested in the way his steel gives when a steel ball is placed on it and pressed down with considerable force. But, in spite of the lack of direct applicability in the engineering tests, a good deal can be maintained in their favour, for there is doubtless some connection between the mechanical properties desired by the manufacturer and the readings of the sclerometer, as the instrument for measuring hardness is called. The interpretation of the readings may be difficult, and will probably require the acquisition of knowledge allied to that attained by the skilled craftsman; but, notwithstanding the difficulties, the regular use of a sclerometer can be productive of nothing but good. The Magnetic Sclerometer which has been put on the market by the Automatic and Electric Furnaces, Ltd., 281–283 Gray's Inn Road, London, W.C.1, may prove to be extremely useful in connection with a large and important class of material, viz. hard steels. As its action does not depend upon mechanical phenomena, its range is limited, and it cannot be used for non-magnetic substances. A rod of steel is placed in a yoke so as to form a complete magnetic circuit, and magnetised almost to saturation. The rod is then taken out of the yoke and the remanent magnetism, *i.e.* the magnetism which remains after the rod has been subjected to the demagnetising action of its own poles, is measured. To make the measurement the rod is placed in a coil connected to a ballistic galvanometer, and the kick of the galvanometer-needle is noted on the rapid removal of the rod from the coil. The throw of the needle, which indicates the amount of magnetic flux still remaining in the rod, may be taken as the reading of the sclerometer. In spite of its lack of direct applicability so far as hardness, in the ordinary sense of the word, is understood, the magnetic sclerometer should prove to be an extremely useful instrument in the hands of the trained researcher.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have just issued a Catalogue (No. 182) of 1670 second-hand books dealing, among other subjects, with archæology, folk-lore, anthropology and kindred subjects, Egyptology, and philosophy; also with scientific serials. In the latter section we notice a set of the first 102 volumes of NATURE. The list includes the archæological and fine art library of the late Dr. Allen Sturge. A copy can be obtained free upon application.

OUR ASTRONOMICAL COLUMN.

COMETS.—Schaumasse's comet (1911 VII., 1919*d*) was detected on its return by M. Schaumasse at the Nice Observatory on October 29, being of magnitude 12. The observation indicates October 19 as the approximate date of perihelion. The following ephemeris is for Greenwich midnight (corrected approximately by the above observation):—

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Nov. 5 ...	12 27 23	6 28	0·0914	0·2610
9 ...	12 41 25	5 19	0·0951	0·2622
13 ...	12 55 13	4 11	0·0993	0·2634
17 ...	13 8 47	3 4	0·1038	0·2649
21 ...	13 22 5	1 58	0·1089	0·2666

As the distances from both sun and earth are increasing, the comet will remain faint.

Continuation of the ephemeris of comet 1919*c* for Greenwich midnight:—

	R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Nov. 7	17 0 44	10 30	Nov. 19	17 41 42	16 57
11	17 13 56	12 41	23	17 56 20	19 0
15	17 27 32	14 50	27	18 11 28	20 59

The comet is approaching perihelion and growing steadily brighter, but it is too near the sun for convenient observation.

THE SOURCES OF STELLAR ENERGY.—There have recently appeared two articles on this subject by Profs. Russell and Eddington. The first (Publications Ast. Soc. Pacific, August, 1919) points out the apparent inadequacy of the contraction hypothesis to explain the long duration of the output of energy (far in excess of Lord Kelvin's twenty million years) which is suggested by geology and by various other arguments. Hence it is concluded that there must be some unknown source of energy in the interior of giant stars, which dies down before the dwarf stage is reached. Making the supposition that the temperature is insufficient for the unknown source to come into action in the pre-M stage of giant stars, Prof. Russell shows that this stage would be short and extremely few stars would be in it at a time; he thus explains our failure to detect stars in this stage.

He also points out that the hypothesis would do away with the difficulty which Prof. Eddington expressed about the maintenance of the pulsations in Cepheid variables, viz. that the leakage of heat from the hotter to the colder regions would damp out the oscillations in a few thousand years. For the unknown source would supply heat to the interior at the greatest rate when it was hottest, thus making good the leakage.

Prof. Eddington (*Observatory*, October) makes a bold speculation as regards the unknown source of heat. He reminds us that a large proportion of the total energy of a star is locked up in its atoms, so that the energy would not be exhausted when the star cooled. It would need to be annihilated to liberate all the energy. He asks whether this annihilation of matter may not be going on in giant stars: "When a positive and negative charge collide centrally they go out of existence." He points out that at moderate temperatures the outer electrons of the atom form a protecting cushion; but in a very high temperature, ionisation is presumed to take place, robbing the nucleus of its protecting electrons and leaving it an exposed target. He makes an estimate that 1 atom out of 5×10^{18} must be annihilated each second. At this rate it would take about 2×10^{11} years to annihilate the whole star, so that the loss of mass in the periods usually assigned to the giant stage would be trifling.

BRITISH SCIENTIFIC SOCIETIES FOUNDED DURING THE PAST FIFTY YEARS.

1869.

Edinburgh Field Naturalists' and Microscopical Society.
Iron and Steel Institute.

1871.

Institution of Electrical Engineers.
Mathematical Association.
Royal Anthropological Institute of Great Britain and Ireland.

1873.

Institution of Municipal and County Engineers.

1874.

Physical Society of London.
Society of Public Analysts and other Analytical Chemists.

1875.

Incorporated Sanitary Association of Scotland.

1876.

Conchological Society of Great Britain and Ireland.
Mineralogical Society.
Physiological Society.
Royal Sanitary Institute.

1877.

Institute of Chemistry of Great Britain and Ireland.

1878.

Folk-Lore Society.
Mining Institute of Scotland.

1879.

Society for the Promotion of Hellenic Studies.

1880.

Aristotelian Society.
The Ophthalmological Society of the United Kingdom.
Scottish Microscopical Society.

1881.

Scottish Natural History Society.
Society of Chemical Industry.

1882.

Royal Academy of Medicine in Ireland.
Royal English Arboricultural Society.
Society of Psychical Research.

1883.

Edinburgh Mathematical Society.

1884.

Anatomical Society of Great Britain and Ireland.
Junior Institution of Engineers (Incorporated).
Marine Biological Association of the United Kingdom.
North-East Coast Institution of Engineers and Shipbuilders.
Royal Scottish Geographical Society.
Society of Dyers and Colourists.

1886.

Institute of Brewing.
Royal Institute of Public Health.

1889.

Institute of Marine Engineers (Incorporated).
Institution of Mining Engineers.
Museums Association.

1890.

British Astronomical Association.

1891.

British Pteridological Society.

1892.

Geographical Association.
Institution of Mining and Metallurgy.
Japan Society.
West of Scotland Iron and Steel Institute.

1893.

Malacological Society of London.

1894.

Child-Study Society.

1896.

British Mycological Society.
Institution of Water Engineers.

1897.

Institution of Heating and Ventilating Engineers (Incorporated).
Röntgen Society.

1899.

Optical Society.

1900.

Ceramic Society.

1901.

African Society.
British Academy.

1903.

Challenger Society.
Faraday Society.
Sociological Society.

1906.

Institution of Automobile Engineers.

1907.

Royal Society of Medicine.
Society of Tropical Medicine and Hygiene.

1908.

Concrete Institute.
Institute of Metals.

1909.

Zoological Society of Scotland.

1910.

India Society.
Society of Engineers (Incorporat
Textile Institute.

1911.

Biochemical Society.

1913.

Institution of Petroleum Technologists.

1916.

Association of British Chemical Manufacturers.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 6.—M. Léon Guignard in the chair.—H. **Deslandres**: Remarks on the constitution of the atom and the properties of band spectra. A continuation of communications previously made on the same subject. Band spectra may be considered as being formed of transversal and longitudinal vibrations, but the exact part of the spectrum which can be attributed to the one or the other of these cannot as yet be precisely determined.—G. **Charpy** and J. **Durand**: A cause of rupture of steel rails and a means of suppressing it. It has been proved by several observers that a frequent cause of breakage of steel rails, not possessing any local faults due to manufacture, consists in the formation of very fine fissures appearing on the surface carrying the wheel after a certain period of use, and it has been proposed that, after a careful inspection of the permanent way, these fissured rails should be detected and removed. The critical age of steel rails appears to be about ten years. The author has found that the incipient cracks are removed by annealing, and suggests a method by which it would be possible to anneal the rails without removal from the track.—E. **Ariès**: The equation of state of ethyl formate.—G. A. **Boulenger**: The genus Saphæosaurus, a Rhynchocephalian of the Kimmeridge formation of Cerin. The examination of the specimens at the Lyons Museum leads the author to agree with the views of L. Lortet as to the classification of this reptile, as opposed to the interpretation of D. M. S. Watson.—N. E. **Nörlund**: An extension of the polynomials of Bernoulli.—M. **Stoïlow**: The analytical representation of functions of several complex variables.—G. **Serf**: The transformations of linear partial differential equations with two independent variables.—J. **Rey**: The experimental predetermination in the laboratory of the characteristic of a lighthouse at the horizon. The distribution of the light intensity in the horizontal plane is studied by means of a series of metallic screens, pierced with a regular series of small holes of accurately known diameter. The results of such a study are shown in a graph.—Ch. **Boulin** and L. J. **Simon**: The action of stannic chloride on dimethyl sulphate. The products of the reaction at a temperature of about 114° C., the boiling point of stannic chloride, are methyl chloride and stannic sulphate.

SYDNEY.

Linnean Society of New South Wales, August 27.—Mr. J. J. Fletcher, president, in the chair.—W. W. **Froggatt**: A new species of wax scale (*Ceroplastes murrayi*) from New Guinea. The author describes a wax scale found on the wild mango in the forests fringing the Kikori River, Delta Division, British New Guinea. The scale, for which the name *Ceroplastes murrayi* is proposed, produces a solid mass of hard, white, wax-like secretion, forming a rounded dome over the resting gravid female coccid. The characters of the female are described. Male unknown.—G. F. **Hill**: Australian Stratiomyidæ (Diptera), with description of new species. Six new species are proposed, belonging to the genera Actina, Hermetia, Odontomyia, Sargus, and Wallacea, two of these genera (Hermetia and Wallacea) not having previously been recorded from Australia.—J. **Mitchell**: Two new Trilobites from Bowning, N.S.W. The Trilobite described in this paper under the name of *Dalmanites (Hausmannia) loomesi* was formerly joined with *Hausmannia (Dalmanites) meridianus*, Etheridge and Mitchell. The examination of additional and much better specimens has shown that the two forms are specifically distinct, and accordingly each of the two forms originally described under the name *H. meridianus* has now been given specific rank. The cephalic characters of the other Trilobite proved to be so unusual that the writer deemed it advisable to propose a new genus (Adastocephalum) of the Phacopidæ for its reception. The chief generic feature in the genotype is the absence of glabellar furrows and lobes.—A. A. **Hamilton**: An ecological study of the salt-marsh vegetation in the Port Jackson district.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY (jointly with the ROYAL ASTRONOMICAL SOCIETY), at 4.30.—Sir Frank Dyson, Prof Eddington, and Others: Discussion on the Results of the Observations obtained at the Total Solar Eclipse on May 29, 1919.

LINNEAN SOCIETY, at 5.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. P. Beddard: Some Remarks on Chronic Arthritis (Bradshaw Lecture).

CHEMICAL SOCIETY, at 8.—F. G. Donnan and W. E. Garner: Equilibra across a Copper Ferrocyanide and an Amyl Alcohol Membrane.—R. R. Le G. Worsley and P. W. Robertson: The Peroxides of Bismuth.—T. M. Lowry and R. G. Early: The Properties of Ammonium Nitrate. Part I. The Freezing-point and Transition-temperatures.—R. H. Vernon: Organic Derivatives of Tellurium. Part I. Dimethyl-telluronium-di-iodide.—J. Reilly and W. J. Hickinbottom: Intramolecular rearrangement of the Alkylarylamine. Formation of 4-amino-*n*-butylbenzene.—H. Swann: A New Modification of 3:4-Dinitrodimethylaniline.—G. Le Bas: (1) The Refractivities of Unsaturated Substances; (2) The Molecular Refractions of Benzene and Aromatic Derivatives.—R. R. Baxter and R. G. Fargher: Some 1:3-Benzodiazolearsinic Acids and their Reduction Products.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. D. Robinson: The *Rôle* of the Cinematograph in the Teaching of Obstetrics (Cinematograph Demonstration).—Dr. H. Spencer: Nine Cases of Inversion of the Uterus.

FRIDAY, NOVEMBER 7.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Committee), at 5.—Col. Sir S. G. Burrard, Prof. A. E. H. Love, and Others: Discussion on Isostasy.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—Prof. Baly: The Spectroscope in the Science of To-day.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. F. E. Shipway: Intratracheal Insufflation of Ether in Operations which involve Bleeding into the Air Passages.

MONDAY, NOVEMBER 10.

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, S.W.7), at 5.—Lt.-Col. G. A. Beazeley: Surveying in Mesopotamia during the War.

BIOCHEMICAL SOCIETY (at King's College), at 5.30.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Surg.-Rear-Admiral Sir Robert Hill: Presidential Address.

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' ASSOCIATION, at 8.—F. M. Green: Modern Steam Turbines.

SURVEYORS' INSTITUTION, at 8.—A. Young: President's Opening Address.

TUESDAY, NOVEMBER 11.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. E. G. Browne: The Origins and Development of Arabian Medicine. I. The Translations (VII.-IX. Cent.). (FitzPatrick Lecture.)

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—S. Hazzledine Warren: A Stone-axe Factory at Penmaenmawr.

WEDNESDAY, NOVEMBER 12.

CONJOINT BOARD OF SCIENTIFIC SOCIETIES (at Royal Society), at 5.—Discussion of Draft Report on the Metric System.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—C. A. Swan: Some Physical and Psychical Effects of Altitude.

THURSDAY, NOVEMBER 13.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Prof. W. B. Bottomley: The Effect of Nitrogen-fixing Organisms and Nucleic Acid Derivatives on Plant Growth.—W. Robinson: The Microscopical Features of Mechanical Strains in Timber and the Bearing of these on the Structure of the Cell-wall in Plants.—Agnes Arber: The Vegetative Morphology of Pistia and the Lemnaceæ.—Lt. Col. R. McCarrison: The Genesis of Œdema in Beri-beri.—W. J. Young, A. Breinl, J. J. Harris, and W. A. Osborne: Effect of Exercise and Humid Heat upon Pulse Rate, Blood Pressure, Body Temperature, and Blood Concentration.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. E. G. Browne: The Origins and Development of Arabian Medicine: II. Four Great Medical Writers of Persia (IX.-XI. Cent.). (FitzPatrick Lecture.)

INSTITUTION OF ELECTRICAL ENGINEERS (At Institution of Civil Engineers), at 6.—Roger T. Smith: Presidential Inaugural Address.

OPTICAL SOCIETY, at 7.30.

FRIDAY, NOVEMBER 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.

PHYSICAL SOCIETY, at 5.—S. Butterworth: The Self-Inductance of Single Layer Flat Coils.—Dr. N. W. McLachlan: An Experimental Method of Determining the Primary Current at Break in a Magneto.—F. H. Newman: Note on a Modified Form of the Wehnelt Interruptor. (With Demonstration.)

SATURDAY, NOVEMBER 15.

PHYSIOLOGICAL SOCIETY (at London School of Medicine for Women), at 4.30.

CONTENTS.

JUBILEE NUMBER.

	PAGE
Valedictory Memories. By Sir Norman Lockyer, K.C.B., F.R.S.	189
Progress and Promise	190
Scientific Worthies. XLI.—Sir Norman Lockyer, K.C.B., F.R.S. By Dr. H. Deslandres (Vice-President of the Academy of Sciences of Paris, Director of the Astrophysical Observatory of Meudon)	191
Retrospect and Prospect. By Sir Archibald Geikie, O.M., K.C.B., F.R.S.	195
The Foundation of Biological Sciences. By Sir E. Ray Lankester, K.C.B., F.R.S.	198
Science and the Church. By the Ven. James M. Wilson, D.D., Canon and Vice-Dean of Worcester	201
The Expansion of Geology. By Prof. T. G. Bonney, F.R.S.	203
The New Birth of Medicine. By Sir T. Clifford Allbutt, K.C.B., F.R.S.	204
Developments of Physiology. By Sir Edward Sharpey Schafer, F.R.S.	207
The Modern School of Psychology	208
Preventive Medicine since 1869. By Dr. C. J. Martin, F.R.S.	210
The Antiquity of Man. By Dr. A. Smith Woodward, F.R.S.	212
The Present Position of the Mutation Theory. By Prof. Hugo de Vries, For. Mem. R.S.	213
The Progress of Mendelism. By Prof. W. Bateson, F.R.S.	214
Telegony. By Prof. J. Cossar Ewart, F.R.S.	216
Progress of Chemistry. By Sir Edward Thorpe, C.B., F.R.S.	217
Chemistry in the Making. By Prof. Henry E. Armstrong, F.R.S.	219
The Discovery of Chemical Elements since 1869. By Prof. H. B. Dixon, F.R.S., and H. Stephen, M.Sc.	221
Physical Chemistry—Past and Present. By Prof. J. C. Philip	223
The Influence of Investigations on the Electrical Properties of Gases on our Conceptions of the Structure of Matter. By Sir J. J. Thomson, O.M., Pres. R.S.	224
Radium and the Electron. By Sir Ernest Rutherford, F.R.S.	226
Atoms and Molecules. By Prof. Frederick Soddy, F.R.S.	230
Ionisation of Gases. By Prof. J. S. Townsend, F.R.S.	233
Spectroscopic Astronomy. By Prof. A. Fowler, F.R.S.	234
X-Rays in Physical Science. By Prof. W. H. Bragg, F.R.S.	235
X-Rays in Medical Science. By A. C. Jordan, M.D., M.R.C.P.	237
Progress of Electrical Invention. By Prof. J. A. Fleming, F.R.S.	239
Developments of Mechanical Science. By Dr. W. C. Unwin, F.R.S.	241
The Trend of Modern Metallurgy. By Prof. H. C. H. Carpenter, F.R.S.	243
Position and Prospects of Aviation. By L. Bairstow, F.R.S.	246
The Liquefaction of Gases. By Prof. C. H. Lees, F.R.S.	247
Progress of Meteorology. By W. H. Dines, F.R.S.	247
Progress of Geography. By Sir John Scott Keltie.	249
Progress of Photography. By Chapman Jones.	251
The Reproduction of Illustrations, 1869–1919. By Emery Walker	252
Progress in Science Teaching. By Sir William A. Tilden, F.R.S.	253
Aspects of Science at Universities. By Dr. Alex Hill	255
Fifty Years of Technical Education. By J. H. Reynolds, M.Sc.	257
The Promotion of Research. By Sir Richard A. Gregory	259
Research and its Application. By Dr. W. H. Nichols	262
British Botanic Gardens and Stations	263
The Scientific and Technical Department of the Imperial Institute	263
The Lister Institute of Preventive Medicine	264
The National Physical Laboratory	264
The Davy Faraday Research Laboratory of the Royal Institution	264
The International Catalogue of Scientific Literature	265
The Tropical Diseases Bureau	265
Women at Cambridge	265
Notes	266
Our Astronomical Column:—	
Comets	269
The Sources of Stellar Energy	269
British Scientific Societies Founded during the Past Fifty Years	270
Societies and Academies	271
Diary of Societies	271

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THURSDAY, NOVEMBER 13, 1919.

THE TURKS OF CENTRAL ASIA.

The Turks of Central Asia in History and at the Present Day: An Ethnological Inquiry into the Pan-Turanian Problem, and Bibliographical Material relating to the Early Turks and the Present Turks of Central Asia. By M. A. Czaplicka. Pp. 242. (Oxford: At the Clarendon Press, 1918.) Price 15*s.* net.

THIS small and closely packed book deals with a big and intricate subject which can be dealt with satisfactorily only on a much larger scale, and it is to be hoped that its talented and learned author will presently give us a larger monograph in which the earlier history of the Turks, with its dramatic ties with the fortunes of Asia and Europe, will be told in much greater detail. It is opportune that such a book should appear when the greatest and most powerful empire established by the Turkish race is passing away, and when the thoughts of many of us are turning with a good deal of interest to the period in its history when the race emerged from the prehistoric age and began its wider sphere of interest. It is not possible in the space which NATURE can spare to do more than give a bare outline of the subject.

The Nomadic peoples who occupy the great stretch of grassy steppes, barren lands, and stony plateaus of Asia from the River Ural to the Yellow Sea form a group which is closely united by physical ties and by language. Their speech, although mutually unintelligible, has a common grammatical structure and a large number of common words. They are divisible into two main branches, respectively known to the Chinese as the Eastern and Western barbarians. Each of these divisions is again separable into two sections, one of them including the Mongols properly so-called, and the Tungus, better known in the West from one of their tribes as Manchus, and occupying the eastern part of Central Asia, of which the great desert of Gobi and its borders form the kernel. The other section, comprising the Turks and Finns (each divided into various tribes), occupies the country west of Mongolia, and is grouped about the great mountain chains of the Urals and the Altai Mountains, and is often spoken of as the Uralo-Altaic section of the human family.

At the time when history first notices this group, they were probably nearly as much separated as they are now, the great distinguishing feature which separates these two branches being that, while the Finnish branch were at that time almost entirely hunters and fishermen, the Turks have always been nomad herdsmen, having been occupied chiefly with the rearing of cattle, horses, and camels.

In their early days one section of the Turks formed the "frontagers" of the Aryan peoples, who lived in the Persian provinces of Khorasan, Balkh, and Transoxisia, which they continually worried and attacked. The two lands, that of the nomads and that of the settled people, were respectively known to the Persian writers as Turan and Iran. This Western section is generally known as the Western Turks, and was perhaps the only portion of the stock specifically called Turks at that time.

Another great section occupied the frontiers of China and the greater part of what is now known as Mongolia, and in the earliest Chinese writers are known as *Hiong Nu*, or *Hiun Nu*. The Hiong Nu formed a very powerful empire, which fought on equal terms with China, and was a serious menace to the latter empire during the Chinese dynasties of the earlier and later Han. The power of the Hiong Nu was gradually sapped in their struggles with the Chinese, and they were eventually attacked and conquered by their Eastern neighbours, known to the Chinese as Yuan Yuan, who thus became the masters of all Nomadic Tartary, and were probably nearly related to the later Mongols. I argued in former years that they were identical with the Avars of the European writers, who appear in the West at the time when the power of the Hiong Nu was destroyed.

Presently, in the sixth century, the Yuan Yuan were themselves conquered and replaced by the true Turks, who then appear *eo nomine* for the first time in the Chinese annals. The Chinese, not having the letter "r" in their alphabet, represented the name "Turk" by that of Thukiu. These Turks were, I feel sure, the Western branch of the race above named. They in turn became the masters of all Tartary, and eventually were divided into two sections, a Western branch and an Eastern, the latter being in a large measure the descendants of the Hiong Nu above named.

It is with the advent of these true Turks into Mongolia that we first meet with signs of a settled community there, marked by many traces of civilisation, which are clearly traceable to the Iranian lands from the borders of which these Turks came. Among these the most notable relics are the remains of towns, and the existence of inscriptions, proving their knowledge of letters. They have left us a number of most interesting inscriptions, which have been studied and illuminated by several notable scholars. The names of the rulers mentioned on these inscriptions are also found in the Chinese annals, and are attributed by them to the Thukiu. We can therefore date them with the greatest precision. They are written in the well-known and widely spread Syriac script known as *estranghelo*, in which the Nestorian inscriptions of China were written, and which was afterwards used by the Uighur Turks and the Mongols for their writings. The capital of these early Turks was in Northern Mongolia, and, as stated above, they have left large traces there of their settlements.

Presently it would seem that the earlier Turks who lived in the East and had been known as Hiong Nu reasserted themselves and conquered and replaced the Turks just named, taking possession of their settlements and capital, and continuing their culture. They also adopted the new name of Uighurs, which the Chinese, having, as I have said, no letter "r," changed into Hoei Hoei and other distorted forms of the name Uighur.

These Uighurs became a highly cultivated people, with a considerable literature, which is still extant, and their dialect is known as Eastern Turki. They apparently inherited from the Western Turks an attachment for the Iranian or Zoroastrian religion, and traces of the Zoroastrian gods and ritual are found among their remains. On other sides their religion was affected by missionaries from other sources. Manicheism found numerous recruits among them, and we are now fast recovering from the buried cities of Eastern Turkestan most interesting remains of the religion of Manes, while the Nestorian clergy founded episcopal sees in their country, and made numerous recruits. Presently, and in the seventh century, Buddhism also made its way among them in the corrupt form, and mixed with the Tantra superstitions, which then prevailed in Tibet, and is known as Red Lamaism in contrast with the reformed Lamaism of the later Yellow Lamas.

At length, in the ninth century, the religion of Islam found its way into Central Asia, being disseminated from the Central Asiatic State governed by the Samanis, and the Western Turks became eager converts to it both in the frontier steppes of the Persian Empire and in Eastern Turkestan. The Eastern Turks or Uighurs continued to be the more cultivated of the race, but the Western were the more powerful warriors, and under the name of Turcomans overran Persia and Asia Minor, founding the famous empire of the Seljuki, which was presently (in the thirteenth century) overwhelmed by the Mongols.

I am conscious of the extremely meagre and arid nature of this epitome, and how little it does justice to the wide reading and sound judgment of the author. No one knows it better, for I have spent a large part of my life in writing four fat volumes on the Mongols, and two sets of papers on the westerly drifting of Nomads and the northern frontagers of China in the old Ethnological Society's Journal and the Asiatic Journal respectively. This may give me at least a claim to speak in terms of high praise of the work before me, in which the author, having the unusual advantage of knowing Russian, has employed it with generous profusion, much to our profit, and in which she describes with clearness the various divisions into which the Turks have been disintegrated, with their geographical, ethnographical, and religious features, and also tells the story of their doings. It is so well done that I cannot pay the book a greater compliment than to repeat my invitation to the learned lady who has written it to give us a much larger work on the subject. I may add that a most ample bibliography occupies 114 of the 242 pages comprised in the work.

HENRY H. HOWORTH.

THE LIVING PLANT.

Botany of the Living Plant. By Prof. F. O. Bower. Pp. x+580. (London: Macmillan and Co., Ltd., 1919.) Price 25*s*. net.

A GOOD deal of discussion has recently taken place among botanists on the subject of the reconstruction of elementary botanical teaching, and one of the main contentions of the originators of the discussion was that in order to secure improvement "comparative morphology should be reduced to a subordinate position." It has further been alleged that in modern botanical teaching the teacher has failed to present the plant as a living organism, thereby implying that morphology has been divorced from physiology. Prof. F. O. Bower has already expressed himself forcibly and with sound sense upon the question in the pages of the *New Phytologist* (vol. xvii., Nos. 5 and 6, p. 105), and has aptly summarised his views with the adage, "Physician, heal thyself."

In his book now under notice he has given so admirable a presentment of the plant as a living organism that instead of there being any antagonism between physiology and morphology, their fusion and interdependence are so impressed on the reader that he can see, not two entities, but "one flesh."

Prof. Bower concludes the article to which reference has been made with the following: "Finally, each teacher with a due sense of his responsibility, and of his opportunities and requirements, must form his own scheme to meet his own needs. If he cannot do this he is not fit for his position."

Prof. Bower has followed this very pertinent criticism with his book, "The Botany of the Living Plant," which is framed on the lines of the annual course of elementary lectures on botany given by him at Glasgow for more than thirty years. His main object has been to present the plant as a living, growing, self-nourishing, self-adapting creature, and he has very finely achieved his ideal.

In his method of treatment of the subject he has allowed the living plant to tell its own story, slowly and naturally unfolding itself stage by stage in such a manner that interest is aroused and observation stimulated. The book may very justly be regarded as an invaluable contribution to sound learning. It does not aim at being an exhaustive treatise, but deals with the fundamental facts of plant life, and is written in a remarkably clear style, so much so that anyone with only a slight acquaintance with plant life should be able to acquire a real knowledge of the science of botany from a careful study of these essays.

The opening chapter is occupied by a careful and comprehensive description of the seed and its germination. It is sometimes considered more reasonable to commence the study of botany with the lower forms of plant life, but it is obviously a better plan to set out with a familiar and easily handled object, such as the seed, which marks a definite starting-point, and can be examined and studied in detail without recourse to the microscope. It is pointed out that in the plan of construction of the higher plants the outstanding feature is the capacity for indefinite vegetative increase which may be termed "continued embryology."

The cellular construction of the plant and the various functions of the cell, cell-division, and protoplasmic continuity naturally follow, and then the tissues are dealt with in further detail. The sequence of events next leads to an account of leaf and root from the morphological point of view, followed by chapters on the relation of plants to water, and on nutrition, storage, and respiration. In the chapter on growth and movement due attention is paid to the statolith theory in connection with geotropism. Succeeding chapters deal fully with the mechanical construction of the plant body, modifications of form in the vegetative system, such as bulbs, tubers, climbing plants, etc., the irregular nutrition of parasitic, semi-parasitic, and carnivorous plants, and vegetative propagation, all of which aspects of plant life are fully discussed with a wealth of well-chosen examples.

The inflorescence and flower and the formation and development of the seed with all that is entailed occupy some eighty pages and bring this first division of the book to its logical conclusion. This portion is not a mere chronicle of well-known facts, but is illuminated by a consideration of flower colours, pollination, and the details of fertilisation, and closes with a description of the mode of dispersal of some of the better-known seeds and fruits.

The second part of the book is arranged in four divisions, dealing respectively with the Gymnosperms, Pteridophyta, Bryophyta, and Thallophyta, followed by two chapters, one on sex and heredity, the other on the alternation of generations and the land habit. These two essays very fittingly come at the end as a summary of the previous chapters dealing with the life-histories of the lower plants.

As in the earlier part of the book, these more specialised chapters on the ferns, mosses, fungi, and algæ are treated on broad lines, and there is no superfluity of detail to obscure the salient features.

The book concludes with two appendices, one on the types of floral construction in Angiosperms, the other on vegetable-foodstuffs, both of which considerably enhance the value of the volume. In the former a few types of flower are described, and notes are added on the natural families to which the particular examples belong. The plants chosen are easily accessible and also represent characteristic features of families the products of which are of economic importance. Further, they are of interest in connection with the production and dispersal of seeds, floral biology, etc. The illustrations in this appendix have been drawn for the most part by Dr. J. M. Thompson, and are particularly clear and useful.

The glossary-index, which completes the book, occupies thirty-two pages, and furnishes a further example of the thorough and careful manner in which Prof. Bower has carried out his object.

We have for so long been accustomed to rely on translations of German text-books for our elementary botanical students that it is very gratifying to find them superseded by so excellent and comprehensive a study of the living plant from one of the most eminent of our own professors and teachers.

A. W. H.

OUR BOOKSHELF.

Influenza: A Discussion opened by Sir Arthur Newsholme. Pp. 102. (London: Longmans, Green, and Co., n.d.) Price 3*s*. 6*d*. net.

The discussion on influenza at the Royal Society of Medicine in November last summarises very completely our knowledge of this obscure epidemic disease. Sir Arthur Newsholme, in his opening remarks, expressed the opinion that influenza is a specific disease recognisable in severe outbreaks, and pointed out that, with the exception of plague and cholera, it has on occasion travelled farther and more rapidly over the world than any other recognised disease, and that it is one over which preventive medicine so far has secured little or no control.

Dr. Stevenson directed attention to certain features of the 1918 epidemic which differed from those of the past twenty-seven years, viz. (1) its intensity was greatly in excess of that of any of its predecessors, and (2) the sudden and startling change which occurred in 1918 in the age distribution of influenzal mortality. In all previous years the majority of deaths—generally about 70 per cent.—occurred at ages above forty-five. But in July, 1918, only about 30, and in October about 20, per cent. of the persons dying were more than forty-five years of age, and only 5·5 per cent. of the deaths of this outbreak were at ages above sixty-five, as against an average of 37 per cent. for the years 1890–1917.

Several speakers dealt with the aspects of the epidemic in the Navy and in the Army, and in France, America, and South Africa, which correspond closely with those observed among the civil population here.

With regard to the bacteriology of the disease, most of the observers noted the presence of the influenza bacillus, the pneumococcus and the streptococcus, but no very definite opinion is expressed as to the nature of the virus. Prophylactic vaccination receives scant notice, probably because the data were insufficient at the time of the meeting.

As regards treatment, Mr. E. B. Turner claimed that large doses of salicin constitute a specific, and certainly his experience, based on the observation of 2500 cases, suggests that this drug deserves an extended trial.

R. T. Hewlett.

The "Daily Telegraph" Victory Atlas of the World. Part i. (London: "Geographia," Ltd., 1919.) Price 1s. 3d. net.

THIS is the first part of a new atlas to be completed in about forty-eight parts. Each part is to consist of three double-page maps, 20½ in. by 26 in. A gazetteer is to complete the work. The first part contains maps of Australia (physical), South-West Spain (political), and Germany (historical), besides several inset maps. The colour printing is good and the lettering particularly legible. The orographical map of Australia is layer coloured, and although it shows some small discrepancies from the recently published official orographical map of the Commonwealth it is an effective and useful sheet. The map of Spain, which we take to be the type of political map of the atlas, would be improved by the omission of the "caterpillar" relief, which is merely misleading and of no value. In this respect the map of Germany is better, for no attempt is made to show relief on it. The changes due to the Peace Treaty are incorporated, but a mistake is made in the area of the Slesvig plebiscite. The atlas promises to be a useful one for general reference purposes. Its low price is much in its favour.

R. N. R. B.

The Mica Miner's and Prospector's Guide. By Archibald A. C. Dickson. Pp. viii+50. (London: E. and F. N. Spon, Ltd., 1919.) Price 4s. 6d. net.

THE mica industry is indebted to the author of this "Guide" for the current system of mining in Kodarma, the most prolific mica field in the world. His memoirs on that field are well known. Any contribution of his to the literature of the subject is therefore sure of careful consideration. The present booklet, which is high-priced—fifty pages for 4s. 6d.—was prepared to help the increased output of mica necessary during the war. It contains much valuable information, but does not cover all the ground that might be expected from the title. It consists mainly of descriptions of eight of the secondary mines of the Kodarma field and of notes on the mining methods there. It contains little information as to costs and values, and would not explain to a miner who had no previous experience of mica-mining how to estimate the probable profit or loss of a newly discovered deposit. The author's main thesis is that mica-mining must be guided by careful geological study, and he insists that all the facts observable during the working of a deposit should be systematically entered on a mine plan. This warning is especially useful with a branch of mining in which so much of the output is from small mines worked by parties of local labourers. Mr. Dickson points out that the mica lenses on the margin of a deposit are apt to be inclined to the shoot, and a miner who was guided only by the facts seen would be diverted from the main body of mica.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Scattering of Light by Resonating Molecules.

PROF. R. W. WOOD (*Phil. Mag.*, vol. xxiii., p. 689, 1912) found that mercury vapour, even at the small density corresponding to atmospheric temperature, when illuminated by the ultra-violet mercury radiation λ2536, re-emits this radiation laterally in considerable intensity.

Further, Wood and Kimura found after repeated examination that this radiation is *completely free from polarisation* (*Phil. Mag.*, vol. xxxii., p. 329, 1916).

I have been very much impressed with the contrast between this case, where there is resonance, and the behaviour of gases in general when illuminated by light which is not in resonance with the free period of the atoms. In the latter case the laterally emitted light usually approximates to complete polarisation (Proc. Roy. Soc., A, vol. xcv., p. 155, 1918). What happens as we gradually depart from exact resonance?

Prof. Wood's experiments were made with the exciting light polarised, and he observed the resonance radiation through the same window by which the exciting light entered. In this way the light examined comes chiefly from the very first stratum of vapour entered by the beam. This stratum gives by far the most intense emission.

As, however, the beam advances into the mercury vapour the light in exact resonance is absorbed, being, in part at least, re-emitted. The lateral emission further on is much fainter, and corresponds presumably to a less exact resonance.

It appeared to be of interest to examine this lateral emission from the deeper strata for polarisation. This I have done, and I give here a brief statement of results, leaving the experimental details for later publication.

After the unpolarised primary beam has traversed 0·4 cm. of mercury vapour at ordinary temperature, the lateral emission shows very perceptible polarisation, the component intensity vibrating parallel to the exciting beam having 90 per cent. of the intensity of the perpendicular component.

After passing through 2·5 cm., this ratio fell to 82 per cent.

After 27·4 cm., the value found was 60 per cent.

Thus it appears that the scattered light is unpolarised only when resonance is very exact. The breadth of the absorption band (reversal) produced by a few millimetres of mercury at atmospheric temperature and *in vacuo* must be extremely small, and probably beyond the range of any but the most powerful spectroscopes. Yet it is only within this narrow spectral range of the exciting light that the scattered light is sensibly unpolarised. When this component is filtered out, and such excitation as remains is by light nearer the edges of the exciting line, polarisation becomes conspicuous.

It need scarcely be said that there is very much more to be done in this direction. Further experiments are in progress.

RAYLEIGH.

Imperial College, South Kensington,
November 1.

Vertical-pipe Irrigation for Orchards and Market-gardens in Arid Climates.

IN the issue of NATURE for September 11, 1919 (p. 44), abstracting from the *Comptes rendus* of the Paris Academy (August 25, 1919, p. 391), mention is made of a new method, proposed by M. Paul Parmentier, for irrigating orchards and market-gardens in Syria, Palestine, and other countries subject to long summer droughts. The observations of M. Parmentier refer especially to the citrus gardens around Jaffa.

In arid climates economy in irrigation-water is obviously of the utmost importance. According to the method proposed by M. Parmentier, the water is applied direct to the roots of each tree by means of earthenware, cement, or iron pipes fixed vertically in the soil. The great losses by evaporation that always occur in open canals and in surface irrigation are thus avoided. M. Parmentier remarks that with vertical-pipe irrigation the water used in a citrus orchard was only 84 litres per hectare, as compared with 600 litres necessary for surface irrigation, applied every five to twelve days. At Jaffa there are 880 trees to 1 hectare ($2\frac{1}{2}$ acres) of citrus orchard, and 1100 plants in the banana gardens. These figures are very high, and imply a great consumption of water.

The method proposed by M. Parmentier is not new. Watering orchards by means of special drain-tubes sunk vertically in the soil is an old practice at Messina, in Sicily, where it is chiefly applied to young plantations. This method of irrigation was first described long ago by Prof. Giuseppe Inzenga, the well-known Sicilian agronomist and botanist, in the *Annali di Agricultura Siciliana*; and again by F. Alfonso-Spagna in his "Trattato d'Irrigazione" (Palermo, 1877, p. 502). In my book of agricultural chemistry ("Chimica Agraria, Campestre e Silvana," Napoli, 1902) this special method of drainage-irrigation is again described. The *catuso* used by the Messina gardeners is a conical earthenware pipe, about 1 metre long, open at both ends. The diameter of the upper opening is 15 cm. and that of the lower 10 cm., the pipe thus holding about 12 litres of water. M. Parmentier proposes pipes holding 20 litres for use in orchard irrigation. At Messina the upper end of the *catuso* projects slightly above the soil, the opening being covered with a brick or tile.

In the summer of 1889, at Portici, near Naples, I experimented on two lemon-trees of the same age and size, watering one in the usual manner and the other by means of a drain-pipe sunk vertically in the earth. During that hot summer, in the sandy, volcanic soil at the foot of Vesuvius, the difference between the effects of the two methods of watering was very apparent. The lemon-tree provided with the vertical drainage-pipe prospered on a ration of water about 50 per cent. less than that necessary for the control tree watered from the surface.

The sunk end of the drainage-pipe is made to rest on loose stones or potsherds, which form air-chambers. Thus clogging of the pipe is prevented, and the water that is poured down gets well absorbed and distributed just where the roots are more vigorously developing and renovating their absorbing organs.

The subsoil air-chamber is as important as the water-pipe. During drought the deep aeration of the soil, when moisture is sufficient, provokes the growth of the roots and the renewing of the root-hairs, increasing their power of absorption and at the same time favouring deep-soil nitrification. The roots are induced to develop chiefly around the reservoir of moist, warm air, where respiration and growth find favourable conditions, the network of young and active rootlets thickening around the spot where the watering is concentrated and nitrates are being actively formed. The loss by evaporation and percolation is minimised. Moreover, the close air under the foliage of the trees, as M. Parmentier remarks, is maintained in a less damp condition than is usual in the deeply shaded citrus orchards, where the development of parasites and pests is much favoured by the moist shade.

M. Parmentier observed that vegetables watered by underground irrigation are more tender and of higher market value than vegetables watered by submersion, or by any other method by which the foliage, stalks, and upper parts of the roots are wetted. Indeed, it may be added that the wetting of the foliage increases transpiration, and consequently the waste of water.

By means of vertical-pipe irrigation dilute liquid manure can be applied far more effectually and economically than by the usual method of night-soil manuring In the case of vegetables and fruit-trees subsoil liquid manuring is also advisable from a sanitary point of view.

In arid climates, and wherever the economy both of water and of liquid nitrogenous manure is of special consequence, the Messina and Parmentier method of underground watering by vertical drainage is much to be recommended.

ITALO GIGLIOLI.

Laboratory of Agricultural Chemistry, University of Pisa, Italy.

New Sources of Aluminium.

I WAS much interested in the account given in NATURE of October 23 of the new methods of extraction of aluminium from clays of the kaolin class (formed from the denudation of volcanic rocks) by means of nitric acid and electric furnaces in Norway. When this source of production is generally adopted, as no doubt it will be owing to the diminishing supplies of cryolite and bauxite, it seems probable that the vast quantities of "decomposed porphyry" discovered by the late Prof. Jacob during his geological explorations in the Rocky Mountains (some of which have been mistaken for chalk by prospectors) will then form an inexhaustible source of supply for that valuable metal.

J. E. BACON.

The Barracks, Fulford, York.

Radiation Temperature: Dew.

THE letter in NATURE of October 23 on radiation temperature from Mr. Spencer Pickering reminds me that the theory of the equilibrium temperature is given by Clerk Maxwell in his little-known article on Diffusion ("Ency. Brit.," ninth edition, p. 218). Maxwell shows that in still-air temperature θ_0 a thermometer will gain heat per sec. $4\pi CK(\theta_0-\theta_1)$, where C is the electrical capacity of the bulb, K the conductivity constant for air; and that it will give up heat per sec. $AR(\theta_1-\theta)$, where A is the area of the bulb, R the radiation constant, and θ the temperature towards which radiation occurs. If the bulb be spherical $C=r$, its radius. Consequently,

$$4\pi rK(\theta_0-\theta_1)=4\pi r^2R(\theta_1-\theta),$$

or

$$K(\theta_0-\theta_1)=rR(\theta_1-\theta).$$

That is, the conductivity effect depends on the radius of the bulb. Mr. Pickering has observed this in the case of small bulbs. He goes on to apply this result to small objects, such as the pistils and stamens of flowers. I would like to point out another effect to which his observations apply, namely, that true dew (arising from radiation) is not found on spiders' webs. If webs are examined when dew is on the ground they are found to be dry. When drops of water are found they arise from the collecting action of the webs on mist or fog, *i.e.* by the collection of drops already formed. I have confirmed this on many occasions. I conclude that whenever drops are found on webs it is the result of fog or mist.

SIDNEY SKINNER.

South-Western Polytechnic Institute, Chelsea.

Surface-Tension.

OWING to surface-tension, a surface of mercury supports easily a sovereign placed flat upon it. Care must, of course, be taken to avoid amalgamation.

I shall be greatly obliged if one of your readers will supply me with a formula for determining the size of the largest sphere of gold that can just be supported by mercury. As the numerical solution of the equation may be troublesome, I venture to ask only for the formula.

C. T. WHITMELL.

Hyde Park, Leeds, November 3.

Exceptional Dryness of October, 1919.

METEOROLOGISTS have directed attention to the exceptional dryness of the past October. It is also interesting to note that the amount of drainage-water percolating through 20 in., 40 in., and 60 in. of soil in the open field for the month of October as recorded by the Rothamsted Experimental Station gauges is *nil*. The three gauges, each measuring 1/1000 acre, were built in 1870, and in no previous year is October shown quite dry, 1897 being the nearest with a reading of 0·001 in. The following are the figures for October:—

	20 in. gauge	40 in. gauge	60 in. gauge	Rainfall
Average of 50 years	1·848	1·798	1·669	3·233
Max. 1891	5·589	5·716	5·479	6·764
Min. 1897	*nil*	0·001	0·001	0·960
1919	*nil*	*nil*	*nil*	1·073

The 50-year records show that October is one of the four months when the ground is wettest.

W. D. CHRISTMAS.

Lawes Agricultural Trust, Rothamsted Experimental Station, Harpenden, November 6.

SOUND RANGING.

SOUND ranging consists in the location of the source of a sound, such as the report of a gun, by means of measurements made on the sound-wave which spreads from the source. When it seemed probable, in the latter part of 1914, that the struggle in France was going to develop into trench warfare, the possibility of locating enemy batteries by this means was recognised, and many experiments were started independently to find a method of sound ranging which could be used in the field.

Suppose that there is a gun at the point S in Fig. 1. The report of the gun spreads as a spherical sound-wave, with a uniform velocity, and is received by stations at A, B, and C. If the time intervals between the arrival of the sound at A, B, and C are measured, a very simple construction gives the position of the gun. For instance, if the sound gets to B a time t_1 after it gets to A, and to C a time t_2 after it gets to A, circles are described around B and C the radii of which are equal to the distances travelled by sound in times t_1 and t_2 respectively. If a circle is found which passes through A, and touches the circles around B and C, the gun position will be at its centre. Therefore, by installing a series of observation stations along the front at surveyed positions, and recording the times at which the report arrives at these stations, it is possible to plot the position of the enemy battery on a map on which the observation stations are marked. This is the essential idea underlying sound ranging. Three stations only are necessary, but more may be employed in order to confirm the location.

There are other ways of plotting the gun position, given the time intervals. For instance, if the time interval between A and B is t_1, the gun must lie on a hyperbola with foci at A and B which is such that the difference in the distances from the foci of any point on the curve is Vt_1, where V is the velocity of sound. Another pair of stations give another hyperbola, and by finding where this intersects the first the gun position is determined. This was the method actually employed on the plotting-boards used by the sound-ranging sections. The hyperbola approximates so closely to its asymptote near the gun position that the asymptote can be used equally well, which makes the method a very simple one in practice.

The French Army started experiments in sound

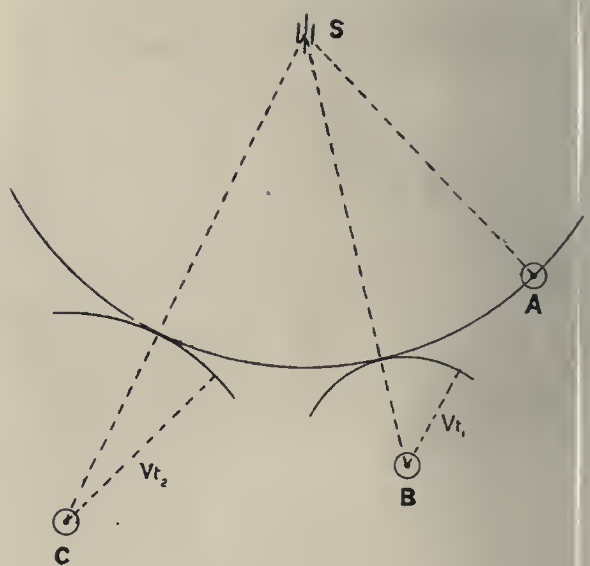

FIG. 1.

ranging in 1914, and obtained results which showed that the method was a promising one. From the very beginning development took place along two lines. Either observers were used, who recorded the time of arrival of the sound by pressing a key, or the sound was registered automatically by some form of microphone. In both cases the stations were connected electrically to a central station, where the signals sent by the observers or microphones were registered on a chronograph of some form. It was soon found that observers were not sufficiently accurate. They made errors amounting to one-tenth of a second, whereas it is necessary to time the arrival of a sound to 0·005 second in order to make a satisfactory location. This accuracy was attained by the system in which the arrival of the sound was registered by a microphone, and both in the French Army and ours a microphone system was finally adopted.

Our attention was directed to the French results in the early part of 1915, and a proposal to form an experimental sound-ranging section was laid before the Experiments Committee at General Headquarters. The committee at first decided against ordering any apparatus, but was persuaded to alter its decision, and an English sound-ranging section was sent to the front in October, 1915. Sound ranging was still in its infancy, and the results obtained were very disappointing. In fact, it was doubtful at one time whether the continuation of the experiments would be authorised. Fortunately, sound ranging just survived these early trials, and during 1916 sufficient sections were formed to cover the whole front.

The apparatus which we adopted was designed by M. Bull, of the Institut Marey, in Paris, and was one of several with which the French Army was experimenting. It is not possible to describe the apparatus fully. The recording apparatus consists of an Einthoven galvanometer with six strings, each string being connected to a microphone at a receiving station. The currents which the microphones send to the recording instrument cause the corresponding strings to vibrate, and their movements are recorded photographically on a moving kinematograph film. At the same time, by interrupting the light which photographs the strings on the film, at intervals of 1/100 second, a series of time markings is ruled on the film, which makes it possible to measure the time interval between the arrival of the sound at two stations. The microphone finally used was of a special type adopted after experiments at the front. Its special feature is that it is very sensitive to sounds of long wave-lengths, such as gun reports or shell bursts (the wave-length of the report of a large gun may be 250 ft.), while comparatively insensitive to ordinary sounds, such as speech, rifle fire, traffic, and so on. The credit of its design is due to Lt. Tucker, an officer serving in the experimental section in 1916.

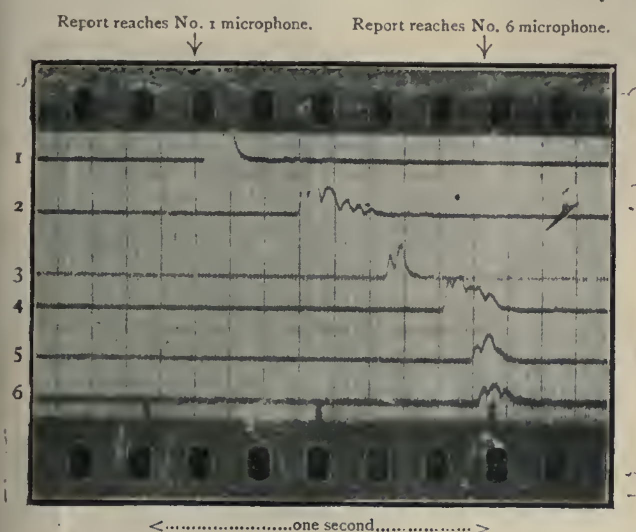

FIG. 2.—The figure is an enlarged print of the record of a 15 cm. howitzer, the report of which has reached No. 1 microphone first and No. 6 microphone last. The film has been moving from right to left while the record was being taken. The time intervals are marked by vertical lines, one hundred to the second, every tenth line being heavier so as to facilitate counting. The horizontal lines represent the shadows of the Einthoven strings, which lie across the slit behind which the film is exposed, and the movements of which are shown on the record.

A record of a German 15-cm. howitzer is illustrated in Fig. 2.

The installation of a section using the Bull apparatus is shown in Fig. 3. There are six microphones, spaced along a "base" about 9000 yards long and 4000 yards behind the front line. These are wired up to a central station which is placed in a cellar or dug-out some 5000–6000 yards from the front line. In front of the base are the "advanced posts." An observer is stationed at each of these. When he hears a hostile gun fired, he presses a key which sets in motion the apparatus at the central recording station. The kinematograph film runs through the camera, the lamp is turned on, and all is ready to record any sounds reaching the microphones. Having allowed time for the sound to reach all the microphones, the forward observer raises his key and the recording apparatus stops. He telephones to the central station a report giving his estimate of the direction from which the firing has come, of the target, and of the calibre of the piece. The film is developed and fixed by a

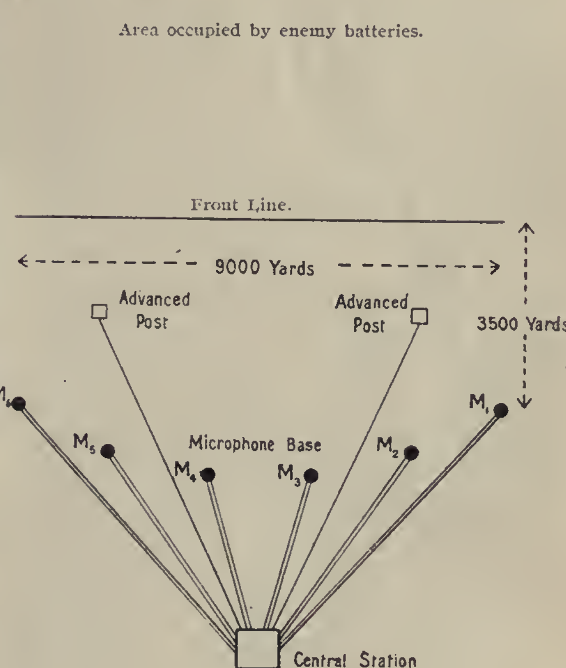

FIG. 3.

photographer; this can be done in ten seconds by using strong solutions. It is handed over to a computer, who reads the time intervals and plots the result, and the location of the battery is telephoned to all interested. The time taken to work out a result is generally from four to ten minutes after the battery fires. The location is first telephoned to the artillery, in order that immediate action may be taken if desired. The neighbouring sections and other units engaged in location are then informed in order that results may be compared. At the end of the day the section sends in a full report of the day's work, and this is used by the compilation staff employed in estimating the positions and strength of the enemy artillery in any particular sector.

In 1917 and 1918 there were about thirty sections on the Western front, each section having four officers and forty men. The average number of locations obtained per day by each section was about five, though on a day when conditions were particularly favourable it was not uncommon for a section to get thirty, forty, or even more locations. Long spells of westerly weather were responsible for keeping the average number so low, because it was found impossible to "sound-range" in a wind blowing from the base towards the enemy guns. The sound is deflected upwards in the well-known manner, and fails to be recorded by the most sensitive microphone.

The accuracy of the results was tested in many ways. After a successful advance it was possible to examine the positions the enemy batteries had occupied and compare them with the locations. When this could not be done, an examination of aeroplane photographs generally revealed the gun pits, when sound ranging or other methods of location had indicated the approximate battery position. The average error of location, at a range of 10,000 yards, was about fifty yards, though naturally the conditions under which the section was working affected the accuracy greatly. Whenever possible, the aeroplane photograph was relied on to give the exact battery position. The sound-ranging results were especially valuable, however, in that they gave not only the approximate location of the battery, but also its calibre and the target at which it was firing. The shell-burst was recorded as well as the gun report, and so the time of flight of the shell could be found. The character of the report was a clue to the calibre of the piece. The area shelled could be examined to find the shell fragments, and there were other clues to the calibre which made it possible for sound ranging to give very full information about any battery recorded, and this greatly enhanced the value of the locations.

The most serious of the difficulties encountered by the sections were: Confusion between the gun report and the shell-wave which precedes it in the case of a high-velocity shell; inaccuracy caused by ignorance as to the effect of wind and temperature on the sound-wave; interruption by the noise of our own artillery and the enemy batteries; cutting of the lines by shell fire and traffic or by enthusiasts of other units collecting cable of a very useful type; the difficulty of survey of the microphone positions in a country where all landmarks were destroyed; and in the final stages of the war the problem of transporting and installing the section quickly when the line moved every few days. Experience solved these difficulties one by one, and towards the end of the war the sections reached a high state of efficiency, though the limit of development had by no means been attained, and it is certain that they might have played an even greater part than they did in the final struggle.

The British system of sound ranging, founded on the Bull recording apparatus, was developed entirely by officers of sound-ranging sections working at the front. The original experimental section was installed on Kemmel Hill, south of Ypres, and its researches were carried out there. Later, when there were sections along the whole front, it was arranged that an officer from each section should attend a conference which was held every two months. At the conference, proposed improvements were gone into, the equipment was discussed, results were compared, and the report of the discussion was submitted to General Headquarters. This informal conference did more than anything else to improve the work of the sections —it stimulated rivalry and ensured that all proposed alterations in the existing methods were subjected to severest criticism by men who had first-hand experience before they were adopted or turned down. The officers were for the greater part university men who had had a scientific training, and it would not be possible to imagine a more keen and enthusiastic body of men. They were sorely tried in the early days of sound ranging, when they worked under great difficulties, and had yet to prove that reliance could be placed on their results; but they were amply repaid when sound ranging came to its own at the end of the war, and was recognised as one of our most valuable means of locating the enemy's batteries.

RESULTS OF THE TOTAL SOLAR ECLIPSE OF MAY 29 AND THE RELATIVITY THEORY.

THE results obtained at the total solar eclipse of May 29 last were reported at a joint meeting of the Royal and the Royal Astronomical Societies, held on November 6. The stations occupied were Sobral, in North Brazil, and Principe Island. Two cameras were employed at Sobral, the 13-in. objective of the Greenwich astrographic equatorial, and a 4-in. lens, of 19-ft. focus, lent, together with an 8-in. cœlostat, by the Royal Irish Academy. It was realised, before the expedition started, that the cœlostat was scarcely suitable for observations of such extreme precision as were required to detect and measure the small shift in the places of the stars that might be produced by the sun's attraction. War conditions, however, made it impossible to construct a suitable equatorial mounting, though it is hoped that this may be done before the eclipse of 1922.

The results, to some extent, but, fortunately, not entirely, justified these apprehensions. The eclipse plates taken with the 13-in. (stopped down to 8 in.) are out of focus. Since the focus was good on photographs taken at night a few hours earlier, and also on the check plates taken before sunrise in July, the explanation appears to be a change of figure of the cœlostat mirror, due to the heat of the sun. These plates were compared with the July check plates by using a duplex micrometer. They show an undoubted gravitational shift, the amount at the sun's limb being 0·93″ or 0·99″, according to two different methods of treatment. The probable error, as estimated by the individual discordances, is about 0·3″, but there is reason to suspect systematic error, owing to the very different character of the star-images on the eclipse and check plates. This instrument supports the Newtonian shift, the amount of which is 0·87″ at the limb. There is one mode of treatment by which the result comes out in better accord with those of the other instruments. Making the assumption that the bad focus did not alter the scale, and deducing this from the July plates, the value of the shift becomes 1·52″.

The results with the 4-in. lens are much more satisfactory. The star-images are well defined, and their character is the same on the eclipse and check plates. As the duplex micrometer would not fit these plates, a key-plate, on which the film was placed away from the lens, was taken in July, and all the plates in turn were placed in contact with this plate and compared with it. The resulting shift at the limb is 1·98″, with a probable error of 0·12″. The values from the separate stars are in good accord, and they support the fact of the shift varying inversely as the distance from the sun's centre; they are thus unfavourable to its being due to refraction, as was suggested by Prof. Newall at the meeting. Moreover, Prof. Lindemann pointed out that the comets of 1880 and 1882 had traversed this region without giving the slightest evidence of having encountered resistance; as their speed was about 300 miles per second, a vivid idea is given of the extreme tenuity of any medium that they encountered.

The Principe expedition was less fortunate in the matter of weather, but a few plates showed five stars. Since no check plates of the eclipse field could be taken there, another field near Arcturus was photographed, and both it and the eclipse plates were compared with plates of the same fields taken at Oxford with the same object-glass. It was, moreover, necessary to assume that the scale of the eclipse plates was the same as that of the check plate. This is justified by the fact that the diurnal variation of temperature in Principe is only some 4° F., and that there had been no bright sunshine on the mirror before totality. The measures indicate a shift at the limb of 1·60″, with a probable error of 0·3″.

It will be seen that the mean of this result and that with the 4-in. at Sobral agrees very closely with Einstein's predicted value 1·75″. It was generally acknowledged at the meeting that this agreement, combined with the explanation of the motion of the perihelion of Mercury, went far to establish his theory as an objective reality. Sir J. J. Thomson, who presided, spoke of the verification as epoch-making; he suggested that it would probably have a bearing on electrical theory, but he regretted the very complicated form in which Einstein expressed his theory, and hoped that it might be possible to put it into a form in which it would be more generally comprehensible and useful.

Dr. Silberstein laid great stress on the failure to confirm Einstein's third prediction, that of the displacement of lines in the sun's spectrum towards the red, to the amount of 1/20 Ångström unit; this had not been verified, in spite of the careful search made by Dr. St. John and Mr. Evershed. As the probable error of their measures was much less than the quantity predicted, he looked on this result as final; some people had suggested that the shift might be veiled by a systematic outward movement of the photosphere, but as Dr. St. John made measures both at the sun's centre and limbs, that suggestion was not tenable. Prof. Eddington admitted that the failure threw doubt on the validity of some of the steps which led Einstein to his gravitational result; but he contended that the two other successes indicated that the result was right, even if reached by a wrong method.

There was some discussion on Prof. Lindemann's method of photographing stars in daylight by the use of red screens. However, the eclipse method seems more trustworthy, and the Astronomer Royal expressed the hope that the eclipse of 1922 might be observed with equatorials. The star-field is not so rich as in the late eclipse, but with longer exposure much fainter stars could be recorded. The eclipse-track crosses the Maldive Islands and Australia, and is therefore fairly accessible.

A. C. D. Crommelin.

THE JUBILEE OF "NATURE": CONGRATULATORY MESSAGES.

It is with a certain amount of diffidence that we give here a number of cordial messages which have reached us upon the attainment of the fiftieth anniversary of the foundation of Nature. We believe, however, that many readers will be interested not only in the friendly greetings expressed in these messages, but also in the references to the work of science, and its expanding field of usefulness. To the official representatives of scientific societies and university institutions, and to the other men of light and leading who have honoured us with their congratulations, we offer our sincerest thanks. Such appreciation of past efforts affords the strongest stimulus to future endeavour.

While Nature has the advantage of the active interest and co-operation of so many distinguished leaders in the world of science, the columns of the journal will continue to represent with authority the position and claims of progressive knowledge. In sending us best wishes for continued fulfilment of this function, Dr. Hilda Brade-Birks and the Rev. S. Graham Brade-Birks, of the South-eastern Agricultural College, Wye, refer us to some striking verses in the seventh chapter of the Wisdom of Solomon in the Apocrypha, and the words are of such interest as expressing the human outlook upon natural knowledge that we are glad to reproduce them:—

God hath granted me to speak as I would, and to conceive as is meet for the things that are given me: because it is He that leadeth unto wisdom, and directeth the wise.

For in His hand are both we and our words; all wisdom also, and knowledge of workmanship.

For He hath given me certain knowledge of the things that are, namely, to know how the world was made, and the operation of the elements:

The beginning, ending, and midst of the times: the alterations of the turning of the sun, and the change of seasons:

The circuits of years, and the positions of stars:

The natures of living creatures, and the furies of wild beasts: the violence of winds, and the reasonings of men: the diversities of plants, and the virtues of roots:

And all such things as are either secret or manifest, them I know.

Scientific and Other Societies.

Royal Society. *President:* Sir Joseph Thomson, O.M.—The council of the Royal Society offer to the Editor and publishers of Nature their congratulations on the fiftieth anniversary of the publication of that journal. They desire to express their appreciation of the services rendered to science by Nature during the past fifty years, both by the promotion of research and especially by providing an efficient and convenient means for workers in one branch of science to keep in touch with the progress made in other departments of scientific activity. They recall with satisfaction the fact that the jubilee of the election into the society of their distinguished fellow, Sir Norman Lockyer, coincides with that of his jubilee as Editor of Nature.

Royal Society of Edinburgh. *President:* Dr. John Horne, F.R.S.—I am glad to have the opportunity of expressing my high appreciation of the invaluable services rendered by Nature in promoting scientific research in Scotland during the last fifty years. In 1862 a distinguished Scottish man of science deplored the progressive decay, during the previous half-century, of the once illustrious Scottish school of geology. Since that time the progress in each department of geological investigation in Scotland has been remarkable through the labours of English and Scottish geologists. The publication of Nature has been a powerful stimulus to geologists and other men of science in North Britain to test all previous work in the light of the most recent research.

Royal Irish Academy. *President:* The Right Hon. and Most Rev. J. H. Bernard, D.D., D.C.L., Provost of Trinity College, Dublin.—The jubilee of Nature marks the completion of fifty years' useful aid to science, and the proprietors are heartily to be congratulated on the fruitfulness of their undertaking. The application of science to the practical needs of mankind is taking a wider range every year, and the president of the Royal Irish Academy wishes all success to the Editor of Nature in his efforts to encourage and give publicity to the aims of scientific research and its importance to the nation.

Royal Dublin Society. *Vice-President:* Prof. J. Joly, F.R.S.—In furthering scientific progress, Nature has played no small part, for it has supplied a vital necessity: early publication of new ideas, new results, and new projects. We who now write know that our earliest efforts found encouragement in its columns. May the early efforts of our successors continue to gather from its columns the same encouragement and the same stimulus! Looking back, we recognise and acknowledge that Nature has played an important part in our lives.

Royal Anthropological Institute. *President:* Sir Everard im Thurn, K.C.M.G.—The council of the Royal Anthropological Institute has commissioned me to convey to the Editor of Nature very hearty congratulations on the jubilee of that journal and on fifty years' successful furtherance of science generally, and not least of anthropology. Our subject may be said to have developed during the same period from a merely interesting to a scientific stage. We anthropologists foresee a very special task lying before us in the immediate future, in the betterment of the almost innumerable races included in our world-wide Empire. We look to Nature for continued and increased help in the furtherance of this work.

Royal English Arboricultural Society. *President:* Major G. L. Courthope.—May I offer my congratulations to Nature upon attaining its jubilee, and upon the excellent work it has done, during its fifty years of life, in the promotion of scientific study? The passing of the Forestry Act opens a fresh vista of useful possibilities to the student of natural science—a vista in which, I am sure, Nature will play its part. In the United Kingdom scientific forestry has been the rare exception rather than the rule, with the result that our 3,000,000 acres of woodlands produce only a fourth of the yield which we might expect from them if scientific principles had been applied to the varying natural conditions of our countrysides. Let us hope that the next fifty years will make up for our shortcomings in the past.

Royal Institute of British Architects. *President:* Mr. John W. Simpson.—Many congratulations will be received on the issue of the jubilee number of Nature, and I shall feel privileged by being allowed to add my own tribute. The journal has achieved a great position in the scientific world by reason of its sane and unprejudiced attitude towards research; and, in common with all highly specialised technical callings, the architectural profession is greatly indebted to it. To the Science Standing Committee of the Royal Institute, and its various committees which are occupied with scientific research into matters connected with heating, lighting, construction, and building materials, Nature is especially valuable. Pray accept my sincere good wishes for a long-continued prosperity.

Royal Astronomical Society. *President:* Prof. A. Fowler, F.R.S.—The field of scientific investigation is ever widening with the advance of knowledge, and those who are engaged in research are fortunate in being always able to look with confidence to Nature to keep them well-informed as to the latest developments in their own and other branches of science. By its timely announcement of approaching phenomena and its record of current work and thought the journal has rendered important services to astronomers, and can scarcely have failed to stimulate an intelligent general interest in the results of their work.

Royal Engineers Institute, Chatham.—The president and council of the Royal Engineers Institute offer their most sincere congratulations to Nature on the attainment of its jubilee. They recognise with a lively sense of appreciation the high standard consistently set in its columns. They offer the Editor their thanks that he has never failed to enforce the great lesson: that the search for knowledge, pursued for its own ends and with no immediate thoughts of material gain, should be one of the most potent driving forces in the life of a nation. Without this impulse no material advance in civilisation is possible. Now at the present time, at the end of a devastating war which finds many exhausted and some despairing of the future, it is more than ever necessary to hold this beacon aloft and to convey a message of encouragement to all workers engaged in the great search for natural knowledge, bidding them remember that, whatever be the temporary distractions of the time, they should never lose sight of the central truth: that with them lies, in no small degree, the future of the world.

Royal Horticultural Society. *Chairman of Council:* Mr. Harry J. Veitch. *Secretary:* Rev. W. Wilks.—Like most ancient arts, the practice of horticulture was rooted in tradition and hedged about by empiricism. Advancing knowledge gradually lets in light upon its many branches, stimulates its dormant buds into growth, and surrounds its roots with the vitalising environment of experiment. It is an art that lays all Nature under contribution; that can flourish best where knowledge of Nature is deepest. In the name of British horticulturists we congratulate Nature, which has done so much to spread knowledge, upon its fifty years of usefulness, and wish it and those whose work it tells of continued diligence and success.

Royal Society of Medicine. *From the* President.—During the fifty years that Nature has provided a weekly summary of science the changes in medicine, particularly as regards diagnosis and treatment, have been without parallel. This is shown by a comparison of the toll of disease, on one hand in the late war, and on the other in the Crimean, North and South, and Franco-Prussian Wars. The changed picture is due to the practical application of science. Pasteur's researches gave us bacteriology and a knowledge of the nature of infection, and rendered possible the modern treatment of wounds, introduced by Lister, and the use of serums and vaccines. The diagnostic and therapeutical use of X-rays, the employment of radium, and many other advances are further gifts from science. But this transformation of medical practice only reveals a multitude of important problems concerned with the prevention, early detection, and effective treatment of disease, and for their solution we must look to scientific research.

Royal College of Surgeons. *President:* Sir George H. Makins, G.C.M.G.—The realm of science may well acclaim the jubilee of Nature, and no less all those concerned in the promotion of the public good. The occasion arrives opportunely, for at no time has the public sense been so forcibly awakened to the influence of the applications of science to such divergent objects as trade, medicine, war, or the feeding of the population. If important changes founded on the progress of science are to be effectively introduced, those who will be affected must be educated and prepared beforehand. In this great work Nature has taken and must take a prominent part, an aim no less wide-reaching than that of bringing students in every branch of science into association and establishing a common bond of sympathy and mutual understanding between them.

Royal United Service Institution. *Chairman of the Council:* Admiral Sir F. C. D. Sturdee, Bart., K.C.B., K.C.M.G., C.V.O.—As chairman of the council of the Royal United Service Institution, I wish to convey the congratulations of the council and myself to the proprietors and Editor of Nature on attaining its jubilee. We all recognise the excellent service that the journal has rendered to science during the last fifty years. Science, while aiming at the development of human progress, was ready to turn its thoughts and genius to helping the Empire in its time of trial. This fact is most thoroughly appreciated by the Navy, Army, and Air Force, and as one of their representatives I wish to express my thanks, and trust that Nature will continue its help to the fighting Services for the defence of the Empire.

Highland and Agricultural Society of Scotland. *Chairman of Directors:* Mr. Charles Douglas, C.B.—It gives me great pleasure to congratulate the Editor of Nature on the attainment by that journal of its jubilee. Writing as a representative of the agricultural industry, I desire to acknowledge the immense benefits which that industry has received from the development of science, and especially in the field of chemistry. It is universally recognised that the future success of the industry depends in large measure on the further application of scientific discovery. Both fundamental and practical research in bacteriology promise to give invaluable results, whether in the near or remote future; and the further development of engineering in its application to agriculture offers great prospects of economy and increased efficiency in production. I offer my most sincere good wishes for the future of Nature.

Society of Public Analysts and Other Analytical Chemists. *President:* DR. SAMUEL RIDEAL.—As president of the Society of Public Analysts, I beg to offer you congratulations on reaching the jubilee of NATURE. The journal has always been the pioneer of scientific progress in this country, and has contributed not a little in its development at the present time. It looks as if the Government and the daily Press are still far from realising what the promotion of science and its value to the national needs means. Members of my society, who are for the most part Government officials under Acts passed so long ago as 1875, a few years after your first number appeared, have recently been, I believe, transferred to a new Government Department, the Ministry of Health, which starts on its new career, like its predecessor, without any adequate representation of pure science on its councils. Your weekly numbers must have a beneficial effect upon the national development, and I hope that your circulation will increase and that the knowledge which you reveal will be assimilated and rendered more and more available for the general good.

Anatomical Society of Great Britain and Ireland. *President:* PROF. ARTHUR KEITH, F.R.S.—NATURE is the link which binds British men of science together. It is essential, and I wish it long life and prosperity.

Institution of Automobile Engineers. *President:* MR. THOMAS CLARKSON.—A lover of science is content to follow devotedly the object of his affection regardless of whether his revenue is likely to be speedily augmented thereby. He should, nevertheless, take a broad view that does not exclude the consideration of probable benefit to the community as a result of his endeavours. In other words, the true man of science is a public servant in the widest sense, and his work is directed to bettering the conditions of life, reducing its toil, evil, and "dis-ease," while increasing its pleasure and charm: for example, by adding to our knowledge and power of controlling the forces and amenities of Nature; by solving the problem of increased production with greater leisure to the worker; by increasing cultivation; by reducing the cost of transport, and thereby facilitating intercourse.

Biochemical Society. DR. ARTHUR HARDEN, F.R.S. —The recognition of biochemistry—linked on one hand with chemistry, and on the other with biology— as a distinct branch of science has gradually come about during the half-century covered by the publication of NATURE. To students of this borderland science NATURE, with its comprehensive and impartial treatment of the physical and biological sciences, has always been of special value, bringing within their reach the opinions and discoveries of other workers, whose results, obtained in fields beyond their own boundaries, are yet of great interest and often of supreme importance to them. It is precisely this universality of scientific interest which constitutes the chief value of NATURE to the investigator, and as long as this is maintained, so long will the journal continue to flourish and earn the gratitude of its scientific readers.

British Academy. *President:* SIR F. G. KENYON, K.C.B.—The jubilee of NATURE is not a matter of interest to students of natural science alone. It is, I hope, generally recognised now that the interests of science and of the humanities are not hostile, and that the welfare of the nation depends on the advance of knowledge in both these spheres, and in a fuller recognition of the necessity of both. NATURE, I am sure, under its present administration, will, without prejudice to the subjects with which it is specially concerned, continue to advocate the cause of knowledge and intellectual culture as a whole; and all friends of the humanities will wish it God-speed.

British Association. *President:* SIR CHARLES A. PARSONS, K.C.B., F.R.S.—The British Association sends its most cordial greetings to NATURE on the completion of its fiftieth anniversary. The influence of NATURE on the advancement of science for half a century has been wide and comprehensive, and a powerful factor in popularising scientific thought and progress. To men of science also it has been of great assistance by chronicling contemporary progress in the advance of the sciences and arts, and has been a medium for the interchange of information, knowledge, and ideas.

Chemical Society. *President:* SIR JAMES DOBBIE, F.R.S.—The advance of chemistry takes place to-day along a front which has been enormously extended since the first number of NATURE was issued. Moreover, it is supported by forces so vastly superior in number, in organisation, and in equipment to those existing in 1869 that scientific workers may go forward in the confident anticipation that the progress of the next fifty years will be even more wonderful than that of the half-century which has witnessed the elucidation of the constitution of the most complex organic compounds and the formulation of the periodic law, and has revealed the structure of the atom. Amongst the agencies to which the improvement of the position of science in this country is due NATURE takes an important place, not only by the opportunities it has afforded scientific men for interchange of views, but also by the force and persistency with which it has advocated the cause of scientific education and brought the claims of science before the attention of the Government.

Institute of Chemistry. *President:* SIR HERBERT JACKSON, K.B.E., F.R.S.—It gives me very great pleasure to offer, on behalf of the Institute of Chemistry, hearty congratulations to NATURE on fifty years of work in the best interests of science. At no part of that period has the importance of applying science to industry been more evident than it is today, and at no time, perhaps, has it been more abundantly clear that sound and broad training in pure science is imperative if real progress is to be made in its applications. May NATURE flourish and continue to spread knowledge of science, to show its necessity in education, and to point out how prolific a source it is of benefits to mankind.

Institution of Electrical Engineers. *President:* MR. ROGER T. SMITH.—NATURE attained its jubilee within a few days of the first full meeting of the International Electrotechnical Commission held since peace was signed. Well-known electrical engineers representing twenty-one foreign countries met in London to standardise, for those nations participating, some of the fundamental constants and relations on which the applications of electrical science to industry depend. NATURE throughout its career has stood in the first place for pure science, and since most of the important applications of science to industry have grown from the discoveries of the worker in pure science, I recognise the high standard of NATURE's work and of its ideals, and hope that both may long continue in the same happy combination.

North-East Coast Institution of Engineers and Shipbuilders. *President:* MR. A. ERNEST DOXFORD.—I have the greatest pleasure in congratulating NATURE upon the attainment of its fiftieth birthday. Throughout the past half-century the journal has maintained its character as the organ of workers in fields where science is studied mainly for its own sake, and has refused to sacrifice accuracy to the demands of what is understood as "popular" science. It is a healthy sign that the periodical should be so prosperous, testifying to the existence of a constant and active desire for British scientific literature of a high standard. I sincerely wish continued prosperity to the good work which NATURE is undoubtedly doing. The development of the journal along its present lines cannot but be beneficial to scientific progress.

Institution of Engineers and Shipbuilders in Scotland. *President:* DR. T. BLACKWOOD MURRAY.—As president of the Institution of Engineers and Shipbuilders in Scotland, allow me to express our congratulations on the occasion of the jubilee of NATURE. While perhaps the journal, dealing as it does largely with questions of pure science, may be said to be at the extreme pole from that occupied by the intensely practical applications of science which form the life-occupation of us engineers, still I think every day it is being more and more realised that it is largely due to the pioneer in pure science that we owe all modern developments in engineering. The worker in pure science may be likened to the explorer making excursions into virgin country, while we follow along after as the builders of towns and founders of industry. The day has passed when the practical engineer was inclined to scoff at science and theory, and was too prone to point to apparent contradictions of practice as against theory. Nowadays no engineer can hope to succeed unless he takes advantage of all that science can teach him. It therefore gives me much pleasure to take this opportunity of wishing NATURE continued prosperity.

Faraday Society. *President:* SIR ROBERT HADFIELD, BART., F.R.S.—It is with much pleasure I learn of the jubilee of NATURE—a publication which has done so much in the past to assist science and scientific development; in fact, its name has been a household word throughout the world. I should like to offer my best wishes for the future success of this valuable aid to those who strive to promote science and scientific interests. There never has been a time in the history of our nation when it was more desirable that the best possible stimulus should be afforded to those who guide the destinies of the British Empire in educational matters, especially matters relating to science and its development, which surely in the near future will have its proper position allotted to it in our Government Departments and establishments. It has been well said that, of developments in such Departments, Science is the "Cinderella." It is therefore to be hoped that steps will be taken to remedy this crying injustice, which is so damaging to the true interests of the nation.

Geological Society. *President:* MR. G. W. LAMPLUGH, F.R.S.—During the past fifty years NATURE has faithfully mirrored for us the advance of science all along the line, and epitomised and discussed the new results, both observational and speculative. It has enabled the individual worker to keep in touch with the main currents of progress in branches other than his own; moreover, it has served him as a general chronicler of happenings in the sphere of science, and has gratified his desire to know something about the personality of the leading investigators, past and present. I congratulate the Editor on the sustained skill with which the complex task has been accomplished, and I look forward with confidence to its successful continuance.

Illuminating Engineering Society. *President:* MR. A. P. TROTTER.—Maxwell, at the British Association meeting in the year after NATURE first appeared, referred to the reciprocal effects of the progress of science. "When the student has become acquainted with several different sciences, he finds that the mathematical processes and trains of reasoning in one science resemble those in another so much that his knowledge of the one science may be made a most useful help in the study of the others." The expansion of all branches of science in these fifty years has compelled most of us to specialise, not in one branch, but in a bough or a twig of the tree of knowledge. The pages of NATURE have enabled this broad acquaintance to be made and this useful help to be rendered, not only between mathematics and physics, but also between all the natural sciences.

Institute of Journalists (Scientific and Technical Circle). *Chairman:* MR. LEON GASTER.—I gladly take this opportunity of congratulating NATURE on the attainment of its jubilee, and expressing my great appreciation of the work it has done, and is doing, for the promotion of science and the encouragement of education. NATURE in many respects occupies a unique position. It speaks with an authority on scientific matters that is unrivalled; it has been fortunate in enlisting the help of experts in every field of science; and its treatment of subjects is invariably up to date. At the same time its outlook is sufficiently broad for it to interest many persons outside strictly scientific circles, and thus to promote that general appreciation of the value of science which is so essential in these times. I am sure that this useful record of work, extending for fifty years, has established the position of NATURE as a permanent and indispensable publication in the interests of the advancement of science.

Linnean Society. *President:* DR. A. SMITH WOODWARD, F.R.S.—The president and council of the Linnean Society desire to associate themselves in the congratulations due to the Editor and publishers of

NATURE on the attainment of the jubilee of the journal. It is a noteworthy achievement of British science to have maintained for fifty years an organ of intercommunication for scientific workers perused and recognised by the men of learning of all nations. In these modern days of high specialisation it is more than ever important that those engaged in research should have the easy access to a summary of all current progress, such as NATURE affords, and naturalists unite with other men of science in expressing their best wishes for the continued success of the weekly publication to which they are already so much indebted.

Manchester Literary and Philosophical Society.—The council of the Manchester Literary and Philosophical Society desires, on the occasion of the completion of fifty years issue of NATURE, to express its high appreciation of the valuable aid which that journal has given to the development of science during that period. The council hopes and believes that the high standard of the reviews, reports, and original articles which has always characterised the journal in the past will be fully maintained in the future, and that with the growing recognition of the vital importance of scientific knowledge the journal will exert a constantly increasing influence for the diffusion of true learning.

London Mathematical Society. *President:* MR. J. E. CAMPBELL, F.R.S.—The London Mathematical Society is just four years older than NATURE; in the early days and later the work of the society was promoted by a brief report of its activities in that journal. The volumes of NATURE with their indexes, especially the earlier ones, have permanent value as one of the most effective sources of reference for the general history of scientific progress in the last half-century. It is much to be desired that this very essential service to the scientific world may be maintained unimpaired.

Institution of Mechanical Engineers. *President:* DR. EDWARD HOPKINSON, M.P.—The jubilee of NATURE is an event of more than passing interest. During the last fifty years NATURE has been a potent factor in the diffusion of scientific knowledge. The realm of science is vast. Its boundaries are being constantly pushed further into the unknown. Of necessity, scientific workers must become more and more specialised in particular lines of research, and they need the help of some organ through which they can watch the progress of science in general. Such a survey NATURE has provided, always up-to-date and always discriminating, and in so doing has helped to raise the status and strengthen the fellowship of scientific men throughout the world. To a much wider circle of men engaged in profession and industry, whose daily work is so exacting as to preclude serious scientific study, NATURE affords the opportunity of keeping in touch with scientific discovery and thought. Lastly, NATURE has done much, though much remains to be done, towards convincing our administrators and politicians that to neglect science and to fail to act upon its precepts is to doom the national life to decay.

Mineralogical Society. *President:* SIR WILLIAM PHIPSON BEALE, BART.—Among the many scientific societies which will be moved to express gratitude and goodwill on the occasion of the jubilee of NATURE the Mineralogical Society of Great Britain and Ireland finds a place. The society was founded in February, 1876, under the presidency of Henry Clifton Sorby; and in December, 1883, under the presidency of Prof. Bonney, it absorbed the Crystallological Society. It is a proud thing to be able to say, in recalling these two names, that the society has seen, and taken some part in, the development of the domain of the mineralogist and crystallographer into the wide fields of molecular physics, the exploration of which has been the most marvellous work of distinguished men of science in recent years. It is equally pleasant to recognise the co-operation of NATURE, associated with the name of Lockyer, in stimulating interest in, and sustaining the work of, such research, cultivating the ground some years before the Mineralogical Society came into existence.

Institution of Mining and Metallurgy. *President:* MR. HUGH K. PICARD.—For fifty years NATURE has provided a link between workers in the fields of pure and applied science. During the war the achievements of chemistry and metallurgy, many of which have been recorded in its pages, were nothing short of astounding; indeed, no branches of scientific learning were more thoroughly tested or gained greater victories over almost insuperable difficulties. Urgency demands that *results* should be secured at any cost; consequently economics had to take second place. In the coming peaceful fight for the world's trade the metallurgist and chemist are faced with a new set of difficulties brought about primarily by the high costs of fuel and labour. They cannot look forward to well-earned rest, but must devote themselves anew to the problem of reducing the cost of production, always having before them the important economic factors which can no longer be put in the background.

Optical Society. *President:* PROF. F. J. CHESHIRE.—There is only one NATURE, as there is only one *Punch*—each supreme in its own sphere.

Institution of Petroleum Technologists. *President:* SIR FREDERICK BLACK, K.C.B.—In earlier days men with scanty knowledge, if any, of science found, and in crude fashion utilised, natural petroleum. To-day large production and economical utilisation demand the services of the geologist, the chemist, and the engineer, all of whom have a common platform in the pages of NATURE. The geologist, by his study of strata, directs effort to the more likely places. The chemist, by research and analysis, ascertains the proportions and properties of the constituent fractions of the crude oil. The applied science of the engineer and the chemist turns laboratory methods and apparatus into those of the commercial refinery. Contrast the early crude methods with those of to-day, and some realisation will result of the work already done by science in guiding the utilisation of a great gift of Nature. The field for similar effort is still great.

Physical Society. *President:* PROF. C. H. LEES, F.R.S.—As president of the Physical Society I desire to offer my congratulations to Nature on attaining its jubilee. There are, unfortunately, few physicists left who read the first number on its appearance, and it is hard for those of us who have grown up to expect Nature as regularly as Friday morning to realise how difficult it was fifty years ago to get trustworthy information on any scientific subject of special interest at the moment without going to original sources and reading at great length. To the specialist who is anxious to keep in touch with the world of science outside his own groove Nature comes as a refresher, and to the general reader who finds his daily paper too untrustworthy on scientific matters it is an invaluable authority.

Physiological Society. Prof. W. D. Halliburton, F.R.S.—The Physiological Society has no president, and has never had one. At a recent meeting of the society I was deputed (as the oldest member present) to convey to the Editor of Nature our hearty congratulations to that journal on having reached its jubilee, and to thank its staff for all they have so successfully done in the promotion of scientific interests during the last fifty years. The position of science to-day is very different from what it was in 1869. There still remains much to be done in the education of the public in reference to the value of science to the nation at large, but we anticipate that in the future, as in the past, Nature will occupy a prominent place in this branch of education. The recent war has during the last five years brought home to the people a keener appreciation of the national value of science than the preceding forty-five years of peace, and in the time of "reconstruction" now entered upon all will hope that both rulers and ruled will realise and act upon the imperative nature of the study of science, both pure and applied, if our efforts to make the world a better place are to be successful. The Physiological Society desires me to allude in conclusion, when sending a message to a literary journal, to the fact that it also has undertaken the publication of a periodical entitled *Physiological Abstracts*, by means of which its own particular part of the gospel may be spread. It was a direct outcome of the powerful stimulus of war, and we trust when the time of its jubilee arrives it may be able to show as good a record as its elder sister Nature.

Röntgen Society. *President:* George B. Batten, M.D.—"Work is worth doing for work's sake." Twenty-four years ago Röntgen, following the work of Crookes and Lenard, discovered X-rays, and a translation of his paper appeared in the columns of Nature (January 23, 1896) within a few days of the announcement of the discovery. In less than a quarter of a century the discovery has been of inestimable benefit to mankind not only in diagnosis and treatment, but also in metallurgy, and has created quite a new and extensive industry. Moreover, the investigation by Rutherford and a host of workers of the properties of X-rays and of the kindred rays of radioactive substances has increased our knowledge to such an extent that our conceptions of the ultimate constitution of matter and of the universe have been enlarged and revolutionised.

Foreign Academies and Scientific Societies.

Belgium.

Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique. *Permanent Secretary:* M. Paul Pelseneer.—It is a great satisfaction for the Royal Academy of Sciences of Belgium to greet the first jubilee of Nature. The Academy highly appreciates what Nature has done for the promotion of science, especially in helping the speedy diffusion of the most important discoveries in every department. The Academy wishes the next period of fifty years to be still more fruitful, and that Nature may assist scientific progress in the future as much as in the past. The Academy thinks that the "Entente Cordiale" of the inter-Allied academies and the newly instituted International Council for Scientific Research, in Brussels, will be, by a methodical co-ordination of work, the best and quickest means of promoting scientific knowledge. Lastly, the Academy thinks all scientific workers understand that it is urgent to compensate for five years' interruption by a renewal of activity and production.

France.

Société d'Encouragement pour l'Industrie nationale. *Le Président:* M. L. Lindet.—La Société d'Encouragement pour l'Industrie nationale a suivi avec intérêt les publications scientifiques du journal Nature; elle y a souvent rencontré des articles de science industrielle dont elle a fait son profit, en même temps qu'elle se félicitait de voir Nature faire à son Bulletin des emprunts fort bien sélectionnés. Son ancienneté, qui remonte à 1801, lui donne toute autorité pour souhaiter à Nature, aujourd'hui cinquantenaire, une longue et glorieuse existence.

Société de Géographie, Paris. *Le Président:* Le Prince Bonaparte, de l'Institut de France. *Le Secrétaire Général:* M. G. Grandidier.—La Société de Géographie ne saurait demeurer indifférente à la célébration du cinquantenaire de Nature. En effet, depuis le jour où elle a commencé de paraître, Nature s'est toujours intéressée à la géographie; elle lui a fait sa place parmi les sciences dont elle s'occupait, et, par nombre d'études publiées dans ses différents fascicules, elle a, d'autre part, indirectement contribué à ses progrès. Aujourd'hui, Nature peut encore agir de même, et même plus efficacement que jamais; il n'y a plus à réaliser de grandes découvertes géographiques; mais, par contre, que d'études minutieuses sur le relief, le climat, la flore, la faune, l'homme aussi, s'imposent aux travailleurs! En publiant des travaux originaux, en donnant les conclusions des principaux mémoires parus ailleurs, Nature continuera de bien servir la géographie après 1919, exactement comme elle l'a fait précédemment, durant le demi-siècle écoulé depuis 1869.

Holland.

Dutch Academy of Sciences, Amsterdam. *President:* Prof. H. A. Lorentz.—On the occasion of the jubilee of Nature I have great pleasure in expressing my high appreciation of the important services it has rendered to science during the fifty years of its existence. The wonderful progress that has been made in all directions has been faithfully recorded in the columns of this journal, which has been a most valuable source of information and a great aid in their work to scientific men all over the world. I heartily hope it may remain so for many years to come.

Norway.

Bergens Museum. *President:* DR. JOHAN LOTHE.—During the war natural science amply proved what immense powers it wields and what great ends it can attain. In the work of reconstruction and peaceful development which is before us we shall look with greater expectations to science and to the results of scientific research. A highly trained staff of scientific workers, with well-furnished laboratories at their command, will then be an invaluable asset to any nation. At the same time we may entertain a hope that science, which is of necessity international, will in course of time be able to renew the bonds of international intercourse and co-operation which have been broken by the war, and thus enable mankind to bring the work for peace among nations to a happy end.

Portugal.

Academia das Sciências de Lisboa. *President (Class of Sciences):* JOSÉ JOAQUIM DA SILVA AMADO.—The great advances of science since the second half of the eighteenth century which are enjoyed by us, and the benefits of which are increasing every day, have been the result of three essential conditions, namely:—(1) The progressive triumph of the freedom of thought over the old tyranny of a dull scholasticism and its metaphysics, by which intellectual advancement was retarded for so long; (2) the establishment of the fertile and sound principles of experimental method; and (3) the wide publication, with comments and criticisms through books and periodicals, of the valuable scientific conquests obtained by the genius of man. In the group of periodicals which have contributed so powerfully to bring the extensions of natural knowledge in their diverse manifestations before a wide circle of readers NATURE, the fiftieth year of which is now celebrated, has contributed very greatly. The journal must be considered an active promoter of scientific learning, and of the spirit by which the treasury of human knowledge is enriched. Associating ourselves with its jubilee feast, we send our very hearty compliments to NATURE's Editor and publishers.

Switzerland.

Société de Physique et d'Histoire Naturelle de Genève. *Le Président:* M. J. CARL. *Le Secrétaire:* M. E. JOUKOWSKY.—Les naturalistes genevois ont appris avec plaisir que le périodique NATURE fêtait prochaînement le cinquantenaire de sa fondation. Ils apprécient les immenses services que ce journal a rendu à la diffusion des sciences naturelles par ses comptes rendus judicieux de l'activité des académies, par ses critiques des publications scientifiques et surtout aussi par des articles originaux dûs à la plume des savants anglais et étrangers les plus éminents. Tout en se mettant au service de la science pure, NATURE s'est toujours efforcé de tenir ses lecteurs au courant des progrès réalisés dans la technique et dans l'enseignement des sciences naturelles. Persuadés que votre journal continuera à occuper un des premiers rangs parmi les périodiques scientifiques, nous rendons hommage au travail que vous avez accompli et souhaitons à votre entreprise le meilleur succès dans l'avenir.

Société Helvétique des Sciences Naturelles. *Central President:* PROF. DR. ED. FISCHER.—I beg to offer my hearty congratulations on the fiftieth anniversary of NATURE. The journal has always in a remarkable manner understood how to present an extraordinarily complete survey of the position and development of the various branches of the natural sciences. It has also had the good fortune to number among its contributors the most distinguished naturalists and thinkers of Great Britain. To our congratulations we add the expression of our grateful recognition of the fact that the journal has repeatedly directed the attention of its readers to Swiss research work and the activity of our society. May NATURE ever succeed in awakening and retaining interest in the high importance of the natural sciences in the widest circles.

United States.

The Franklin Institute, Philadelphia. *President:* MR. WALTON CLARK. (By cable.)—The Franklin Institute extends to NATURE heartiest congratulations on the attainment of its jubilee. No journal has contributed more in the past fifty years to stimulate interest in physical and natural science. May you be as successful in the future; for a widespread knowledge of science is to-day imperative if the civilised nations are to continue to exist.

National Academy of Sciences, Washington. *Foreign Secretary:* PROF. G. E. HALE. (By cable.)—The president, Dr. Charles D. Walcott, requests me to offer his congratulations to NATURE on the occasion of its jubilee and on behalf of the Academy to express the deep appreciation felt in the United States for the work accomplished by NATURE in the advancement of research in the world. During a period of specialisation NATURE's extensive survey of the progress of research has stimulated wider vision and larger effort in spite of repeated discouragement. It has urged upon the statesmen of two generations the vital importance of science to the nation. At a time when the branches of science, no longer isolated, are uniting in common channels, and when Governments once unappreciative are recognising the bearing of research on national security and public welfare, we rejoice in NATURE's expanding influence and the higher opportunities for services opening to it in a newly ordered world.

UNIVERSITIES.

Queen's University of Belfast. *Vice-Chancellor:* REV. THOMAS HAMILTON, D.D.—Most heartily do I congratulate the Editor and proprietors of NATURE on its jubilee. The progress of science in the half-century which has passed since November 4, 1869, when the first number of NATURE appeared, has undoubtedly been more illustrious than that of any previous fifty years (or, for that matter, any previous one hundred and fifty years) of the world's history, and there can be no question that, in that progress, Nature has been indeed *pars magna*. All the indications, however, point to the conclusion that, splendid and memorable as has been the advancement of science in that half-century, the next fifty years will see the chariot wheels revolving with a vastly increased velocity. That being probably so, it is equally clear that the services of such a journal as Nature will, in the future, be more needed than ever before. I congratulate, *ex imo pectore*, all concerned in its publication on the conspicuous ability with which it has been conducted, the splendid progress it has made, and the value of the work it has done since the issue of its initial number. But I also congratulate, with equal cordiality, the entire scientific world, at the commencement of another vitally important half-century, on the possession of such a very ably conducted and enlightened organ, and I fervently pray that, when the year 1969 arrives, it will find our beloved Nature still holding on its way and, in its very old age, still bringing forth such fruit as it now yields from week to week with ceaseless regularity, acceptance, and success.

University of Birmingham. *Vice-Principal:* Sir Wm. Ashley.—The influence of Nature on the welfare of modern universities is matter for grateful acknowledgment. It has fostered that local generosity and enlightened opinion which led to their foundation and endowment. Through its columns there has appeared an informed and helpful criticism that has furthered university growth and development, and its records of progress in science have been of value to all graduates, and specially to those scattered in distant centres. The list of universities is not yet complete. A new age of learning has begun. New centres for promoting "humane" and scientific knowledge are arising. Meanwhile, as one of recent growth, the University of Birmingham cordially congratulates Nature on its successful advocacy of higher learning, and sincerely hopes that its influence may continue to help those who are shaping the educational future of the Empire during the fateful years that are coming.

University of Bristol. *Vice-Chancellor:* Sir Isambard Owen, D.C.L., M.D.—I hope I may be permitted to offer my hearty congratulations to Nature upon the attainment of its jubilee. Since its first appearance in 1869 Nature has occupied an essential place in the scientific life of this country, and may pride itself on having attained the rare position of an indispensable publication. I shall but be voicing the feeling of the whole scientific world in wishing it a long career of continued prosperity and usefulness.

University of Cambridge. *Vice-Chancellor:* Dr. P. Giles.—It must be a great satisfaction to all who admire and wish well to British learning to know that at the end of its fifty years of successful career Nature remains as it has so long been: a most valuable medium of opinion and criticism on scientific subjects. To Nature the man who is remote from academic centres looks for the first information on new discoveries and for a sound judgment on the publications of the scientific world. One result of the war has been an advance, rapid beyond past experience, in many fields of knowledge. Of all such advances may Nature continue to be the herald as heretofore!

University of Durham. *Vice-Chancellor:* Mr. J. S. G. Pemberton.—The Vice-Chancellor, on behalf of the University of Durham in general, and the Dean of the Faculty of Science, on behalf of the Science Faculty at Armstrong College in particular, send hearty congratulations to Nature on the celebration of its jubilee. Nature, in the past, has occupied a unique position in forming a connecting link between workers in various branches of science the world over. Many a time discussions on subjects of interest to more than one scientific section have been carried on in its columns. A notable case was when the late Lord Rayleigh in 1892, in a letter to Nature, asked for suggestions from chemists as to the reason for the discrepancy he had found between the densities of "atmospheric" and "chemical" nitrogen. This led eventually to the successful co-operation of Lord Rayleigh and Sir William Ramsay in the discovery of "argon." Such interlinking between the sciences promises to be of even greater importance in the future.

University of Edinburgh. *Principal and Vice-Chancellor:* Sir Alfred Ewing, K.C.B., F.R.S.—My debt to Nature extends back to the 'seventies, when we were both very young. From time to time I have been a contributor; always an interested reader. In the steady advance and diffusion of scientific knowledge during half a century Nature has taken an honourable part, maintaining a standard which has never failed to command the respect and gratitude of serious workers. That its usefulness may long continue is the confident hope of many who in a double sense are students of Nature.

University of Glasgow. *Vice-Chancellor:* Sir Donald MacAlister, K.C.B.—I attended the dinner given to the Editor of Nature five-and-twenty years ago, when Huxley and other contemporary leaders in science bore strong testimony to the great part which the journal had played in furthering the cause of natural knowledge and inquiry in this country. Nature has, in the fateful years since then, maintained and enhanced its influence and usefulness. It has become, indeed, an indispensable factor in the development of British science. It still furnishes "solid ground" to "the mind that builds for aye." It still informs, chastens, and stimulates the scientific worker and the scientific teacher. None interested in modern higher education in particular can afford to overlook a single weekly number, except at the risk of missing a link in the evolution of the subject.

The University, Leeds. *Vice-Chancellor:* Sir Michael Sadler, K.C.S.I.—We bring our tribute of gratitude and honour to those who have made the columns of Nature during its fifty years of public service a source of indispensable help and stimulus to students of science and to those engaged in scientific education. The exacting care with which it has been edited, the impartiality and precision of its judgments, the wide range of its information, the accuracy of its reports, have given NATURE in its own sphere unique distinction and authority. These have been used for the disinterested furtherance of investigation and for the support of the claims of science upon national attention and support.

University of Liverpool. *Vice-Chancellor:* PROF. J. G. ADAMI, F.R.S.—Looking backwards over the last quarter of a century spent overseas in Canada, I cannot but realise the heavy debt owed by me and other university teachers there to NATURE for keeping us in touch with the advances made in the various fields of science. Here, in Britain, the great dailies deal increasingly with the latest scientific developments. It is not so with the daily Press in North America. That is becoming more rather than less local and provincial. The broad survey given in NATURE fills a void in the New World that is in part bridged over in the Old. Perhaps more abundant illustrations and one or two articles each week upon the application of science and the laws of Nature to industry, added to the present contents, would widen the circle of its readers, increase its influence, and reflect the spirit of the age.

University of Manchester. *Vice-Chancellor:* SIR HENRY A. MIERS, F.R.S.—In common with all readers of NATURE, I regard its jubilee as a great event. Life would have been a different thing to us without our weekly NATURE, which has become an old friend because it has preserved its character unchanged. This is a great achievement and a testimony to the wisdom with which it was originally planned. Always a real scientific journal, it has continued to be also a popular journal in the best sense, and a great help in these days of increasing specialisation. A new and complete index to the first 100 volumes would be invaluable to all scientific workers.

University of Oxford. *Vice-Chancellor:* REV. DR. H. E. D. BLAKISTON.—The Vice-Chancellor of the University of Oxford is interested to hear that NATURE attains its jubilee in November, and offers his congratulations to the Editor. He cannot profess to be a constant reader of any scientific periodical; but when he wants clear information on any topic of scientific interest which is attracting public attention, or details of the career of any member of the University or of his own college who has obtained distinction in natural science, his first thought is to obtain the loan of a copy of the current number of NATURE.

University of Sheffield. *Chancellor:* THE MOST HON. THE MARQUESS OF CREWE, K.G.—I am happy to add my name, as Chancellor of Sheffield University and chairman of the Governors of the Imperial College, to the long list of those who are congratulating NATURE on its life of fifty years. As the nation becomes more and more conscious of its need for scientific training and the encouragement of research, it will continue to set an increasing value on NATURE, both as a record of progress and as the trusted vehicle for the expression of scientific opinions.

PERSONAL.

PROF. ISAAC BAYLEY BALFOUR, F.R.S.—NATURE, founded in the period of revolution in scientific thought following Darwin, by presentation of the work and aims and its advocacy of the claims of science, has been a powerful factor during fifty years in securing recognition by the nation of the importance of science which the lessons of the war have enforced. The world of science is proud of it. May its influence in this new period of reconstruction continue to operate forcefully, so that congratulations at its centenary may be as gratefully tendered as are those we offer now.

SIR GEORGE BEILBY, F.R.S.—I gladly record my grateful appreciation of the services rendered by NATURE to the cause of scientific culture in the best sense. The increasing tendency to specialisation by individual workers makes it more and more desirable that their touch with science in its widest aspects should be maintained with the minimum of effort on their part. This, it appears to me, will continue to be—as it has been in the past—one of the most valuable functions of NATURE.

SIR JAMES CRICHTON-BROWNE, F.R.S.—For fifty years NATURE has held the mirror up to Science and faithfully reflected her every movement. Each volume has been a record of the best brain-work of the year, ranging from the simplest observations to the most recondite abstractions. Recent issues have revealed the tremendously destructive forces that science wields, and have suggested that it has been owing to the lack of science in high places, and to the blundering that ignorance and arrogance beget, that these malign forces have been let loose on mankind. But science unperverted is beneficent, and nothing is more urgently needed at this hour than its teaching and popular exposition. Great is Science—"mightiest in the mightiest"—and NATURE is its handmaid. *Floreat Scientia! Floreat "Natura"!*

RIGHT HON. LORD BRYCE, O.M., F.R.S.—The amazing, and indeed unprecedentedly rapid, progress made during the last half-century in practically every branch of physical science, together with the increasing specialisation of most branches, has made it more and more difficult for those non-scientific persons who watch with eager curiosity the steps in that progress to follow its developments. Such persons, and especially those who occupy themselves with the study of the humanistic departments of knowledge, have long valued highly the help they receive from your journal. As one of these, I desire to congratulate the conductors of NATURE on the services it has rendered, and to express cordial wishes for its continued prosperity.

SIR FRANCIS DARWIN, F.R.S.—NATURE has for a number of years seemed to its many readers to be a beneficent natural phenomenon occurring weekly. It is wisely variegated so as to give just the type of information and criticism that we need. I warmly congratulate the Editor on its jubilee.

PROF. WYNDHAM R. DUNSTAN, C.M.G., F.R.S., DIRECTOR, IMPERIAL INSTITUTE.—I gladly take this opportunity, on the occasion of its jubilee, to congratulate NATURE on the important aid it has given to scientific work and interests, and on the position it has achieved as an organ of scientific opinion, not only in this country, but throughout the world.

SIR F. W. DYSON, F.R.S., ASTRONOMER ROYAL.—The advancement of science owes a great deal to NATURE, which keeps men of science in constant touch with one another's work. The outstanding feature of the journal is the combination of thoroughness and trustworthiness with readability and attractiveness of form. Grateful recognition should be accorded to NATURE for its able championship of the necessity of scientific research and the claims of workers in science. It was pointed out to me recently how closely the first number published fifty years ago resembles in form and contents the current numbers. Evidently great care and thought were given to the design and scope of the journal. In offering congratulations to the Editor and publishers, I should like to express the hope that NATURE may be as useful and successful in the next fifty years.

RIGHT HON. H. A. L. FISHER, M.P., PRESIDENT OF THE BOARD OF EDUCATION.—NATURE is one of the authoritative voices of current scientific opinion. It provides the members of the scientific community with the means of publishing newly discovered facts of general interest and importance, and enables them to follow the current work and thought in their own and in other branches of science. To those dwelling on the outskirts of the scientific community, the non-professional men of science, it furnishes a valuable *résumé* of scientific news and progress, while in its columns the general public can never fail to find intelligible references to facts of interest and importance. For fifty years NATURE has most successfully performed this important function. Victory in the war could not have been achieved without the aid of science; and the vigorous pursuit of science, both pure and applied, is essential to the welfare of the nation in peace. And now we find that a general interest in science has been reawakened by its successes in the war, while our universities and colleges are crowded with students whose keenness has never been equalled, and from whom science will recruit the workers lost during the war. I trust that a new era of progress and prosperity has opened for British science, and I hope that in this era NATURE will continue to play its important part and to add to its success of the past.

M. CAMILLE FLAMMARION.—La collection de NATURE brille aux meilleurs rayons de la bibliothèque de mon observatoire. C'est une opulente et précieuse mine scientifique, admirablement composée. Dès la première page, du 4 novembre 1869, nous avons sous les yeux son vaste programme, dans un éloquent commentaire de Huxley sur les aphorismes de Goethe : "Nature ! We are surrounded and embraced by her : powerless to separate ourselves from her, powerless to penetrate beyond her." Oui, la Nature nous enveloppe de ses merveilles ; la Science a pour mission de l'interpréter. "Un demi-siècle passera," ajoutait Huxley, "et nous jugerons notre œuvre." Ce demi-siècle est passé. La Rédaction de cette revue peut être fière de son œuvre. J'ajouterai que NATURE est souvent en avance de plus d'un demi-siècle. Ainsi, dans ce premier volume, de 1869, on peut voir, p. 304, une carte du "railway tunnel under the Channel," p. 407, une dissertation sur la 4e dimension, et p. 14, une étude de Norman Lockyer sur la couronne solaire, le tout en avence sur nos réalisations actuelles ! Félicitations et vœux pour un nouveau demi-siècle.

RIGHT HON. SIR AUCKLAND GEDDES, K.C.B., G.B.E., M.P., PRESIDENT OF THE BOARD OF TRADE.—I should like to congratulate NATURE on its long life now extending to half a century, and to wish it an even more vigorous and fruitful existence in the future. Any influence which at the present time directs the English mind to the facts of science is of service to the State. Industry, which we must now develop both in scientific economy and in volume to a level undreamed of in the days of our national pre-war wealth, needs every inspiration which science can give. NATURE is one of the possible vehicles of that inspiration, and therein lies its immediate practical importance. Of its importance to science it is unnecessary for me to speak.

DR. J. W. L. GLAISHER, F.R.S.—I was an undergraduate in my third year of residence when I saw the first number of NATURE in a shop-window, and I remember well its purchase and my interest in reading it, and how a little group of undergraduates criticised its name and discussed its contents and future. I now contemplate with admiration the hundred and three volumes and their services to science, and I am impressed by their perfect uniformity and absolute consistency of purpose. The "Notes" date from the first number, and have supplied scientific information, English and foreign, such as did not exist before, and is still unique. From the first, astronomy occupied a prominent place, and the "Astronomical Column" has been a most valuable feature from the early 'seventies. The reviews and accounts of the British Association meetings have always seemed to me especially important. The study and teaching of natural science in the University of Cambridge were in 1869 just making a feeble beginning. I read in the first number of NATURE that Mr. Bonney, of St. John's (still among us), would lecture on natural science, and that Mr. Trotter (Coutts Trotter of the "Coutts Trotter Studentship," who died in 1887) would lecture on electricity, magnetism, and botany, and the Editor added the remark that he congratulated the University on the increased desire for instruction in these subjects, but asked whether the number of men in the University competent to teach them was so small that it was found necessary to entrust electricity and botany to the same lecturer. Well, so it was. Trotter, a fellow of Trinity, had just returned from a course of study in Germany, and had induced the college to let him give these lectures. Though a mathematical man, I (perhaps induced by the paragraph in NATURE) was one of the three persons who attended Trotter's lectures on physiological botany, then an absolutely new subject in the University. The other two students soon ceased to attend, and I was the sole lecturee until Trotter considered that he had carried the subject far enough. This illustrates the vast change that fifty years have made in the University. Not many persons are now living who can remember

—and those of a later generation must find it difficult to credit—the almost complete lack of interest in natural science that existed in the University when NATURE was founded; and even in mathematics (though included in the arts) there was no encouragement—quite the reverse—to research of any kind. The progress that has been made from the stagnation of the 'sixties is enormous, and to this great expansion of thought, study, and learning NATURE has largely and worthily contributed.

SIR R. T. GLAZEBROOK, F.R.S., LATELY DIRECTOR OF THE NATIONAL PHYSICAL LABORATORY.—Those of us who have read the pages of NATURE weekly for nearly the full period of its life can realise very keenly its value and appreciate the influence it has had on the progress of natural science. It fills, and that in a most admirable manner, an important place in scientific literature; it has served as the means whereby many of the most marked advances of science have been made known to the world, and in its pages will be found the account of discoveries of the highest value to mankind. It is a privilege to send to its veteran founder the heartiest congratulations on its jubilee.

SIR DANIEL HALL, K.C.B., F.R.S., PERMANENT SECRETARY, BOARD OF AGRICULTURE.—Looking back even so far as one's earliest student days, I see NATURE as a continuous and essential part of my scientific life. It has been especially so to me, because most of my time has been spent in the country, remote from the ordinary scientific meeting grounds, and with few opportunities of learning by conversation what was going on in the scientific world. Thus one became dependent upon NATURE for information as to the changing currents of scientific opinion and for the necessary knowledge of what work was being done in other fields of science than one's own. During the period in which I have known it, the notable features of NATURE have been its catholicity, its fairness, and its dignity. It has worthily stated the case of science to the English-speaking world.

MR. W. B. HARDY, SEC. R.S.—I congratulate NATURE on its fifty years' record. Since the journal was founded science has advanced to an extent which will be realised only by the historian of the future. The advance has been made possible by intense specialisation, and the greatest service which NATURE has rendered (and indeed, in my opinion, can render) is that it has kept its readers in touch with the general progress in natural knowledge. Every movement of importance has found an expression in its pages.

PROF. W. A. HERDMAN, F.R.S., PRESIDENT-ELECT OF THE BRITISH ASSOCIATION.—NATURE is now a firmly established institution in the world of science, bringing us week by week welcome additions to knowledge, news of work in progress, helpful discussions of new views, and sound critical judgments on affairs scientific and educational. Throughout the past fifty years this journal has consistently and authoritatively upheld the freedom, dignity, and practical importance of science, and has established a splendid record of scientific progress and a fine tradition of disinterested service to the advance and diffusion of natural knowledge.

SIR ALFRED KEOGH, G.C.V.O., G.C.B., RECTOR, IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.—The attainment by NATURE of its jubilee is a notable event. Fifty years of labour in the furtherance of those principles by which, in many departments of work, unsubstantial axioms were to yield pride of place to scientific truth is no mean achievement. We may well think that the burden of the future, if different from that of the past, is no less difficult. The stimulation of inquiry, the spreading of knowledge, and the demonstration of the necessity of not merely thinking, but of thinking scientifically, are amongst the most important achievements which NATURE has successfully attempted. The interests of science are the interests of the State, and in the vista which is now opening we can all perceive a future in which the well-being of humanity is entirely dependent upon the progress of knowledge and discovery. To aid, encourage, and stimulate progress and to record advancing knowledge is henceforward, as in the past, the task of NATURE. As we look back with pride, so we may look forward with an expectant hope.

SIR JOSEPH LARMOR, M.P., F.R.S.—The early volumes of NATURE especially formed an admirable, indeed still indispensable, record of the progress of scientific discovery in our times. They were interesting without ceasing to be exact, and thereby potent to mitigate the specialisation that is inevitable for the secure and fruitful advancement of knowledge. The journalistic and discursive tendencies of the present time render such an authoritative organ, of type purely scientific, more than ever desirable.

PROF. A. LIVERSIDGE, F.R.S.—Having been a subscriber to NATURE from its first appearance, and having read every number, I wish to offer my congratulations upon its jubilee, as well as my best wishes for its continued usefulness and success.

SIR OLIVER LODGE, F.R.S.—I well remember the appearance of the first number of NATURE, when I was eighteen years old and an enthusiastic amateur student of science. The comprehensive character of the new journal was typified by an eloquent introduction by Huxley at the request of Sir Norman Lockyer. And many a man of science must have been grateful to one of the few periodicals which at a high level keeps its readers in touch with practically all branches of scientific knowledge. Over-specialisation is a real danger, and most publications necessarily cater for a limited group only, thus preventing free and easy interchange of thought across the boundary, and excluding the ordinarily educated public from participation in the current progress of science. Comprehensiveness has been the note of NATURE, and consequently it has been able to render conspicuous service. Even our rulers and literary men may occasionally find time to glance at a periodical such as this, and thereby the disastrous divorce between science and letters and public affairs is mitigated. Long may NATURE flourish, and continue to be read in all civilised countries.

PROF. W. C. MCINTOSH, F.R.S.—NATURE, with which I have been familiar from its first number onward to date, has filled an important place in the scientific literature of our country, and in a manner which has won the confidence and elicited the help of every department of science. Moreover, its reputation is as solid abroad as at home. Its long series of volumes is indispensable in every university library and in every scientific institution or laboratory. The attainment of its jubilee, therefore, is an occasion for cordially congratulating the Editor and publishers on their long and successful labours, and for wishing them a future as fertile as the past.

SIR PHILIP MAGNUS, M.P.—As one of the early contributors to NATURE, I welcome the celebration of its jubilee as indicating its value to an ever-increasing number of readers, and the permanent place it has made for itself in the scientific world. During the past half-century the progress of science has been even more rapid than the most sanguine of its devotees could have anticipated. Towards that progress the publication of NATURE has largely contributed. It has stood in close touch with the results of the most recent scientific investigations, and one may truly say that no journal has been more ably conducted; none has been more successful in realising and satisfying the requirements of those who are actively engaged in scientific work. To the Editor of NATURE and his staff I venture to offer my sincere congratulations.

RIGHT HON. SIR HERBERT MAXWELL, BART., F.R.S.—As one of what must be but a small remnant of those who remember the birth of NATURE, let me offer humble, but cordial, tribute to the great service it has rendered to science throughout half a century. Born in a period of fierce controversy, it has proved faithful to the purpose of its sponsors, shedding a clear and steady light on the pathway of research, maintaining a lucid record of modern discovery, and stimulating the appetite for knowledge in many minds. The hand of its veteran Editor, Sir Norman Lockyer, has indeed been steady on the helm. May NATURE long retain its pre-eminence among English scientific journals!

RIGHT HON. SIR ALFRED MOND, M.P., FIRST COMMISSIONER OF WORKS.—I heartily congratulate the Editor of NATURE on the fact that his periodical, which has done so much to awaken and foster interest in science, should now be celebrating its jubilee. It has always presented the progress of scientific activities in a readable, popular, and accurately scientific manner. The readers of NATURE have been enabled to keep abreast of scientific progress, and always knew that they could rely upon the soundness of the information to be found in its pages. I hope that the general recognition of the importance of science to the progress of humanity which is now manifesting itself will extend still further in the future the valuable work and influence of this excellent journal.

PROF. JOHN PERRY, F.R.S.—I congratulate NATURE on its jubilee. I have read with interest the greater part of almost every copy issued in the fifty years, and this interest has not been confined to my own subjects, for NATURE is constantly enticing me across the borders into biology. I cannot recollect a single copy which has been much below the standard which the paper has established for itself, and I can recollect many which exceeded even that very high standard. If England were idealistic, it would bestow a decoration much higher than O.M. upon NATURE.

SIR WILLIAM J. POPE, K.B.E., F.R.S.—During the last fifty years the great truth that all human progress is dependent upon scientific knowledge has gained much more general recognition than it previously enjoyed. The life-work and the writings of our foremost men of science of the last half-century—Huxley, Tyndall, Kelvin, Roscoe, Meldola, and a host of others—have been largely instrumental in clarifying popular opinion as to the value and significance of scientific research. Throughout this period NATURE has devoted itself persistently to the task of presenting the case for science, both by systematically recording the conclusions of scientific men and by editorial elucidation and comment. Although much has been achieved, far more remains yet to be done. We look to NATURE in the future, as in the past, to impress public opinion with the necessity for giving scientific methods and results a prominent place among the activities and in the councils of the nation.

SIR DAVID PRAIN, C.M.G., C.I.E., F.R.S.—Among the services rendered by NATURE to science during the half-century which has passed since its foundation, one of the greatest will appear to the thoughtful to have been the adoption of the attitude consistently maintained in its pages towards the application of natural knowledge to everyday affairs. Launched at a dismal time when the philistinism of the nineteenth-century attitude of men of affairs towards science was only equalled by that of men of science towards affairs, NATURE had the courage to revert and adhere to that more humane perception of the seventeenth century: that the first duty of Science herself is to improve her new knowledge for use. The wider acceptance of this old doctrine which we welcome to-day NATURE may fairly claim as an abiding reward.

SIR HARRY R. REICHEL.—Hearty greetings to NATURE on its fiftieth anniversary! Science is now becoming the guiding principle of material progress, and its pursuit is justified and recommended to the public by the promise of material returns. Among those who still regard science as a branch of philosophy and worthy for its own sake, NATURE will always hold its own peculiar and honourable place. In its pages the worker whose horizon is not restricted by exclusive devotion to his own subject can follow the lines of advance along other paths of inquiry. A journal which can serve such a wide range of interests without falling into "popular" science must always occupy a unique place in the intellectual life of the nation.

PROF. J. EMERSON REYNOLDS, F.R.S.—I beg to offer my hearty congratulations to the Editor of NATURE on the jubilee of that valuable journal. NATURE has long filled so important a position in British scientific journalism, and reflected scientific progress so fully in the past, that I doubt not it will continue to do so in the future with even greater success.

PROF. W. RIPPER.—I desire to add my tribute of congratulation and thanks to the many which you will doubtless receive on the occasion of the attainment of Nature's first jubilee. The whole scientific community of this country is indebted to you for the great service you have rendered to science in recording with wise discrimination the progress of science and the growth of natural knowledge. Your journal is welcomed week by week as a very real friend, and we trust it may long continue to serve the great cause of science with the same distinction and ability as in the past.

Sir Ronald Ross, K.C.B., K.C.M.G., F.R.S.—I write as editor of *Science Progress* to congratulate Nature on attaining its jubilee. It is with warm feelings that I do so, because Nature has been the medium of publication for almost all scientific men, whether as regards their scientific work or their personal difficulties, or even questions of organisation, emolument, and so on, for fifty years. It is preeminent as a scientific organ, and the editorship of it is universally recognised as being extraordinarily efficient. I myself know the difficulties, and appreciate, therefore, the way in which they are completely overcome.

Prof. Arthur Schuster, Sec. R.S.—I desire to convey to the Editor of Nature my sincere congratulations on the completion of the first fifty years of life of the periodical which under his guidance has attained a unique position in the scientific world. By a well-balanced combination of scientific articles, reviews, discussion by correspondence, personal notes, and general information, it soon established and continued to maintain a distinguished reputation wherever science is pursued. If continued in the same spirit of liberal thought and impartial criticism, Nature may look forward to an equally prosperous future.

Dr. D. H. Scott, F.R.S.—The fifty years of Nature's brilliant career have seen great developments in botany, as in every other science. It is true that the previous half-century, which witnessed the birth of the cell theory and the acceptance of evolution, was a greater era; it was then that scientific botany, as part of biology, was created; the succeeding period has been one of vigorous and manifold growth. When Nature started Darwinism had already won its first triumphs; it maintained and strengthened its position down to the end of the century, and then came a change. The rediscovery of Mendel's work in plant-breeding established the new science of genetics and transformed current ideas of evolution. Another new science, cytology, the intimate study of the cell, and especially of the nucleus, arose, to work hand-in-hand with genetics, revealing the nature of fertilisation and, in a certain degree, the mechanism of segregation. These are matters of fundamental significance, common to both the biological sciences. In the same field, but within the stricter limits of botany, we have the discovery of the spermatozoids of the maidenhair-tree and the Cycads, linking these primitive seed-plants with the Cryptogams, and through them with the animal kingdom, and of the strange phenomenon of double fertilisation in the higher flowering plants. Other new developments are the growth of a comparative anatomy of plants, now extended to the oldest fossil remains, and the advent of ecology, or physiology in the field. Of all this and much more a record will be found in the long series of the volumes of Nature.

Sir Aubrey Strahan, K.B.E., F.R.S., Director of the Geological Survey of Great Britain.—I am glad to avail myself of the opportunity of sending my congratulations on the attainment by Nature of its jubilee. The high standard aimed at in the earliest issue has been well maintained, and Nature has now for half a century been our leading weekly journal on pure science. As regards geological literature, apart from the valuable original articles which appear in its columns, its reviews especially supply a want which is not provided for elsewhere. I venture to express the hope, which I believe will be shared by all scientific men, that Nature may continue to fulfil its high functions for many years to come.

Sir J. J. H. Teall, F.R.S., lately Director of the Geological Survey of Great Britain.—That Nature has rendered great services to science in general and to all its branches is universally admitted. I have followed its development from the time of its first appearance until now with interest, sympathy, and admiration; and it is with a profound feeling of gratitude that I offer my hearty congratulations on the celebration of the jubilee of the great journal which has been edited with so much tact and ability for fifty years.

Prof. H. H. Turner, F.R.S.—The benefits of such work as yours are absorbed into the scientific system so naturally that, for the most part, they excite no attention. All the more is it, therefore, appropriate that at certain epochs notice should be expressly directed towards them and an attempt made to integrate what we have been quietly receiving for so many years in order that we may be truly thankful. It gives me great pleasure to be one of those invited to put our thanks into words.

Dr. Henry de Varigny, Scientific Editor of the "Journal des Débats."—As an old and very faithful reader who has never failed throughout forty years to read Nature, I beg to send my thanks to the Editor, contributors, and publishers for the pleasure and information they have given me. Nature has been, and remains, *the* organ of British scientific thought and progress. All the work of Britain's magnificent team of naturalists, astronomers, physicists, chemists, biologists, etc., has been made known to the world by Nature. Sincere thanks are due for the good work done in the interest of scientific progress, and cordial congratulations to the Editor on this anniversary. May both he and Nature live long to pursue their task, one which becomes more useful and essential than ever before to culture, *haud teutonico sed humano sensu*; and may we all, on both sides of the Channel, maintain that cordial understanding so firmly maintained through the ordeal of blood and fire for the freedom of civilisation.

Sir H. Trueman Wood.—I have been a regular reader of Nature since 1870—for forty-nine out of its fifty years of existence. There cannot be very many now left who can say as much, so I hope I may be allowed to add my voice to the chorus of congratulation which I am sure will greet the completion of its first half-century. Others may be better qualified to testify to the value of its services to various branches of science, but nobody can be more appreciative of the help it has given to the progress of science generally, especially in this country, which is fortunate in possessing what is admittedly the leading scientific newspaper in the world. The thanks of all associated with scientific matters are due alike to its eminent founder, still happily amongst us, and to the publishers who co-operated with him in what at the time can scarcely have been regarded as a very promising speculation.

Dr. Henry Woodward, F.R.S.—Having been present at a dinner at the Garrick Club in 1869 to inaugurate the birth of Nature, now in its fiftieth year, I feel proud to be permitted to offer by hearty congratulations to the Editor and the publishers upon this memorable occasion of its jubilee. It is no small undertaking to have produced more than 2600 weekly numbers of a journal embracing every branch of natural knowledge during half a century. Long may Nature flourish, and long may the founder be spared to see its prosperity and, with the eminent firm of Macmillan, enjoy its cosmopolitan honours and high scientific reputation.

NOTES.

The King has been pleased to approve of the following awards this year by the president and council of the Royal Society:—Royal medal to Prof. J. B. Farmer for his notable work on plant and animal cytology, and Royal medal to Mr. J. H. Jeans for his researches in applied mathematics. The following awards have also been made by the president and council:—Copley medal to Prof. W. M. Bayliss for his contributions to general physiology and to biophysics; Davy medal to Prof. P. F. Frankland for his distinguished work in chemistry, especially that on optical activity and on fermentation; Sylvester medal to Major P. A. MacMahon for his researches in pure mathematics, especially in connection with the partition of numbers and analysis; and Hughes medal to Dr. C. Chree for his researches on terrestrial magnetism. The following is a list of those recommended by the president and council of the Royal Society for election to the council at the anniversary meeting on December 1:—*President:* Sir J. J. Thomson, O.M. *Treasurer:* Sir David Prain, C.M.G. *Secretaries:* Mr. W. B. Hardy and Mr. J. H. Jeans. *Foreign Secretary:* Prof. W. A. Herdman. *Other Members of the Council:* Mr. J. Barcroft, Mr. C. V. Boys, Sir J. J. Dobbie, Sir F. Dyson, Prof. J. B. Farmer, Sir W. M. Fletcher, K.B.E., Prof. F. W. Gamble, Sir R. T. Glazebrook, Prof. J. W. Gregory, Dr. A. C. Haddon, Sir R. A. Hadfield, Bart., Sir A. B. Kempe, Sir W. J. Pope, K.B.E., Dr. S. H. C. Martin, Prof. A. Schuster, and Prof. W. P. Wynne.

The President of the French Republic, accompanied by Mme. Poincaré, received a cordial welcome upon his arrival in London on Monday, on a visit to the King and Queen. British men of science would wish to convey to President Poincaré the expression of their high regard for the influence France has always exerted in the cause of science and civilisation in Europe, and of fraternal greetings to the eminent leaders in intellectual activity who are preserving this great heritage. A banquet in honour of President and Mme. Poincaré was given by the King and Queen at Buckingham Palace on Monday evening. On Tuesday the President, accompanied by Mme. Poincaré, visited the City and were presented with an address by the Lord Mayor. To-day the President is to be installed as Lord Rector of Glasgow University, and, with Mme. Poincaré, will be entertained at luncheon at the University, after which he is to be presented with the freedom of the city.

A correspondent informs us that the Village Club at Wimbledon, wherein, as Sir Norman Lockyer explained in our jubilee number, the idea of Nature was born, was founded by Dr. Joseph Toynbee (father of Arnold Toynbee), and one of his intentions was to have a local museum in the building. Such a museum is now there, brought together by the more recently established John Evelyn Club for Wimbledon. The Village Club premises were occupied by the military during the war, but the collections have now been replaced and are again open to the public. They include prints, pictures, maps, and a photographic survey, as well as many antiquities, bygones, and natural history specimens, all connected with the locality. It is hoped that the portrait of Sir Norman Lockyer will soon adorn the walls of the museum.

Sir E. Ray Lankester has just completed fifty years' editorship of the *Quarterly Journal of Microscopical Science,* and the current issue of that well-known periodical (vol. lxiv., part 1) contains a brief summary by Prof. G. C. Bourne of the contents of the journal for the last half-century, demonstrating very clearly the important part that it has played in the development of modern biological science. We offer our hearty congratulations to Sir Ray Lankester on this notable occasion, and hope that many more volumes may appear under his distinguished editorship.

In reply to a question by Sir Philip Magnus, Mr. Bonar Law has announced that the Commissioners to be appointed under the Forestry Acts are as follows:—Lord Lovat (chairman), Director of Forestry, B.E.F., France, and member of Forestry Reconstruction Sub-Committee and of the Interim Forest Authority; Mr. F. D. Acland, M.P., chairman of the Home-grown Timber Committee, chairman of the Forestry Reconstruction Sub-Committee, and chairman of the Interim Forest Authority; Lord Clinton, formerly president of the Royal English Arboricultural Society and member of the Interim Forest Authority; Mr. L. Forestier-Walker, M.P.; Sir John Stirling-Maxwell (hon. secretary), formerly president of the Royal Scottish Arboricultural Society and member of the Forestry Reconstruction Sub-Committee; Mr. T. B. Ponsonby, member of the Interim Forest Authority; Mr. R. L. Robinson, member of the Interim Forest Authority, secretary of the Forestry Reconstruction Sub-Committee, and formerly head of the Joint Forestry Branches of the Board of Agriculture and Office of Woods; and Col. W. T. Steuart-Fotheringham, member of the Interim Forest Authority.

After a successful military campaign the House of Commons has frequently voted large sums of money from public funds to the commanders under whose guidance the conquest was won. National recognition of a like kind was given to Jenner by a grant of 10,000*l.* made by the House in 1802, and by a further grant of 20,000*l.* five years later, the intervening period having strengthened the opinion as to the efficacy of vaccination and its great benefits to the nation at large. Sir Ronald Ross has long urged that this principle should be commonly followed in connection with great discoveries by which numerous human lives are saved, as it is as the result of military conquests. In the case of a medical man devotion to research means the sacrifice of private practice, and when the result of his work is to the great advantage of the human race at large, or the nation in particular, much can be said in favour of just compensation to him. To further this reasonable claim for awards for medical discovery, a joint committee of the British Medical Association and the British Science Guild has just been formed. Sir Ronald Ross entertained the members of the committee to luncheon on November 4, and among those present were Prof. W. M. Bayliss, Sir Alfred Keogh, G.C.B., Dr. R. T. Leiper, Prof. B. Moore, Col. Nathan Raw, M.P., and Dr. W. Somerville. At a meeting held on the same day it was decided that each of the members of the committee should collect information regarding medical research work and discovery already carried out which he considers worthy of recompense by the Government or other bodies, and Sir Ronald Ross undertook to collate and edit the information in a report to the committee for further action.

IN June, 1917, the Fuel Research Board was asked by the Board of Trade and other Government Departments concerned to advise as to the most suitable composition and quality of gas. In January last the Board made its report, and this has since been the basis of negotiations between representatives of the Board of Trade, gas companies, and local authorities. An agreement has now been reached, and from a recent statement by Sir A. Geddes, in reply to a question in the House of Commons, a Bill will shortly be introduced to give effect to the recommendations of the Fuel Research Board as modified by the agreement now arrived at. The gas consumer will be charged for the potential thermal units supplied to him, the unit to be 100,000 British thermal units. The gas companies are to declare the calorific value of the gas they propose to supply, no fixed standard being laid down by Parliament. The British thermal units supplied are to be calculated by multiplying the number of cubic feet registered by the consumer's meter by the *declared* gross calorific value of the gas per cubic foot. (The original proposal of the Fuel Research Board is modified by the introduction of the word "declared.") The calorific value of the gas is to be continuously measured and recorded. As regards the proportions of inert constituents allowable, the Board's original proposal was a maximum of 12 per cent., the gas companies claiming to be freed from any restrictions in this direction. The compromise now agreed upon states that the amount of inert constituents shall not exceed 20 per cent. for two years, 18 per cent. for the next two years, and 15 per cent. afterwards. The gas undertaking is to adjust, and if need be to replace gratis, the burners in consumers' appliances so that the gas delivered can be burned in these appliances with safety and efficiency. It will no doubt require some time for the consumer to become accustomed to these changes and to be educated up to grasp the meaning of the new unit, but, owing to the time required to make the new instruments and to adjust the consumer's appliances, it will probably be three or four years after the passing of the new Bill before gas is supplied over the whole country under the new conditions.

PROF. A. FOWLER, professor of astrophysics, Royal College of Science, South Kensington, has been awarded a gold medal by the National Academy of Sciences, Washington, in recognition of his eminent contributions to astronomical science.

PROF. A. W. CROSSLEY, professor of chemistry in the University of London (King's College), has been appointed director of research to the British Cotton Industry Research Association.

NOTICE is given that applications for grants from the Chemical Society Research Fund, made upon forms obtainable from the assistant secretary of the society, must be received on or before Monday, December 1 next.

THE Geological Survey of Great Britain and Museum of Practical Geology, Jermyn Street, S.W.1, have been transferred for administrative purposes from the Board of Education to the Department of Scientific and Industrial Research as from November 1. Correspondence with reference to the work of the Survey should be addressed as heretofore to the Director of the Survey and Museum, Jermyn Street, S.W.1.

AT a general meeting of the members of the Royal Institution, held on November 3, the special thanks of the members were returned to Mr. Richard Pearce for his donation of 100*l.* to the fund for the promotion of experimental research at low temperatures; to Mr. Robert Mond for his gift of laboratory material; and to Sir Humphry Davy Rolleston for his gift of a drawing of Sir Humphry Davy's birthplace and a water-colour of his statue in the Market Place, Penzance.

AT University College, London, on Tuesday, tablets in memory of Lord Lister were unveiled before a large and distinguished assembly. The Duke of Bedford, who opened the proceedings, said that every civilised community realised the debt of gratitude it owed to Lord Lister. Sir George Makins, president of the Royal College of Surgeons, unveiled the tablet to be erected in University College Hospital, and Sir Joseph Thomson, president of the Royal Society, that to be erected in University College.

AT the anniversary meeting of the Mineralogical Society, held on November 4, the following officers and members of council were elected:—*President*: Sir William P. Beale, Bart. *Vice-Presidents*: Prof. H. L. Bowman and Mr. A. Hutchinson. *Treasurer*: Dr. J. W. Evans. *General Secretary*: Dr. G. T. Prior. *Foreign Secretary*: Prof. W. W. Watts. *Editor of the Journal*: Mr. L. J. Spencer. *Ordinary Members of Council*: Mr. H. F. Collins, Mr. J. P. De Castro, Prof. H. Hilton, Mr. Arthur Russell, Dr. A. Holmes, Miss M. W. Porter, Mr. R. H. Rastall, Sir J. J. H. Teall, Mr. A. F. Hallimond, Dr. F. H. Hatch, Mr. J. A. Howe, and Mr. W. Campbell Smith.

THE meeting of the Physical Society of London on November 28 (at 5 p.m. in the Imperial College of Science, South Kensington) is to be devoted to a discussion of the subject of lubrication. The physical qualities of a good lubricant have for long eluded capture, and it is expected that the discussion will at least furnish a step towards the solution of the problem, and at the same time create a wider interest in the subject. Amongst those who will take part are the following:—L. Archbutt, R. Mountford Deeley, W. B. Hardy, secretary R.S., F. W. Lanchester, H. M. Martin, Principal Skinner, and Dr. T. E. Stanton. The meeting is an open one, and all who are interested in the subject are invited to attend.

DR. JOHN BROWNLEE has investigated statistically the periodicity of influenza epidemics. Considering specially the years 1889–96, he finds that the interval between the epidemics is thirty-three weeks, there being a missed epidemic when an epidemic is due in the autumn (*Lancet*, November 8, p. 856). With regard to the recent epidemics, from July 13, 1918, to March 1, 1919, the maximum points are separated by thirty-three weeks; from March 1 to October 1, 1919, is also thirty-three weeks. An epidemic is therefore due, but falls at an unsuitable season, and should therefore be small, and so far this is the case. On the same sequence the next epidemic should occur in January or February of the new year.

LORD MILNER, Secretary of State for the Colonies, has appointed a Committee to consider the position of the medical services of the various Colonies and Dependencies, with the view of maintaining and increasing the supply of candidates and of securing contentment within the service; and to consider whether the principle of assimilating the medical service of neighbouring Colonies may usefully be extended, and, if so, how far and by what means. The members of the Committee are:—Sir Walter Egerton, K.C.M.G. (chairman), Lt.-Col. Sir Harry Verney, Bart., Sir Humphry D. Rolleston, K.C.B., Sir W. B. Leishman, K.C.M.G., Lt.-Col. Sir James Kingston Fowler, K.C.V.O., Mr. T. Hood, Mr. A. Fiddian, and Mr. J. E. W. Flood (secretary).

AMONG the old mathematical worthies who are buried in the churches of the City of London is Nathaniel Torporley, who was interred in the church of St. Alphage, London Wall, now being demolished. Torporley, of whom there is a sketch in the Dictionary of National Biography, was born in 1564, the same year as Shakespeare. From the Shrewsbury Grammar School he passed to Oxford, graduating in 1584 from Christ Church and taking Holy Orders. It is said that for some years he resided in France and was amanuensis to François Vietá. After his return to England he became one of the pensioners of Henry Percy, the ninth Earl of Northumberland, and, like his contemporaries Harriott, Dee, Warner, and Allen, spent a part of his life at Sion College. Among his writings was one containing a rule for solving spherical triangles. Torporley died at Sion College, and was buried on April 17, 1632. The Church of St. Alphage was, we understand, destroyed in the Fire of London, 1666, but was afterwards rebuilt.

THE activities of the Royal Photographic Society naturally divide themselves into two sections, namely, the pictorial and generally illustrative and the scientific and technical. We are very pleased to see that a few of the more energetic members are taking the latter division in hand in order to develop it by extending its scope and encouraging scientific work. The "Scientific and Technical Group" consists already of 137 members of the society, and it is hoped that this number will soon be largely augmented. The members of the group pay a small additional subscription, the disposal of this fund being exclusively under the control of the administrative committee of the group. It is hoped to be able to distribute among the members abstracts or translations of scientific communications made to other societies or publications, as well as to arrange for scientific and technical lectures and papers. The Royal Photographic Society has always been the most important photographic centre in this country, and it is to be hoped that this new arrangement will be energetically pursued, and that it will lead to a greatly increased interest being taken in the science of photography.

THE annual council meeting of the National Union of Scientific Workers was held on Saturday, November 8, at the Imperial College Union, South Kensington, and was attended by delegates from nine branches. The chair was taken by the retiring president, Dr. O. L. Brady, and the chief business was the adoption of the annual report and of the rules, and the election of officers and executive committee for the ensuing year. Dr. J. W. Evans was elected president, Dr. Norman Campbell treasurer, and Mr. Eric Sinkinson secretary. At the dinner which followed, Dr. Evans, who presided, expressed the hope that the union, in company with such other bodies as the British Association and the British Science Guild, would do great things for science. Sir Ronald Ross, replying to the toast of "The Guests," thought there were three points for which the union might press:—(1) Better payment for newly qualified men, including the modification of the present system of research assistantships; (2) pensions on a transferable basis for staffs of universities and other institutions; and (3) payment for advice given to Government and municipal bodies, which frequently did not even give travelling allowances. The union should also press for public recognition and awards for inventions.

IN an able and very valuable summary of the mammals in the Melbourne Zoological Park, Dr. W. H. D. Le Souef, the director, contrives to give a lively description of all the more important indigenous mammals of Australia. As might have been expected, he adds some very interesting facts to what is known of the life-histories of these animals. Throughout he is constantly insisting on the need for legislation to stay the work of tho exterminator. Over vast tracts of country some species have become absolutely wiped out. It is not a little disconcerting indeed to learn that the skins of wallabies and kangaroos are exported by the hundred thousand, for this means that vested interests are sure to beget strenuous opposition to the proposal which has been made to frame protective measures to secure the survival of at least a remnant of this remarkable fauna. But we trust this legislation will be speedily effected, or it will come too late. An additional toll upon this fauna is levied by the dogs, foxes, and cats which have been introduced by settlers, and in many cases have become feral. This memoir, which is illustrated by a number of very beautiful photographs, is issued by the New York Zoological Society.

THE *Journal of Indian Botany*, the first number of which appeared in September, has been started under the editorship of Mr. P. F. Fyson, of the Presidency College, Madras, to provide a means of publishing botanical work done in India which would not naturally find a home in the existing botanical journals of that country. In addition to original papers it is proposed to publish abstracts and reviews of papers which appear in other journals. The editor appeals for help to Indian botanists to make the journal, which will appear monthly, a success. The present issue contains a short paper by L. A. Kenoyer on the dimorphic female flower of *Acalypha indica*, a common tropical weed belonging to the family Euphorbiaceæ, which grows over most of India as a weed on waste ground. The lateral female flowers resemble those of Ricinus (Castor Oil) and the Euphorbiaceæ generally, but the terminal flower of the spike has one in place of three carpels, and develops one seed, which also differs slightly in size and structure from the normal seed. S. L. Ghose gives a systematic account of the Myxophyceæ, or blue-green algæ of Lahore, which occur throughout the year in drains and watercourses, artificial tanks, ditches, and on moist ground and tree-trunks. The study of this group has hitherto been neglected in

India. The author describes about twenty species which occur commonly, and others are occasionally met with. L. J. Sedgwick discusses the distinguishing features of some closely allied species of the genus Alysicarpus (Leguminosæ); and P. F. Fyson and M. Balasubrahmanyam describe the growth and root-structure of the strand-grass, *Spinifex squarrosus*, as a factor in the marine strand vegetation of Madras.

THE recent work of the French in Morocco under the direction of Gen. Lyautey is described in detail by M. A. de Tarde in a well-illustrated article in the *Geographical Review* for July (vol. viii., No. 1). Gen. Lyautey has not stayed his hand during the war, but has continued a policy of reconstruction on a bold scale, building roads, railways, and harbours, improving agriculture, and multiplying schools, hospitals, and administrative buildings. The growth of European population in the larger town is not to be allowed to crush the native town, nor is the European quarter to form part of the old town. All European towns are to be separated from native towns by a strip of ground, on which no building is allowed. The task of planning the European towns has been entrusted to competent architects and engineers under the direction of M. Prost, who recently drew up plans for the extension of Antwerp. The plans for Casablanca, the chief port, Rabat, Fez, Marrakesh, and Meknes are now complete.

AT the first meeting of the new session of the Institution of Petroleum Technologists, held on October 21, a paper was read by Mr. A. Philip on "Some Laboratory Tests on Mineral Oils." The author referred at length to the imminent need for the standardisation of tests and methods in petroleum analysis, and considered that it would not be feasible to prepare and circulate standard material of known composition. He therefore urged the very detailed description of procedure, so that it would be possible for a reasonably accurate repetition of results to be obtained from chemists working in different laboratories. The sampling of oils was described minutely as practised at Portsmouth, and great emphasis was laid on this all-important preliminary operation. The author then dealt with the distillation of crude oils, and described a novel experimental still of very considerable merit and ingenuity, designed to minimise the time occupied in the determination of the light oils and water-content of a given material. Tabular matter illustrated the application of the method, and results were given of the analysis of the Hardstoft oil. Methods of determining the vapour pressure of petrol, calorific value, moisture, and flash-point were criticised, and the procedure adopted in the lecturer's laboratory was detailed. It was shown that the flash-point of a fuel oil was liable to an experimental error of nearly 5 per cent., whilst if the oil was wet the discrepancies were very much more serious. In consequence a considerable tolerance should be allowed in specifications. A discussion followed, in which Sir Thomas Holland, Prof. Brame, and Dr. Ormandy made reference to the subject of standardisation, whilst Dr. Dunstan, Mr. Mitchell, and Mr. Lomax brought forward criticisms of the various methods detailed in the paper.

THE *Engineer* for October 24 contains a description of the recently completed undertaking for the supply of water to Greater Winnipeg. The quantity rendered available amounts to 85,000,000 gallons per day, which should suffice for the needs of the city for some time to come, as the present number of inhabitants is only some quarter of a million, and the consumption 44 gallons per head per day. The water is obtained from Shoal Lake, with an area of 107 square miles, and a catchment basin of 360 square miles, which is connected with the larger expanse of 1400 square miles known as the Lake of the Woods. It is described as soft and excellent in quality; the chlorine content is three parts per million. The distance conveyed is 96½ miles. Of this 77⅓ miles is cut-and-cover work, with culverts varying from 10 ft. 9 in. by 9 ft. to 6 ft. 5 in. by 5 ft. 5 in. There are 7 miles of river siphons and 9½ miles of reinforced concrete pressure pipe. The distributing mains in the city of Winnipeg consist of 2⅝ miles of 48-in. concrete pipe. The work was commenced in 1913, and estimated to cost just above 2,600,000*l*.

MR. F. W. CLIFFORD, librarian to the Chemical Society, contributes to the *Library Association Record* for August an article on "The Library of the Chemical Society: A Record of a Recent Attempt at Co-operation." The Chemical Society has always aimed at including in its library every book and periodical that might help its fellows in their work. During the war this library has been of the greatest assistance to the nation, since it was found to contain most of the important works of foreign origin which Government Departments and manufacturers wished to consult. This increased use of the books impressed upon the library committee the importance of further extension in the technical direction. The council therefore invited a number of kindred societies to co-operate with it in extending the technical equipment of the library by appointing representatives on the library committee and by giving financial assistance for the purchase of books. The members of the societies thus co-operating are able to use the library on the same terms as fellows. The invitation has been accepted by the Association of British Chemical Manufacturers, the Biochemical Society, the Faraday Society, the Institute of Chemistry, the Society of Chemical Industry, the Society of Dyers and Colourists, and the Society of Public Analysts. This form of co-operation might perhaps be adopted with advantage by other libraries devoted to special branches of knowledge.

Messrs. George Bell and Sons, Ltd., announce:—"The Physiology of Vision: With Special Reference to Colour-blindness," Dr. F. W. Edridge-Green; "Practical Biological Chemistry," Bertrand and Thomas, translated by Capt. H. A. Colwell; "An Introduction to the Study of Vector Analysis," Prof. C. E. Weatherburn; "Nomography," Dr. S. Brodetsky; "Differential Equations and their Applications," Dr. H. Pioggio; and "Intermediate Chemistry," Prof. A. Smith. The same publishers have in preparation "Recent Investigations in Fluorescence and Related Phenomena," Prof. R. W. Wood; "A Text-book of Zoology," Prof. C. H. O'Donoghue; and "Physics: An Intermediate Course," Dr. A. O. Rankine. *Messrs. J. M. Dent and Sons, Ltd.*, are about to publish a portfolio of twenty-four coloured "Nature Studies" by E. J. Detmold. The issue will be limited to 500 sets, each of which will be numbered and accompanied by a certificate signed by the artist. *Messrs. Longmans and Co.* have in the press for appearance next year vol. i. of the treatise on "Higher Inorganic and Theoretical Chemistry," in six volumes, upon which Dr. J. W. Mellor has been working for the past twelve years. They also announce "A Manual of Practical Anatomy," 3 vols. (vol. i., The Extremities; vol. ii., The Head and Neck; and vol. iii., The Thorax and Abdomen), Prof. T. Walmsley; "Structural Steelwork," E. G. Beck; "A First-Year Physics for Junior Technical Schools," G. W. Farmer; and "Life in Early Britain: A Survey of the Social and Economic Development of the People of England from Earliest Times to the Norman Conquest," N. Ault. The new list of *Messrs. George Routledge and Sons, Ltd., and Kegan Paul and Co., Ltd.*, includes:—"The Social Maladies: Tuberculosis, Syphilis, Alcoholism, Sterility," Dr. J. Héricourt, translated, with a final chapter, by B. Miall; "Agriculture and the Farming Business," O. H. Benson and G. H. Betts; "Wonders of Insect Life," J. H. Crabtree; "Germination," A. E. Baines; and "Bakery Machinery," A. W. Mathys; "The Clay-working Industries," A. B. Searle; "Direct-current Dynamos and Motors," Prof. W. B. Griffith; "Electric Cooking and Heating," W. A. Gillott; "Engineering Instruments and Meters," E. A. Griffiths; "Manufacture and Installation of Electric Cables," C. J. Beaver; "Reproduction and Utilisation of Sound," H. O. Merriman; "The Turbo-Alternator," Dr. S. F. Barclay; and "The Utilisation of Natural Powers," E. L. Burne (in Routledge's Industrial Supremacy Books).

Arrangements have been completed for the amalgamation of the business carried on by Mr. Robt. W. Paul at New Southgate, London, with the Cambridge Scientific Instrument Co., Ltd. Mr. Paul will join the board of directors, and the manufacture of instruments will be continued both at Cambridge and at New Southgate. On January 1, 1920, the name of the company will be altered to the Cambridge and Paul Instrument Co., Ltd., and as soon as possible the head office and showrooms will be transferred to London.

The South-Eastern Union of Scientific Societies was established in 1896, and includes more than seventy affiliated societies. A correspondent writes to point out that the union was omitted from the list given last week. The list was not intended, however, to include unions or federations of societies, but rather individual societies which meet periodically throughout the year.

OUR ASTRONOMICAL COLUMN.

The Leonid Meteors.—Though no special display of these objects is to be expected this year, the sky should be vigilantly watched on the nights from November 13 to 16, and particularly during the hours following midnight. The moon will be at the last quarter on November 14, being visible in the morning hours, but her light will be feeble and cannot materially interfere with the aspect of the shower. The radiant point in Leo does not rise until about 10.20 p.m. If any of the usual bright, streaking meteors are observed from this system, their apparent paths amongst the stars should be carefully recorded. There is no doubt, from the observations obtained in past years, that the stream of November Leonids is continuous in all sections of the orbit, and that there are considerable differences in the apparent strength of the shower witnessed from year to year. The maximum may be expected on the morning of November 15 or 16.

The shower of meteors connected with Biela's comet is due to return a few nights later than the Leonids, and, as the moon will then have waned to the crescent shape, observations may be favourably made should the atmosphere be suitable and free from the clouds and fogs so common to our climate at this season of the year.

The Group of Helium Stars in Orion.—There has for long been a natural curiosity to find the distance of the great nebula in Orion. The problem became more hopeful when it was found that the group of helium stars was probably connected with the nebula, as appeared both by their configuration and by identity of radial motion (about +22 km./sec.). Dr. Bergstrand, of Upsala, has published (Nova Acta Reg. Soc. Scient. Upsal., ser. iv., vol. v., No. 2) an attempt to find this distance. First, he made a careful re-examination of proper motions in order to find the rate of closing in on δ Orionis, owing to increasing distance from us; he found for the parallax 0·0044″, with probable error 0·0049″. The second method was based on the assumption that the scattering of individual proper motions is comparable with that of the radial velocities; he thus obtained 0·0076″, with probable error less than 0·002″. It will be seen that the two determinations are of the same order of magnitude, and are also comparable with some other values; thus Dr. Charlier, in his memoir on the B stars, gave figures for the Orion group of which the mean is 0·0118″, and Prof. Kapteyn by another method found 0·0058″. Also four of the stars are binaries, and the mean of their hypothetical parallaxes, as given by Messrs. Hertzsprung and Stebbins, is 0·0078″.

From the large area that the group covers in the sky there is reason to expect a corresponding range in the individual distances. Hence we may look on the various determinations as satisfactorily accordant, and conclude that in putting the distance of the nebula as 400 light-years we are not very far from the truth.

The Secular Acceleration of the Moon.—In a recent paper Mr. Nevill claimed to have shown that the observations of the last three centuries prove that the acceleration does not differ from its theoretical value. Prof. E. W. Brown, in the Proceedings of the Royal Society (Series A, vol. xcvi.), shows that, by making suitable changes in initial longitude and mean motion, a change as great as 5·4″ in the acceleration will make changes in the longitude that are less than 1·6″ for the whole interval between 1620 and 1950. Quantities so small as this cannot be evaluated from the observations, so long as the large inequality with period of the order of three centuries remains unexplained by theory. Hence, apparently, the ancient eclipses, unsatisfactory as the records of them are, supply the only material available for determination of the acceleration.

THE GLASS RESEARCH ASSOCIATION.

It is now widely known that among the industries which have been profoundly influenced by the war the glass and glassware industry of the United Kingdom occupies a foremost place. Not only have the pre-war products of this industry, as they existed in this country before the war, been found essential for a wide range of national purposes during wartime, but the necessity has also been forcibly realised of creating certain special sections of this industry, previously non-existent in the country, to supply glass and glassware, glass instruments, and glass apparatus directly necessary for the prosecution of the war, as well as similar articles equally vital as being indispensable for the efficient operation of other industries. The importance of the glass industry to the economic life of the nation is to be measured largely by its effect upon, and indispensability to, other industries. This has been fully recognised by the Government in the inclusion of scientific glassware and illuminating glassware, as well as optical glass, in the schedule of unstable "key" industries.

But the revolutionising effect of the war upon the glass industry is not alone manifest in the creation of these "key" sections which previously were monopolised by Germany and Austria, whose glass manufacturers had attained great strength and reputation, and certainly dominated the markets of the world, or even in the resuscitation of other sections (*e.g.* the so-called "flint" glass sections) of the industry, which, though long established in this country, were rapidly declining as the result of unfair foreign competition. The feature even more significant than either of these, and the ground of the future hope that a stable and prosperous British glass industry will be firmly established, is the shedding of the old spirit of isolation and exclusiveness which possessed the manufacturers of this country. Invariably in each works there existed a policy of secrecy, together with an unwarranted satisfaction with old-fashioned rule-of-thumb manufacturing ideas and an absence of scientific method. This inevitably resulted in inability to organise for production upon progressive modern lines. During the war there has been a wonderful awakening to the new possibilities of glass production in this country, and there is now happily evidenced among the manufacturers a new spirit of co-operation combined with an enthusiasm for investigation and research, and a desire to adopt new methods and equipment involving the scientific control of manufacturing operations.

The establishment of the Glass Research Association, which after nearly twelve months' spade-work by an earnest provisional committee was launched on its career on October 14 at the first general meeting held at the Institute of Chemistry, when the first council of the association was elected, well illustrates the changed aspect which the industry has assumed. This association has been formed on the lines approved by the Department of Scientific and Industrial Research for the encouragement of research. During the next five years the association will expend at least 100,000*l.* upon investigations into the many problems of glass and glassware manufacture.

There is a vast and difficult field to cover, as will appear from the consideration of the following groups of main problems to be attacked:—Chemical and physical properties of glasses; fuels, refractories, furnaces, treatment of glass-making materials, glass-founding, temperature measurement and control; glassware-forming operations (hand and mechanical), glassware-making machinery; annealing, lamp-blown work, and other finishing operations; design, lay-out, and equipment of glass factories; and scientific methods of storing, packing, and transit. These are but the general problems. When they are considered in relation to the enormous varieties of types of glass articles, from common bottles, food and beverage containers, chemical and medical bottles, on one hand, to the elaborate products of the lamp-blown glassware bench-worker (*e.g.* condensers, gas-analysis apparatus, thermometers, artificial eyes, X-ray tubes, syringes, etc.) on the other; from window-glass and plate-glass to beakers, flasks, and accurately calibrated and graduated glassware; from tumblers and the numerous domestic and fancy articles of glassware in common use to electric lamps, miners'-lamp glasses, and a host of articles essential for illuminating purposes; and, in addition, the varieties of special glasses required for scientific instruments, for decorative purposes, for machinery, and for building, it is easy to realise that the problems are not lacking in number, variety, or fascination.

To consider only one problem for a moment: the manufacture of glass tubing. All scientific workers understand the essential importance of being able to obtain varieties of glass tubing having definite chemical and physical properties, and at the same time satisfying stipulated degrees of dimensional accuracy within narrow limits. Few realise the enormous difficulties involved in the production of such tubing, the wastage caused by the careful selection necessary to obtain satisfactory quality, and how much depends upon the high degree of individual skill in the worker engaged in glass tube-drawing. The Glass Research Association will not rest satisfied until, by securing the concentration of engineering genius upon this problem, glass tubing can be turned out with dimensional accuracy comparable with that secured in producing tubing of brass or other metals, and at the same time possessing such specific chemical and physical properties as are necessary for workability in the blow-lamp. This problem affects vitally a whole section of the industry—the lamp-blown scientific glassware section—for glass tubing is the raw material of this section, and the problems involved in making many precise and important instruments (*e.g.* butyrometers, clinical and other thermometers, hydrometers, etc.) are nearly all solved when the proper tubing can be accurately and consistently produced.

There are at the present time approximately four hundred firms engaged in glass and glassware manufacture in the United Kingdom, employing about 50,000 workers. It is anticipated that the research work of the association will commence in earnest at the beginning of next year. Before that date the council of the association hopes that every one of these four hundred firms will have applied for membership.

The report of the provisional committee to the general meeting on October 14 showed that a membership of 107 had already been reached; that a promise had been secured from the Committee of the Privy Council for Scientific and Industrial Research to pay to the association a total grant not exceeding 75,000*l.* within a period of five years on condition that during this period members of the association contribute an aggregate sum of not less than 5000*l.* per annum in subscriptions. The financial statement also revealed that towards this sum of 5000*l.* per annum promises from the 107 members had reached 4654*l.* 10*s.* (subscriptions from members are on a voluntary basis from 10*l.* to 100*l.* per annum, according to ability to pay), and, in addition to this, the association had received a handsome donation of 1000*l.* from a well-known firm of glass manufacturers.

In addressing this first general meeting of the Glass Research Association, Sir Frank Heath, Secretary of the Department of Scientific and Industrial Research, who with his colleagues has rendered invaluable assistance to the promoters of the association, congratulated the members upon having brought together in this scheme of co-operative research such diverse sections of a complex industry, and also upon the particularly high financial contribution secured from the Government, due to the inclusion of unstable "key" industry sections of the glass industry, and the recognition that, in spite of the great things already accomplished in the production of these special types of glassware, an enormous amount of research and experimental work is still necessary to place these sections on a firm foundation.

Referring to various phases of the future activities of the Glass Research Association, Sir Frank Heath suggested that existing facilities such as those available at the National Physical Laboratory and the Sheffield University Department of Glass Technology should be used to the utmost, at any rate in the initial stages; that a bureau of information should be established; and that very careful efforts should be made to obtain the right director of research. The importance of his being able to win the best from his research workers by "team-work" was mentioned. In this connection the council of the association wishes it to be widely known amongst scientific workers that it is anxious to secure that the best available scientific brains and ability shall be devoted to the problems of this industry. There can be no doubt as to the value of the opportunity offered for research, the attractiveness of the subjects for investigation, and the huge difficulties to be surmounted. The ideal director for this association is not an individual research worker whose glory is to work in splendid isolation, but is he who will bring expert knowledge of the methods of scientific research to bear upon these complex problems, who possesses such personality as to attract promising young research workers to his side, and who is also an administrator qualified to secure the carrying on of a large volume of research work along a broad front touching the various sectional interests concerned, and to co-ordinate the efforts being made through the various laboratories, institutions, and works to which specific research and experimental work will be allotted.

In an advertisement which has appeared for a director of research a lower limit to the salary has been mentioned, but it may here be stated that the council intends to pay a salary commensurate with the qualifications of the candidate selected to fill the office, and it will be very considerably higher than the figure mentioned if the council can obtain its ideal director.

There are brilliant opportunities in this field of scientific investigation for the chemist, the physicist, and the engineer. Glass engineering in particular is in its infancy in this country, and the modern problems of glass manufacture are rapidly resolving themselves into those to be solved mainly by the highly trained engineer who specialises in the study of glass-making processes.

The Glass Research Association is an earnest effort to carry out co-operative research on an extensive scale for an industry of prime national importance, and it has been launched with great promise. Everything now depends upon the support of the whole industry and upon the calibre of the scientific workers who will undertake the investigations.

It is not too much to hope that the present membership will soon be doubled, and that scientific ability and genius of the highest order will be found to energise this great undertaking and ensure its success.

EDWARD MEIGH.

THE TOBACCO BEETLE.

BULLETIN No. 737 of the United States Department of Agriculture, published last March, has for its subject "The Tobacco Beetle: An Important Pest in Tobacco Products," and on reading what its writer, Mr. G. H. Runner, has to say about the pest, one is almost tempted to believe that the "precious herbe" is fitted for nothing so much as the breeding of maggots. At any rate, Mr. Runner makes it quite clear that tobacco at every stage of its manufacture, from the dried leaf up to the finished product, is a most attractive diet for the grub or larva, and that the conditions under which the leaf is usually manufactured and stored are almost ideal for the development and reproduction of the beetle. What a pity King James did not know all this when he wrote his "Counterblaste," and was led in irony to exclaim, "O omnipotent power of tobacco!" But the tobacco beetle, *Lasioderma serricorne*, was probably altogether unknown in his days, and even now is not at all common in England. It cannot withstand exposure to extreme cold for any great length of time, and thrives best, sometimes reproducing at the unusual rate of three or more generations each year, where a warm, equable temperature, a moist atmosphere, and suitable food for the grub occur together. That is why it is so much better known in America, especially in the States bordering on the Gulf of Mexico, than it is in this country. It is well known also in India and the islands of the Far East.

Here in England the tobacco beetle is an imported species, only occasionally met with, though sometimes in very large numbers, as was the case not many years ago when it swarmed in the warehouses around one of the London docks, whither it had come in a cargo of turmeric from India. Its larvæ feed, like those of the common "biscuit weevil" or "drug-store beetle," *Sitodrepa panicea*, which belongs to the same family, on almost every kind of dried product of vegetable origin. Hence the beetle is almost as much at home with the druggist and the grocer as it is with the tobacconist. Tobacco, however, except in the green or growing state, which it does not touch, appears to be its principal food, and, according to Mr. Runner, it selects the higher grades of leaf, cigar, and cigarette in preference to those of inferior quality.

Methods to be taken for the destruction or control of the little pest, and various experiments and trials made with that object in view, are described at some length in the bulletin, which contains as well a full account of the whole life-history of the insect illustrated by figures, some of which are particularly well done, and there is also a list of special memoirs and other papers relating to the subject. The bulletin, therefore, although apparently prepared more especially for the benefit of the tobacco manufacturer and dealer, will be of considerable value to the practical entomologist, and ought, indeed, to have some interest also for every true lover of the weed.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY PROF. ARTHUR KEITH, M.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

The Differentiation of Mankind into Racial Types.

FOR a brief half-hour I am to try to engage your attention on a matter which has excited the interest of thoughtful minds from ancient times—the problem of how mankind has been demarcated into types so diverse as the Negro, the Mongol, and the Caucasian or European. For many a day the Mosaic explanation—the tower of Babel theory—was regarded as a sufficient solution of this difficult problem. In these times most of us have adopted an explanation which differs in many respects from that put forward in the book of Genesis; Noah disappears from our theory and is replaced in the dim distance of time by a "common ancestral stock." Our story now commences, not at the close of an historical flood, but at the end of a geological epoch so distant from us that we cannot compute its date with any degree of accuracy. Shem, Ham, and Japheth, the reputed ancestors of the three great racial stocks of modern times—the white, black, and yellow distinctive types of mankind—have also disappeared from our speculations; we no longer look out on the world and believe that the patterns which stud the variegated carpet of humanity were all woven at the same time; some of the patterns, we believe, are of ancient date and have retained many of the features which marked the "common ancestral" design; others are of more recent date, having the ancient pattern altered in many of its details. We have called in, as Darwin has taught us, the whole machinery of evolution—struggle for existence, survival of the fittest, spontaneous origin of structural variations, the inheritance of such variations—as the loom by which Nature fashions her biological patterns. We have replaced the creative finger by the evolutionary machine, but no one is more conscious of the limitations of that machine than the student of human races. We are all familiar with the features of that racial human type which clusters round the heart of Africa; we recognise the Negro at a glance by his black, shining, hairless skin, his crisp hair, his flattened nose, his widely opened dark eyes, his heavily moulded lips, his gleaming teeth and strong jaws. He has a carriage and proportion of body of his own; he has his peculiar quality of voice and action of brain. He is, even to the unpractised eye, clearly different from the Mongolian native of North-Eastern Asia; the skin, the hair, the eyes, the quality of brain and voice, the carriage of body and proportion of limb to body pick out the Mongol as a sharply differentiated human type. Different from either of these is the native of Central Europe—the Aryan or Caucasian type of man; we know him by the paleness of his skin and by his facial features—particularly his narrow, prominent nose and thin lips. We are so accustomed to the prominence of the Caucasian nose that only a Mongol or Negro can appreciate its singularity in our Aryanised world. When we ask how these three types—the European, Chinaman, and Negro—came by their distinctive features, we find that our evolutionary machine is defective; the processes of natural and of sexual selection will preserve and exaggerate traits of body and of mind, but they cannot produce that complex of features which marks off one racial type from another. Nature has at her command some secret mechanism by which she works out her new patterns in the bodies of man and beast—a mechanism of which we were almost ignorant in Darwin's day, but which we are now beginning to perceive and dimly understand. It is the bearing of this creative or morphogenetic mechanism on the evolution of the modern races of mankind which I propose to make the subject of my address.

Hid away in various parts of the human frame is a series of more or less obscure bodies or glands, five in number, which, in recent times, we have come to recognise as parts of the machinery which regulate the growth of the body. They form merely a fraction of the body—not more than 1/180th part of it: a man might pack the entire series in his watch-pocket. The modern medical student is familiar with each one of them—the pituitary body, about the size of a ripe cherry, attached to the base of the brain and cradled in the floor of the skull; the pineal gland, also situated in the brain, and in point of size but little larger than a wheat-grain; the thyroid in the neck, set astride the windpipe, forms a more bulky mass; the two suprarenal bodies situated in the belly, capping the kidneys, and the interstitial glands embedded within the substance of the testicle and ovary, complete the list. The modern physician is also familiar with the fact that the growth of the body may be retarded, accelerated, or completely altered if one or more of these glands become the seat of injury or of a functional disorder. It is thirty-three years now since first one woman and then another came to Dr. Pierre Marie in Paris seeking relief from a persistent headache, and mentioning incidentally that their faces, bodies, hands, and feet had altered so much in recent years that their best-known friends failed to recognise them. That incident marked the commencement of our knowledge of the pituitary gland as an intrinsic part of the machinery which regulates the shaping of our bodies and features. Dr. Marie named the condition acromegaly. Since then hundreds of men and women showing symptoms similar to those of Dr. Marie's patients have been seen and diagnosed, and in every instance where the acromegalic changes were typical and marked there has been found a definite enlargement or tumour of the pituitary body. The practised eye recognises the full-blown condition of acromegaly at a glance, so characteristic are the features of the sufferers. Nay, as we walk along the streets we can note slight degrees of it—degrees which fall far short of the borderline of disease; we note that it may give characteristic traits to a whole family—a family marked by what may be named an acromegalic taint. The pituitary gland is also concerned in another disturbance of growth—giantism. In every case where a young lad has shot up, during his late "teens," into a lanky man of seven feet or more—has become a giant—it has been found that his pituitary gland was the site of a disordered enlargement. The pituitary is part of the mechanism which regulates our stature, and stature is a racial characteristic. The giant is usually acromegalic as well as tall, but the two conditions need not be combined; a young lad may undergo the bodily changes which characterise acromegaly and yet not become abnormally tall, or he may become—although this is rarely the case—a giant in stature and yet may not assume acromegalic features. There is a third condition of disordered growth in which the pituitary is concerned—one in which the length of the limbs is disproportionately increased—in which the sexual system and all the secondary sexual characters of body and mind either fail to develop or disappear—where fat tends to be deposited on the body, particularly over the buttocks and thighs—where, in brief, a eunuchoid condition of body develops. In all these three conditions we seem to be dealing with a disordered and exaggerated action of the pituitary gland; there must be conditions of an opposite kind where the functions of the pituitary are disordered and reduced. A number of cases of dwarfism have been recorded where boys or girls retained their boyhood or girlhood throughout life, apparently because their pituitary gland had been invaded and partly destroyed by tumours. We shall see that dwarfism may result also from a failure of the thyroid gland. On the evidence at our disposal, evidence which is being rapidly augmented, we are justified in regarding the pituitary gland as one of the principal pinions in the machinery which regulates the growth of the human body and is directly concerned in determining stature, cast of features, texture of skin, and character of hair—all of them marks of race. When we compare the three chief racial types of humanity—the Negro, the Mongol, and the Caucasian or European—we can recognise in the last-named a greater predominance of the pituitary than in the other two. The sharp and pronounced nasalisation of the face, the tendency to strong eyebrow ridges, the prominent chin, the tendency to bulk of body and height of stature in the majority of Europeans, is best explained, so far as the present state of our knowledge goes, in terms of pituitary function.

There is no question that our interest in the mechanism of growth has been quickened in recent years by observations and discoveries made by physicians on men and women who suffered from pituitary disorders, but that a small part of the body could influence and regulate the growth and characterisation of the whole was known in ancient times. For many centuries it has been common knowledge that the removal of the genital glands alters the external form and internal nature of man and beast. The sooner the operation is performed after birth, the more certain are its effects. Were a naturalist from a unisexual world to visit this earth of ours it would be difficult to convince him that a brother and a sister were of the same species, or that the wrinkled, sallow-visaged eunuch with his beardless face, his long, tapering limbs, his hesitating carriage, his carping outlook, and corpulent body was brother to the thick-set, robust, pugilistic man with the bearded face. The discovery that the testicle and ovary contain, scattered throughout their substance, a small glandular element which has nothing to do with their main function—the production of genital cells—was made seventy years ago, but the evidence which leads us to believe that this scattered element—the interstitial gland—is directly concerned in the mechanism of growth is of quite recent date. All those changes which we may observe in the girl or boy at puberty—the phase of growth which brings into full prominence their racial characteristics—depend on the action of the interstitial glands. If they are removed or remain in abeyance the maturation of the body is both prolonged and altered. In seeking for the mechanism which shapes mankind into races we must take the interstitial gland into our reckoning. I am of opinion that the sexual differentiation—the robust manifestations of the male characters—is more emphatic in the Caucasian than in either the Mongol or Negro racial types. In both Mongol and Negro, in their most representative form, we find a beardless face and almost hairless body, and in certain Negro types, especially in Nilotic tribes, with their long, stork-like legs, we seem to have a manifestation of abeyance in the action of the interstitial glands. At the close of sexual life we often see the features of a woman assume a coarser and more masculine appearance.

Associated with the interstitial glands, at least in point of development, are the suprarenal bodies or glands. Our knowledge that these two comparatively small structures, no larger than the segments into which a moderately sized orange can be separated, are connected with pigmentation of the skin dates back to 1894, when Dr. Thomas Addison, a physician to Guy's Hospital London, observed that gradual destruction of these bodies by disease led to a darkening or pigmentation of the patient's skin, besides giving rise to other more severe changes and symptoms. Now it is 150 years since John Hunter came to the conclusion, on the evidence then at his disposal, that the original colour of man's skin was black, and all the knowledge that we have gathered since his time supports the inference he drew. From the fact that pigment begins to collect in and thus darken the skin when the suprarenal bodies become the seat of a destructive disease we infer that they have to do with the clearing away of pigment, and that we Europeans owe the fairness of our skins to some particular virtue resident in the suprarenal bodies. That their function is complex and multiple the researches of Sir E. A. Sharpey Schafer, of T. R. Elliott, and of W. B. Cannon have made very evident. Fifteen years ago Bulloch and Sequeira established the fact that when a suprarenal body becomes the site of a peculiar form of malignant overgrowth in childhood, the body of the boy or girl undergoes certain extraordinary growth changes. The sexual organs become rapidly mature, and through the framework of childhood burst all the features of sexual maturity—the full chest, muscularity of limbs, bass voice, bearded face, and hairy body—a miniature Hercules—a miracle of transformation in body and brain. Corresponding changes occur in young girls—almost infants in years—with a tendency to assume features which characterise the male. Prof. Glynn (*Quart. Journ. of Med.*, vol. v., p. 157, 1912) has recently collected such cases and systematised our knowledge of these strange derangements of growth. There can be no doubt that the suprarenal bodies constitute an important part of the mechanism which regulates the development and growth of the human body and helps in determining the racial characters of mankind. We know that certain races come more quickly to sexual maturity than others, and that races vary in development of hair and of pigment, and it is therefore reasonable to expect a satisfactory explanation of these characters when we have come by a more complete knowledge of the suprarenal mechanism.

During the last few years the totally unexpected discovery has been sprung upon us that disease of the minute pineal gland of the brain may give rise to a train of symptoms very similar to those which follow tumour formation of the cortex of the suprarenal bodies. In some instances the sudden sexual prematurity which occurs in childhood is apparently the immediate result of a tumour-like affection of the pineal gland. We have hitherto regarded the pineal gland, little bigger than a wheat-grain and buried deeply in the brain, as a mere useless vestige of a median or parietal eye, derived from some distant human ancestor in whom that eye was functional, but on the clinical and experimental evidence now rapidly accumulating we must assign to it a place in the machinery which controls the growth of the body.

We come now to deal with the thyroid gland, which, from an anthropological point of view, must be regarded as the most important of all the organs or glands of internal secretion. Here, too, in connection with the thyroid gland, which is situated in the front of the neck, where it is so apt to become enlarged and prominent in women, I must direct attention to a generalisation which I slurred over when speaking of the pituitary and suprarenal glands. Each of these glands throws into the circulating blood two sets of substances—one set to act immediately in tuning the parts of the body which are not under the influence of the will to the work they have to do when the body is at rest and when it is making an effort; another set of substances—which Prof. Gley has named morphogenetic—has not an immediate but a remote effect; they regulate the development and co-ordinate the growth of the various parts of the body. Now, so far as the immediate function of the thyroid is concerned, our present knowledge points to the gland as the manufactory of a substance which, when circulating in the body, regulates the rate of combustion of the tissues; when we make a muscular effort, or when our bodies are exposed to cold, or when we become the subjects of infection, the thyroid is called upon to assist in mobilising all available tissue-fuel. If we consider only its immediate function it is clear that the thyroid is connected with the selection and survival of human races. When, however, we consider its remote or morphogenetic effects on growth, its importance as a factor in shaping the characteristics of human races becomes even more evident. In districts where the thyroid is liable to that form of disease known as goitre it has been known for many a year that children who were affected became cretins—dwarf idiots with a very characteristic appearance of face and body.[1] Disease of the thyroid stunts and alters the growth of the body so that the subjects of this disorder might well be classed as a separate species of humanity. If the thyroid becomes diseased and defective after growth of the body is completed, then certain changes, first observed by Sir William Gull in 1873, are set up and give rise to the disordered state of the body known as myxœdema. "In this state," says Sir Malcolm

[1] The story of the discovery of the action of the thyroid gland is told by Prof. G. M. Murray, *Brit. Med. Journ.*, ii., p. 163, 1913.

Morris (*Brit. Med. Journ.*, i., p. 1038, 1913), "the skin is cold, dry, and rough, seldom or never perspires, and may take on a *yellowish* tint; there is a bright red flush in the malar region. The skin as a whole looks transparent; the hair of the scalp becomes scanty; the pubic and axillary hair, with the eyelashes and eyebrows, often falls out; in many cases the teeth are brittle and carious. All these appearances disappear under the administration of thyroid extract." We have here conclusive evidence that the thyroid acts directly on the skin and hair, just the structures we employ in the classification of human races. The influence of the thyroid on the development of the other systems of the body, particularly on the growth of the skull and skeleton, is equally profound. This is particularly the case as regards the base of the skull and the nose. The arrest of growth falls mainly on the basal part of the skull, with the result that the root of the nose appears to be flattened and drawn backwards between the eyes, the upper forehead appears projecting or bulging, the face appears flattened, and the bony scaffolding of the nose, particularly when compared with the prominence of the jaws, is greatly reduced. Now these facial features which I have enumerated give the Mongolian face its characteristic aspect, and, to a lesser degree, they are also to be traced in the features of the Negro. Indeed, in one aberrant branch of the Negro race—the Bushman of South Africa—the thyroid facies is even more emphatically brought out than in the most typical Mongol. You will observe that, in my opinion, the thyroid—or a reduction or alteration in the activity of the thyroid—has been a factor in determining some of the racial characteristics of the Mongol and the Negro races. I know of a telling piece of evidence which supports this thesis. Some years ago there died in the East End of London a Chinese giant—the subject, we must suppose, of an excessive action of the pituitary gland—the gland which I regard as playing a predominant part in shaping the face and bodily form of the European. The skeleton of this giant was prepared and placed in the Museum of the London Hospital Medical College by Col. T. H. Openshaw, and anyone inspecting that skeleton can see that, although certain Chinese features are still recognisable, the nasal region and the supra-orbital ridges of the face have assumed the more prominent European type.

There are two peculiar and very definite forms of dwarfism with which most people are familiar, both of which must be regarded as due to a defect in the growth-regulating mechanism of the thyroid. Now, one of these forms of dwarfism is known to medical men as achondroplasia, because the growth of cartilage is particularly affected, but in familiar language we may speak of the sufferers from this disorder of growth as being of the "bulldog breed" or of the "dachshund breed." In the dachshund the limbs are greatly shortened and gnarled, but the nose or snout suffers no reduction, while in the bulldog the nose and nasal part of the face are greatly reduced and withdrawn, showing an exaggerated degree of Mongolism. Among achondroplastic human dwarfs both breeds occur, but the "bulldog" form is much more common than the "dachshund" type. The shortening of limbs with retraction of the nasal region of the face—pug-face or prosopia we may call the condition—has a very direct interest for anthropologists, seeing that short limbs and a long trunk are well-recognised racial characteristics of the Mongol. In the second kind of dwarfism, which we have reason to regard as due to a functional defect of the thyroid, the Mongolian traits are so apparent that the sufferers from this disorder are known to medical men as "Mongolian idiots"—for not only is their growth stunted, but their brains also act in a peculiar and aberrant manner. Dr. Langdon Down, who gave the subjects of this peculiar disorder the name "Mongolian idiots" fifty-five years ago, knew nothing of the modern doctrine of internal secretions, but that doctrine has been applied in recent years by Dr. F. G. Crookshank ("The Universal Medical Record," vol. iii., p. 12, 1913) to explain the features and condition of Mongoloid imbecile children. Some years ago (*Journ. of Anat. and Physiol.*, 1913) I brought forward evidence to show that we could best explain the various forms of anthropoid apes by applying the modern doctrine of a growth-controlling glandular mechanism. In the gorilla we see the effects of a predominance of the pituitary elements; in the orang, of the thyroid. The late Prof. Klaatsch tried to account for the superficial resemblances between the Malay and the orang by postulating a genetic relationship between them; for a similar reason he derived the Negro type from a gorilline ancestry. Occasionally we see a man or woman of supposedly pure European ancestry displaying definite Mongoloid traits in their features. We have been in the habit of accounting for such manifestations by the theory, at one time very popular, that a Mongoloid race had at one time spread over Europe, and that Mongoloid traits were atavistic recurrences. An examination of the human remains of ancient Europe yields no evidence in support of a Turanian or Mongol invasion of Europe

All these manifestations to which I have been directing your attention—the sporadic manifestation of Mongoloid characters in diseased children and in healthy adult Europeans, the generic characters which separate one kind of ape from another, the bodily and mental features which mark the various races of mankind—are best explained by the theory I am supporting, namely, that the conformation of man and ape and of every vertebrate animal is determined by a common growth-controlling mechanism which is resident in a system of small but complex glandular organs. We must now look somewhat more closely into the manner in which this growth-regulating mechanism actually works. That we can do best by taking a glimpse of a research carried out by Bayliss and Starling in the opening years of the present century. They were seeking to explain why it was that the pancreas poured out its digestive juice as soon as the contents of the stomach commenced to pass into the first part of the duodenum. It was then known that if acid was applied to the lining epithelial membrane of the duodenum, the pancreas commenced to work; it was known also that the message which set the pancreas into operation was not conveyed from the duodenum to the pancreas by nerves, for when they were cut the mechanism was still effective. Bayliss and Starling solved the puzzle by making an emulsion from the acid-soaked lining epithelium of the duodenum and injecting the extract of that emulsion into the circulating blood. The result was that the pancreas was immediately thrown into activity. The particular substance which was thus set circulating in the blood and acted on the pancreas, and on the pancreas alone, and thus served as a messenger or hormone, they named secretin. They not only cleared up the mechanism of pancreatic secretion, but at the same time made a discovery of much greater importance. They had discovered a new method whereby one part of the human body could communicate with and control another. Up to that time we had been like an outlandish visitor to a strange city, who believed that the visible telegraph or telephone wires were the only means of communication between its inhabitants. We believed that it was only by nerve-fibres that intercommunication was established in the animal body. Bayliss and Starling showed that there was a postal system. Missives posted in the general circulation were duly delivered at their destinations. The manner in which they reached the right address is of particular importance for us; we must suppose that the missive or hormone circulating in the blood and the recipient for which they are intended have a special attraction or affinity for each other—one due to their physical constitution—and hence they, and only they, come together as the blood circulates round the body. Secretin is a hormone which effects its errand rapidly and immediately, whereas the growth or morphogenetic hormones, thrown into the circulation by the pituitary, pineal, thyroid, suprarenal, and genital glands, act slowly and remotely. But both are alike in this: the result depends not only on the nature of the hormone or missive, but also on the state of the local recipient. The local recipient may be specially greedy, as it were, and seize more than a fair share of the manna in circulation, or it may have "sticky fingers" and seize what is not really intended for local consumption. We can see that local growth—the development of a particular trait or feature—is dependent not only on the hormones supplied to that part, but also on the condition of the receptive mechanism of the part. Hence we can understand a local derangement of growth—an acromegaly or giantism confined to a finger or to the eyebrow ridges, to the nose, to one side of the face, and such local manifestations are not uncommon. It is by a variation in the sensitiveness of the local recipient that we have an explanation of the endless variety to be found in the relative development of racial and individual features.

Some ten years after Starling had formulated the theory of hormones, Prof. W. B. Cannon, of Harvard University, piercing together the results of researches by Dr. T. R. Elliott and by himself on the action of the suprarenal glands, brought to light a very wonderful hormone mechanism—one which helps us in interpreting the action of growth-regulating hormones. When we are about to make a severe bodily effort it is necessary to flood our muscles with blood, so that they may have at their disposal the materials necessary for work—oxygen and blood-sugar, the fuel of muscular engines. At the beginning of a muscular effort the suprarenal glands are set going by messages passing to them from the central nervous system; they throw a hormone—adrenalin—into the circulating blood, which has a double effect; adrenalin acts on the flood-gates of the circulation, so that the major supply of blood passes to the muscles. At the same time it so acts on the liver that the blood circulating through that great organ becomes laden with blood-sugar. We here obtain a glimpse of the neat and effective manner in which hormones are utilised in the economy of the living body. From that glimpse we seem to obtain a clue to that remarkable disorder of growth in the human body known as acromegaly. It is a pathological manifestation of an adaptational mechanism with which we are all familiar. Nothing is better known to us than that our bodies respond to the burden they are made to bear. Our muscles increase in size and strength the more we use them; increase in the size of our muscles would be useless unless our bones also were strengthened to a corresponding degree. A greater blood supply is required to feed them, and hence the power of the heart has to be augmented; more oxygen is needed for their consumption, and hence the lung capacity has to be increased; more fuel is required—hence the whole digestive and assimilative systems have to undergo a hypertrophy, including the apparatus of mastication. Such a power of co-ordinated response on the part of all the organs of the body to meet the needs of athletic training presupposes a co-ordinating mechanism. We have always regarded such a power of response as an inherent property of the living body, but in the light of our growing knowledge it is clear that we are here dealing with an hormonic mechanism, one in which the pituitary gland is primarily concerned. When we study the structural changes which take place in the first phase of acromegaly (see Keith, *Lancet*, ii., p. 993, 1911; i., p. 305, 1913), we find that not only are the bones enlarged and overgrown in a peculiar way, but also the muscles, the heart, the lungs, the organs of digestion, particularly the jaws; hence the marked changes in the face, for the form of the face is determined by the development of the upper and lower jaws. The rational interpretation of acromegaly is that it is a pathological disorder of the mechanism of adaptational response; in the healthy body the pituitary is throwing into the circulation just a sufficiency of a growth-regulating substance to sensitise muscles, bones, and other structures to give a normal response to the burden thrown on the body. But in acromegaly the body is so flooded with this substance that its tissues become hypersensitive and respond by overgrowth to efforts and movements of the slightest degree. It is not too much to expect, when we see how the body and features become transformed at the onset of acromegaly, that a fuller knowledge of these growth-mechanisms will give us a clue to the principles of race differentiation.

There must be many other mechanisms regulated by hormones with which we are as yet totally unacquainted. I will cite only one instance—that concerned in regulating the temperature of the body. We know that the thyroid and also the suprarenal glands are concerned in this mechanism; they have also to do with the deposition and absorption of pigment in the skin, which must be part of the heat-regulating mechanism. It is along such a path of inquiry that we expect to discover a clue to the question of race colour.

This is not the first occasion on which the doctrine of hormones has been applied to biological problems at the British Association. In his presidential address to the Zoological Section at Sheffield in 1910 Prof. G. C. Bourne applied the theory to the problems of evolution; its bearing was examined in more detail in an address to the same section by Prof. Arthur Dendy during the meeting at Portsmouth in 1911. At the meeting of the association at Newcastle in 1916 Prof. MacBride devoted part of his address to the morphogenetic bearings of hormones. Very soon after Starling formulated the hormone theory, Dr. J. T. Cunningham applied it to explain the phenomena of heredity (Proc. Zool. Soc. London, p. 434, 1908). Nay, rightly conceived, Darwin's theory of pan-genesis is very much of the same character as the modern theory of hormones.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. G. H. F. Nuttall, Quick professor of biology, has received from Mr. P. A. Molteno, of Trinity College, a letter dated October 23 desiring to present to the University a sum of 20,000*l.* to provide suitable buildings and fittings for an institute for research in parasitology, and a further sum of 10,000*l.* to provide an income for the upkeep and maintenance of the institute. Plans have been drawn up by Mr. Harry Redfern for the erection of this institute on the Downing site.

The special lectures by Sir J. J. Thomson on positive rays, and by Prof. Eddington on the theory of relativity and gravitation, have been postponed until the Lent term.

The recommendations of the General Board of Studies on (*a*) a proposed readership in geography, (*b*) a proposed readership in agricultural physiology, and (*c*) a proposed readership in estate management have been passed by the Senate.

The University is full to overflowing, and the difficulty of obtaining accommodation has been met only partially by extending the limits to a 2½-mile radius from Great St. Mary's Church. Practically all the colleges are strictly limiting their numbers. One of the most striking characteristics of the post-war population is the enormous increase in the numbers of men pursuing the study of natural, economic, and mechanical sciences. For example, the engineering school has now between 600 and 700 students; in the chemistry school between 1100 and 1200 names have been entered for lectures and nearly 1000 for practical work; while, instead of the 100 expected, some 240 students attended the elementary class in physiology. The difficulties of accommodation are severe now, but next year and the year after, when these students have passed the elementary stage and require more elaborate equipment and teaching, the situation will be almost impossible unless steps are taken to increase the laboratory accommodation and teaching resources. The difficulty in doing so is partly that of building—though, fortunately, the building strike has just been settled—and partly that of providing the funds required for construction, equipment, and *personnel*. Some help in this direction may be expected from the State, but the State will not be able to replace the private benefactor in assisting the University in its present exceptional opportunity of promoting the teaching of and research in science.

OXFORD.—The question of admitting women to matriculation and degrees has entered upon a new phase. It had been intended to seek Parliamentary sanction for the framing by the University of provisions for the removal of the academic disabilities of women. It now appears that, by the unsolicited action of the House of Commons itself, the way will be opened for the admission of women to matriculation and degrees without any special appeal to Parliament for the purpose. Legislation with this object will probably be undertaken in the near future.

Col. Thomas E. Lawrence, a leading authority on the topography, ethnology, and languages of Arabia and Mesopotamia, distinguished also for his political and military services in the late Arabian anti-Turkish campaign, has been elected to a research fellowship at All Souls College.

In Congregation on November 11, the statute making Greek optional in Responsions, which was thrown out by Convocation in June last, was reintroduced with a fresh preamble, under which it will be possible for amendments to be moved limiting the exemption from compulsory Greek to candidates for honours in science or mathematics, and to candidates for a pass degree. The preamble, after speeches by Mr. Barker, of New College, and Prof. Gilbert Murray, passed without a division.

DR. J. H. GRINDLEY, of Cork, has been appointed principal of the Dudley Technical College.

DR. ALEX HILL is resigning the principalship of University College, Southampton, in order to devote his full activities to the Universities Bureau, of which he is secretary.

MISS M. E. LAING has been appointed research assistant in physical chemistry in connection with the Leverhulme chair of physical chemistry at the University of Bristol.

A READER in estate management is shortly to be appointed by the General Board of Studies of the University of Cambridge at an annual stipend of 500*l*. Applications for the post must be sent to the Vice-Chancellor on or before November 30.

APPLICATIONS are invited by the Senate of the University of London for the Keddey Fletcher-Warr studentships for the promotion of post-graduate research. The studentships are open to men and women, tenable for three years, and of the annual value of not less than 200*l*. Applications must be received by the Academic Registrar of the University of London, South Kensington, S.W.7, not later than December 31 next.

A SERIES of free public lectures has been arranged for delivery in the botanical lecture-room of the University of Glasgow during the winter session, 1919–20, at 8.30 p.m., on the second Monday of each month from November to March inclusive. The list of lectures, including that by Prof. C. H. Desch, on November 10, on "The Growth of Crystals," is as follows:—On December 8, "Scotland and France," Prof. R. S. Rait; on January 12, "The Language of the Poilus"; on February 9, "The Beginnings of Geography," Prof. J. W. Gregory; and on March 8, "Finance and Reconstruction," Prof. W. R. Scott.

PROF. JOHN COX will resume on Monday next, at 6.30 p.m., the course of lectures on modern scientific discoveries and their practical application to life and industry at Gresham College, Basinghall Street, E.C.2, by a lecture on "Oerstedt and the Telegraph." These lectures are given mainly with the view of enforcing the need that applied science is necessary, not only for the commercial prosperity of any modern community, but also for its very existence. Other lectures in the course deal with long-distance telephony, the motor and dynamo, the nature of light, streamlines and aeroplanes, sound-ranging, directional wireless, listening under water, radio-activity, etc.

THE annual general meeting of the Science Masters' Association will be held at the London Day Training College, Southampton Row, W.C.1, on Tuesday and Wednesday, January 6 and 7, 1920, under the presidency of Mr. W. W. Vaughan, master of Wellington College. Among the subjects to be discussed are:—The Teaching of Organic Chemistry; Biology in the School Science Syllabus; Laboratory Management—(*a*) Training of Assistants and (*b*) Cost of Apparatus; Science Teaching in the Early Stages—(*a*) Science in the Preparatory School and in Common Entrance and Entrance Scholarship Examinations for Public Schools, and (*b*) Teaching Junior Forms; and The Divorce of Laboratory and Class-room Courses.

A CONFERENCE of representative men and women which met at the Bedford College for Women (University of London) on November 5 unanimously decided on carrying out an extension which will involve an appeal to the public for funds. In order to organise the appeal, an executive committee has been appointed, of which Col. Sir Hildred Carlile, Bart., M.P., is chairman and Viscountess Elveden hon. treasurer. The college, built to accommodate 400 students, now has 550. The proportion of science students has greatly increased, and is now one-third of the total number. In the chemistry department the students number 130, and the working places are only forty-six. In the matter of residence the same difficulties occur; despite the addition of three new hostels, there remains this term a long waiting list of students wishing to come into residence. It is hoped that the appeal will enable the college to make provision for the increased demands made upon it by the attention now given to higher education for women.

SOCIETIES AND ACADEMIES.

London.

Zoological Society, October 21.—Prof. E. W. MacBride, vice-president, in the chair.—E. G. **Boulenger**: Report on the research experiments on methods of rat destruction carried out at the society's gardens.—Dr. A. Smith **Woodward**: The zoological position and affinities of Tarsius.

Paris.

Academy of Sciences, October 13.—M. Léon Guignard in the chair.—C. **Moureu** and C. **Dufraisse**: The stabilisation of acrolein. The methods of spontaneous alteration of acrolein. The spontaneous transformation into disacryl, the soluble resin, appears to be a modification undergone by pure acrolein. Acrolein purified with the greatest care always underwent this spontaneous condensation on standing. The speed of transformation can be modified by light, high temperature, and the presence of impurities.—R. **Bourgeois**: A collection of paintings of clouds.—M. **Leblanc**: Very rapid rotations.—P. **Boutroux**: A family of multiform functions, integrals of a differential equation of the first order.—J. **Andrade**: The weighing of a friction during the relative sliding of two solids in contact.—E. **Belot**: The movement of translation of a gaseous vortex ring in a resisting medium.—H. **Vanderlinden**. The ephemeris of the Borrelly comet, 1919*c*.—G. **Sagnac**: The absolute mechanics of waves and the Newtonian relativity of energy.—Q. **Majorana**: Gravitation.—G. **Claude**: The industrial employment of extremely high pressures. In compressing gases to pressures of 1000 atmospheres, no difficulties may be expected to arise in the pumps of the compressors or in the receivers, which can easily be made of sufficient strength to give security. The real difficulty will arise in the connections, which must be absolutely tight if serious losses are to be avoided. The author has constructed apparatus which, after charging with gas compressed to 1000 atmospheres and immersing in water, allowed no bubbles of gas to escape.—A. **Bolland**: Microchemical reactions of thiosulphuric acid.—V. **Cremieu** and A. **Lepape**: The separation by solidification of pure carbon dioxide from a gaseous mixture. Starting with a mixture containing 95 per cent. of carbon dioxide, cooling to −80° C., and compressing slightly, the solid carbon dioxide precipitated is chemically pure.—J. **Guyot** and L. J. **Simon**: The action of concentrated sulphuric acid on methyl alcohol.—J. **Révil** and P. **Combaz**: The age and the conditions of formation of the lignites of Voglans in the Chambéry region. A discussion and criticism of the views recently put forward by M. Corceix.—I. **Barthoux**: Succession of old eruptive rocks in the Arabian Desert.—J. **Pellegrin**: New contribution to the ichthyological fauna of Lake Tchad.—F. **Ladreyt**: The complex symbiotic cell.—J. **Amar**: Respiration in confined air.—F. **Bordas**: The preparation and conservation of sera and vaccines by drying in an absolute vacuum. The vaccines are dried in a high vacuum and the water-vapour evolved is removed by freezing. After drying, the tube is sealed and the vaccine thus removed from the action of both water and oxygen. The activity of such preparations can be preserved for several years.

October 20.—M. Léon Guignard in the chair.—M. **Henneguy**: An account of the work of the late Gustav Retzius.—G. **Bigourdan**: A project of uranographic classification, completing other classifications in present use.—A. **Blondel**: The characteristics of oscillation of lamps with three electrodes, utilised as generators of sustained oscillations.—M. **de Chardonnet**: Remark on a communication of Gen. Bourgeois. The use of autochrome plates instead of hand-paintings for clouds is suggested as being more practical. As regards the question of the stability of the images, some coloured photographs of the sky taken ten years ago, now presented to the Academy, are still in a good state of preservation.—M. **Petrovitch**: Definite integrals, of which the decimal part is expressed with the aid of prime numbers.—G. **Kolossoff**: The movement of a solid in an indefinite liquid.—A. **Foch**: The resonance of water-mains provided with an air-chamber.—A. **Bichet**: A system of aiming at objects in the air. Suggestions for a new means of mounting telescopes, searchlights, and guns for improving the aim at moving objects in the air.—G. **Chavanne**, L. P. **Clerc**, and L. J. **Simon**: Analyses of German aviation petrols. The results given were obtained by a combination of careful fractional distillation with the measurement of the critical solution temperature of the fractions in aniline, details of which have been given in earlier communications. Twenty specimens were examined, the composition of which averaged 10 per cent. aromatic hydrocarbons, 40 per cent. saturated cyclic hydrocarbons, and 50 per cent. paraffins. The deviations of the separate specimens from the average were very small.—P. **Robin**: The peroxide of benzaldoxime. A study of the decomposition by prolonged boiling in benzene solution, and of the prolonged oxidation with iodine and sodium carbonate.—J. **Barthoux**: Cretacean volcanic rocks of Egypt and Sinai.—G. B. M. **Flamand**: The discovery of a lens of coal at Port-Gueydon. Two analyses are given, together with reasons for supposing that this deposit really belongs to the Coal Measures.—M. **Bezagu**: Variations of the respiration of leaf-cells with age.—A. **Sartory**: A new fungus of the genus Scopulariopsis isolated from a case of onychomycosis.

BOOKS RECEIVED.

The Philosophy of Conflict, and Other Essays in War-time. By H. Ellis. Second series. Pp. 299. (London: Constable and Co., Ltd.) 6*s.* 6*d.* net.

Organic Chemistry for Students of Medicine. By Prof. J. Walker. Second edition. Pp. xi+332. (London: Gurney and Jackson.) 10*s.* 6*d.* net.

Essays in Common Sense Philosophy. By C. E. M. Joad. Pp. 252. (London: The Swarthmore Press, Ltd.) 8*s.* 6*d.* net.

The Struggle in the Air, 1914–1918. By Major C. C. Turner. Pp. viii+288. (London: E. Arnold.) 15*s.* net.

Iron Bacteria. By Dr. D. Ellis. Pp. xix+179+v plates. (London: Methuen and Co., Ltd.) 10*s.* 6*d.* net.

The Venereal Problem. By E. T. Burke. Pp. 208. (London: H. Kimpton.) 7*s.* 6*d.* net.

Some Wonders of Matter. By the Right Rev. J. E. Mercer. Pp. 195. (London: S.P.C.K.) 5*s.* net.

Joseph Dalton Hooker. By Prof. F. O. Bower. Pp. 62. (London: S.P.C.K.) 2*s.* net.

Herschel. By the Rev. H. Macpherson. Pp. 78. (London: S.P.C.K.) 2*s.* net.

The Profession of Chemistry. By R. B. Pilcher. Pp. xiv+199. (London: Constable and Co., Ltd.) 6*s.* 6*d.* net.

Cambridge University Calendar for the Year 1919–1920. Pp. xxvi+1125. (Cambridge: At the University Press.) 15s. net.

Notes on Magnetism: For the Use of Students of Electrical Engineering. By C. G. Lamb. Pp. viii+94. (Cambridge: At the University Press.) 5s. net.

A Text-book of Quantitative Chemical Analysis. By Dr. A. C. Cumming and Dr. S. A. Kay. Third edition. Pp. xv+416. (London: Gurney and Jackson.) 12s. 6d. net.

Just Look! or, How the Children Studied Nature. By L. B. Thompson. Pp. viii+204+58 plates. (London: Gay and Hancock, Ltd.) 5s. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 13.

ROYAL SOCIETY, at 4.30.—Lt.-Col. R. McCarrison: The Genesis of Œdema in Beriberi.—W. Robinson: The Microscopical Features of Mechanical Strains in Timber and the Bearing of these on the Structure of the Cell-wall in Plants.—W. B. Bottomley: The Effect of Nitrogen-fixing Organisms and Nucleic Acid Derivatives on Plant Growth.—Agnes Arber: The Vegetative Morphology of *Pistia* and the Lemnaceæ.—W. J. Young, A. Breinl, J. J. Harris, and W. A. Osborne: Effects of Exercise and Humid Heat upon Pulse Rate, Blood Pressure, Body Temperature, and Blood Concentration.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. E. G. Browne: The Origins and Development of Arabian Medicine: II. Four Great Medical Writers of Persia (IX.-XI. Cent.). (FitzPatrick Lecture.)

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.—H. Curtis: Three Cases of Malignant Disease of the Face illustrating Modern Methods of Radical Operation.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Roger T. Smith: Presidential Inaugural Address.

OPTICAL SOCIETY, at 7.30.—Miss L. M. Gillman: The Chromatic Variation of Spherical Aberration in Cemented Doublets.—Instructor-Commander T. Y. Baker: The Correction of First Order Astigmatism of a Single Lens used with a Stop.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—P. Sargent: Lessons of the War applied to Spinal Surgery.

FRIDAY, NOVEMBER 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. S. Franks: Micrometrical Measures of Double Stars, List VII.—F. Strömgren: A New Class of Periodic Solutions in the General Problem of Three Bodies.—J. Evershed: (1) Is Venus Cloud-covered? (2) The Solar Prominence of 1919, May 29.—J. Halm: Statistical Investigation of the Distribution of the Stars and their Magnitudes.—H. H. Turner and Mary A. Blagg: The Long-period Variable W Cygni.—N. Liapin: A Method of Determining the Mean Accidental Variation in Daily Rate of a Number of Chronometers.—H. Bell: A Proposal to Construct New Tables for Finding Position-lines at Sea.—The following Paper is promised:—Royal Observatory, Greenwich: Corona and Prominences at the Eclipse of 1919 May 29.

PHYSICAL SOCIETY, at 5.—S. Butterworth: The Self-Inductance of Single Layer Flat Coils.—Dr. N. W. McLachlan: An Experimental Method of Determining the Primary Current at Break in a Magneto.—F. W. Newman: Note on a Modified Form of Wehnelt's Interrupter. (With Demonstration.)

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.—G. C. Robson: Studies in British Hydrobiidæ, Part I.—H. C. Fulton: Description of a New Sub-species of *Papuina tayloriana*, Ad. & Rve.—J. E. Cooper: Additions to a List of Recent Middlesex Mollusca.

SATURDAY, NOVEMBER 15.

PHYSIOLOGICAL SOCIETY (at London School of Medicine for Women), at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—W. E. Warrilow and others: Discussion on Engineering Advertising.

SURVEYORS' INSTITUTION (Junior Meeting), at 7.

MONDAY, NOVEMBER 17.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—W. R. Davidge: The Problems of London Housing.

ROYAL GEOGRAPHICAL SOCIETY (at the Æolian Hall), at 8.30.—Sir Alfred Sharpe: A Recent Journey in Liberia.

TUESDAY, NOVEMBER 18.

ROYAL HORTICULTURAL SOCIETY (at Vincent Square, S.W. 1), at 3.—C. H. Senn: Potato Possibilities.

ROYAL SOCIETY OF MEDICINE, General Meeting of Fellows, at 5.

ROYAL STATISTICAL SOCIETY, at 5.15.—E. H. Godfrey: Fifty Years of Canadian Progress, 1867–1917.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—M. F. Wilson: Admiralty Harbour, Dover

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Rear-Admiral (Retd.) P. Dumas: The Conservation of Oil.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir Edmund Giles Loder, Bt.: Exhibition of the Skull of a Beaver.—Major J. S. Hamilton: Field-Notes on some Mammals in the Bahr el Gebel, Southern Sudan.—Dr. J. F. Gemmill: (1) The Development of the Mesenteries in *Urticina crassicornis* (Actinozoa). (2) The Leptomedusan *Melicertidium octocostatum*.—M. Turner: The Nematode Parasites of a Chapman's Zebra.—Rev. A. H. Cooke: The Radula of the Mitridæ.—Lt.-Col. S. Monckton Copeman: Experiments on Sex Determination.—Dr. C. F. Sonntag: The Variations in the Digastric Muscle of the Rhesus Macaque and the Common Macaque.—E. S. Russell: Note on the Righting Reaction in *Asterina gibbosa*, Penn.

WEDNESDAY, NOVEMBER 19.

ROYAL UNITED SERVICE INSTITUTION, at 3.—D. Ogg: German Naval Propaganda.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir H. Trueman Wood: Science and Industry.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Lieut. C. W. B. Normand: Effect of High Temperature, Humidity, and Wind on the Human Body.—Capt. A. J. Bamford: Some Observations of the Upper Air over Palestine.—E. G. Bilham: Barometric Pressure and Underground Water Level.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. J. E. Marr: The Pleistocene Deposits in the Neighbourhood of Cambridge.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Sectional Meeting) (at Institution of Civil Engineers), at 6.—Prof. C. L. Fortescue: The Design of Multiple Stage Amplifiers using Three Electrode Thermionic Valves.

ROYAL MICROSCOPICAL SOCIETY, at 8.—H. M. Carleton: Note on Cajal's Formalin-silver Nitrate Impregnation Method for the Golgi Apparatus.—F. I. G. Rawlins: Report on the Collection of Metallurgical Specimens recently presented to the Society by Sir Robert Hadfield, Bart., F.R.S.

THURSDAY, NOVEMBER 20.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* W. J. Johnston: A Linear Associative Algebra suitable for Electro-magnetic Relations and the Theory of Relativity.—Sir Joseph Larmor: Note on Mr. W. J. Johnston's Calculus for Generalised Relativity.—G. E. Bairstow: The Variation with Frequency of the Conductivity and Dielectric Constant of Dielectrics for High Frequency Oscillations.—F. J. W Whipple: Equal Parallel Cylindrical Conductors in Electrical Problems.—G. A. Schott: The Scattering of X- and Y-Rays by Rings of Electrons. A Crucial Test of the Electron Ring Theory of Atoms.

LINNEAN SOCIETY, at 5.—T. K. Patten: Plants collected in Mesopotamia and in Southern India.—C. C. Lacaita: *Orchis maculata* from Monte Gargano.—Dr. G. C. Druce: Two New British Plants.—Miss Trower: Paintings of British *Rubi*.—Prof. R. C. McLean: Sex and Soma.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—H. L. Sulman: A Contribution to the Study of Flotation.

CHEMICAL SOCIETY (and Informal Meeting), at 8.

FRIDAY, NOVEMBER 21.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—C. G. Conradi: The Present Position of Mechanical Road Traction.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—A. P. Trotter: Opening Address.

CONTENTS PAGE

The Turks of Central Asia. By Sir Henry H. Howorth, K.C.I.E., F.R.S. . . . 273
The Living Plant. By A. W. H. . . . 274
Our Bookshelf . . . 275
Letters to the Editor:—
Scattering of Light by Resonating Molecules.—Right Hon. Lord Rayleigh, F.R.S. . . . 276
Vertical-pipe Irrigation for Orchards and Market-gardens in Arid Climates.—Prof. Italo Giglioli . 276
New Sources of Aluminium.—Major J. E. Bacon . 277
Radiation Temperature: Dew.—Sidney Skinner . 277
Surface-Tension.—C. T. Whitmell . . . 278
Exceptional Dryness of October, 1919.—W. D. Christmas . . . 278
Sound Ranging. (*Illustrated.*) . . . 278
Results of the Total Solar Eclipse of May 29 and the Relativity Theory. By Dr. A. C. D. Crommelin 280
The Jubilee of "Nature": Congratulatory Messages 281
Notes . . . 295
Our Astronomical Column:—
The Leonid Meteors . . . 299
The Group of Helium Stars in Orion . . . 299
The Secular Acceleration of the Moon . . . 299
The Glass Research Association. By Edward Meigh 299
The Tobacco Beetle . . . 301
The British Association at Bournemouth:—
Section H—Anthropology—Opening Address by Prof. Arthur Keith, M.D., LL.D., F.R.S., President of the Section . . . 301
University and Educational Intelligence . . . 305
Societies and Academies . . . 307
Books Received . . . 307
Diary of Societies . . . 308

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THURSDAY, NOVEMBER 20, 1919.

VERTEBRATE EMBRYOLOGY.

Text-book of Embryology. Vol. xi. *Vertebrata with the Exception of Mammalia.* By Prof. J. Graham Kerr. Pp. xii+591. (London: Macmillan and Co., Ltd., 1919.) Price 31*s.* 6*d.* net.

THE second volume of this important text-book of embryology deals with all the vertebrate groups with the exception of the mammalia. It is unnecessary to say that a more highly qualified authority than Prof. Graham Kerr to expound the many intricate problems of the subject could not be found, but what does impress the reader is the clear insight into the depths of these problems that the author has gained by his own detailed and important original investigations.

It is not surprising to find that, in this comprehensive treatise, the archaic but unfortunately inaccessible mud-fish—Lepidosiren—plays a predominant *rôle*, and that our old friends of the embryological laboratory—the chick and the tadpole—are relegated to minor parts; but Prof. Kerr convinces us that this is as it should be.

The highly specialised vertebrates that we can get in abundance for our class work are not the best types in which to search for the clues to the solution of the many problems of vertebrate embryology. It is rather in the more archaic forms with larger histological elements and a primitive anatomical structure—such as the Dipnoi, the Ganoidei, and the Urodela—that the embryologist has found by experience that he obtains his most satisfactory results.

The need for a text-book of this description which deals fully with the fundamental problems of embryology, as distinct from a text-book that deals only with the development of a few selected types, has long been felt, and a brief reference to one or two of these problems may be given to indicate the manner in which the author expounds them in the light of modern embryological research.

There has been no more highly controversial problem in embryology than the question of the origin of the nerves from the central nervous system. Prof. Kerr describes in some detail the result of his own researches on the development of the motor nerves of Lepidosiren, and gives a critical summary of the theories of His, Balfour, and Hensen. His own opinion is finally expressed and may be very briefly indicated by the following sentence (p. 111): "It is suggested that the development of the actual nerve fibril is simply the gradual coming into view of a pathway produced by the repeated passage of nerve impulses over a given route."

The origin of the paired appendages of vertebrata is another of these debated problems on which distinguished morphologists have held very divergent views. Here, again, the author sets before the student the "branchial theory" associated with the name of Gegenbaur, and the continuous "lateral fin" theory which was supported by Balfour, before expounding his own views in what he calls the "external gill hypothesis." This hypothesis is based on the supposition that the external gills extended further back than they do in any living vertebrate, and that, being potential organs of support, and also potential organs of movement, as indicated by their flicking movements in some existent larvæ, they became transformed into purely locomotive and supporting paired appendages. The limb girdle on this hypothesis is a modified branchial arch skeleton, shifted backwards as in the theory of Gegenbaur.

With the lateral fin theory already so well established in this country, it is not likely that Prof. Kerr will find his views in this matter generally accepted, but there is so much that is interesting and ingenious in the way in which his hypothesis is expounded that the student must benefit by its careful consideration. There are many other problems of absorbing interest, to which space does not permit us to refer, discussed in the spirit of just consideration of the views of previous writers, and a clear expression of the author's own opinion. This is the feature which commends the volume most strongly to the student who is capable of appreciating something more than a plain statement of the facts that have been discovered.

But a word of high praise must also be given for those parts of the work that are purely descriptive. It is always a difficult matter to condense into the allotted space the main results of exhaustive researches, but Prof. Kerr has accomplished this part of the task with great skill and judgment. In some cases, perhaps, a little more expansion would have been advisable. For example, in the chapter on the development of the brain a fuller explanation, with a figure, of what is meant by the term "Archipallium" would be most useful, or, again, in the description of the development of the vertebral column of Sphenodon, in which the student, puzzled by the myotomes being opposite to the protovertebræ in Fig. 152 C, but alternate with them in Fig. 152 B, will find no key to the puzzle in the text. But minor criticisms such as these seem out of place in reviewing a book which has so many merits.

We are glad to find that in writing this text-book Prof. Kerr has not withheld from us the fruits of his ripe experience as a teacher and investigator, for we find in chap. x. a most excellent general account of the development of the chick, illustrated by many good figures, and accompanied by practical instruction in laboratory methods. This chapter will prove to be of great value to the beginner and to his teachers. Moreover, in the last two chapters we are given most interesting and useful comments on the practical study of the embryology of the lower vertebrata and on the guiding principles of embryological research. Prof. Kerr has rendered a great service to scientific students by the publication of this volume, a volume which undoubtedly will take a high rank among modern text-books of zoological science. It is something better than a mere text-book of embryology, as it deals very fully with many of the most important principles of biological philosophy, and will prove very useful as a guide for practical research work in other branches of zoological science. S. J. H.

THE RARER ELEMENTS.

(1) *The Analysis of Minerals and Ores of the Rarer Elements for Analytical Chemists, Metallurgists, and Advanced Students.* By Dr. W. R. Schoeller and A. R. Powell. (Griffin's Scientific Text-books.) Pp. x+239. (London: Charles Griffin and Co., Ltd., 1919.) Price 16s. net.

(2) *The Metals of the Rare Earths.* By Dr. James Frederick Spencer. (Monographs on Inorganic and Physical Chemistry.) Pp. x+279. (London: Longmans, Green, and Co., 1919.) Price 12*s.* 6*d.* net.

THE two volumes before us, taken together, form a very complete treatise on the rarer elements, their occurrence, properties, and the methods for their separation. Although they overlap in some measure, each contains much information of the highest importance at the present day.

The practical value of many of the rarer elements has recently been brought into prominence, and it is becoming increasingly plain that, locked up in these little-known minerals widely distributed over the earth's surface, there are elements possessing properties of hitherto unrealised value and importance.

Radium has shaken the old conceptions in chemistry and physics to their very foundations. Uranium, tungsten, tantalum, molybdenum have given us steels which have profoundly influenced the engineering trades and the production of artillery. Thorium and cerium have preserved the gas industry as a means of illumination. Cerium and the rare earth metals rendered us almost independent of the lucifer match. These are but a few indications of the potential value of the rarer elements.

(1) This volume, which naturally comes first, deals exhaustively with the minerals from which the rarer elements are derived, and gives very clear and practical instructions for their recognition, and the properties, chemical reactions, and method for separating the elements. The design of the work is distinctly original, and the authors have included as much trustworthy information about each element as is available at the present time, together with descriptions of the spectroscopic, magnetic, electroscopic, and other apparatus used in research. It is abundantly clear that they have a very practical acquaintance with their subject; novel chemical and physical reactions are given that are apparently taken direct from the laboratory note-books.

The elements are taken in the order of their groups in the periodic system, and the text is arranged under two headings—"General Information," which includes spectroscopic and other physical reactions; and "Mineral Analysis," including qualitative and quantitative estimations and chemical reactions.

There is no general index, but in its place two lists are produced, one giving the names of nearly two hundred minerals containing rare elements, and the other the various methods for separating them from the bodies most frequently accompanying them.

A table of atomic weights and gravimetric factors is included.

(2) The title of this volume strikes one as a little inappropriate, for the metallic properties of the rare earth elements are those about which least is known, but the author is to be congratulated upon having collected together the essential details of all that is known in the domain of the "Rare Earths."

This field has a fascination of its own, quite apart from any utilitarian considerations; that is only realised by those who have worked in it; so great is that fascination that it has claimed the best energy of some of the most honoured men of science. Berzelius, Nilson, Clevé, Lecoq de Boisbaudran, Delafountain, Moissan, Crookes, Urbain are only a few that have fallen under the spell of the "Rare Earths." The work, hitherto exceedingly difficult on account of the rarity of the minerals needed, has been greatly facilitated by the development of the "mantle" industry, because in the extraction of the very large quantities of thorium and cerium needed for that purpose, all the members of the rare earth group are thrown out as by-products, and can be procured with comparative ease.

The substantial monograph under notice is an advance upon any of the excellent works that have recently appeared on the subject. The most remarkable feature in the volume is the great number of references to authorities that are given; these number as many as 1029, and will be found of very great value to the student, enabling him easily to consult the original memoir.

The author's remarks, though good, are sometimes liable to be misleading; in this connection we notice that, in reviewing the work of the late Sir William Crookes on the rare earths, and the suggestion there put out as to the possible existence of "meta-elements," the author states on page 7 that Crookes, by fractional precipitation, obtained seven fractions of different basicity which had different absorption spectra, which he called meta-elements. This may be a clerical error by the use of the term "absorption" instead of "phosphorescence," for the matter is quite correctly stated on page 66.

In point of fact, Crookes's contention was that the purest yttria obtainable gave under the cathodic discharge, *in vacuo*, a discontinuous spectrum consisting in numerous more or less nebulous coloured bands, and that by fractionating this material it was possible to separate these bands forming bodies from each other, and it was to these bodies, all components of pure yttria, that he gave the name of meta-elements. This question of the cause of the discontinuous phosphorescent spectra is by no means settled, and offers a field of most interesting research.

The history and analysis of each of the chief rare earth minerals is given, and this is followed by a good description of the various methods of fractionation used for separating the closely associated members of the rare earth groups. The methods of spectroscopic analysis are given, as is also the use of the magnetometer, an instrument only recently applied to these researches.

The cerium and yttrium groups of the rare earths are each separately described, and the latest determination of the atomic weights are given, together with the methods by which they were obtained.

In the discussion of the position of the rare earths in the periodic system the author includes the elements scandium and thorium, which for various reasons are not generally considered members of the rare earth group at all. It is not difficult to find places for these, especially the former, which is undoubtedly the "ekaboron" of Mendeléeff, but the placing of the closely allied bodies of the cerium and yttrium groups remains as big a puzzle as ever.

The final chapter deals with the uses of the rare earth elements; with the exception of cerium, which is absolutely essential to the production of an efficient "mantle," these are not numerous and are comparatively recent. But enough has been said to show the importance and value of the study of the rare earths, and the author's very complete work, taken in connection with that of Messrs. Schoeller and Powell, will aid very greatly in the study of these little-known bodies from which we can confidently expect great results.

J. H. GARDINER.

RACE AND NATIONALITY.

Race and Nationality: An Inquiry into the Origin and Growth of Patriotism. By Dr. John Oakesmith. Pp. xix+300. (London: William Heinemann, 1919.) Price 10*s.* 6*d.* net.

THE thesis which Dr. John Oakesmith maintains in this work is one which concerns anthropologists as well as politicians and historians. His doctrine that the national frontiers of Europe have no racial significance is a truth so apparent that no proof needs to be adduced. Yet it is perhaps well that the fact should again be insisted on at the present time because the public mind is still influenced by the vigorous anthropological teaching of last century, wherein it was maintained that the Saxon and Celtic elements in the population of these islands were of diverse racial stocks. We agree with Dr. Oakesmith that there is no single character or set of characters in body or mind by which an anthropologist can tell an Irishman from an Englishman. The claim for Irish separation does certainly not depend on a difference of race, for both English and Irish are members of the same racial stock, and of the two the Irish are the more representative of the Nordic or North Atlantic race.

The independence of nationality and race, however, is but a minor issue in Dr. Oakesmith's main thesis. This concerns itself chiefly with an inquiry into the nature of nationality. He defines and redefines it in many passages, but the following may be taken as representing his final conclusion (p. 75): "Nationality is a conviction based upon practical realities, upon the facts of historical development, and upon the demands of human experience." This represents rather what he hopes nationality may come to mean in the future, for in the present he recognises that mixed with its rational or utilitarian qualities there are both passions and emotions. Rightly enough, he maintains that if these passions and emotions could be eliminated and only the intellectual conception of nationality left, then wars would cease, and the world would come by the peace it longs for. Such is the main thesis of this book.

Does race, then, play no part in separating and keeping apart the masses of humanity? Dr. Oakesmith seriously maintains that "to envisage race as an operating objective factor in evolution of societies is both unscientific and unphilosophical" (p. 74). He cites the case of the Jewish people in England to prove that "race is a metaphysical conception having no foundation in practical life." "With proper adjustments of education," Dr. Oakesmith solemnly asserts, "you can turn an Oriental Jew into an Occidental Englishman." In other words, were we to substitute a Jewish for a native baby in every cradle of England for a generation, English nationality would remain just what it has been since the Anglo-Saxon invasion. Or, to alter the parallel, if we were to substitute babies from China, Central Africa, or Greenland, England would stand just where she did if Dr. Oakesmith is right. It is unnecessary, in the light of experience to be gathered from every part of the world, where diverse races come in close contact, to do more than say that race, unfortunately, is much more than Dr. Oakesmith supposes it to be—a "metaphysical conception."

A. KEITH.

OUR BOOKSHELF.

Sanitation Practically Applied. By Dr. Harold Bacon Wood. Pp. vi+473. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 13*s.* 6*d.*

THE author of this volume is assistant commissioner to the West Virginia State Department of Health, and he prepared it as a "corollary to the numerous excellent treatises on the theory of hygiene and the laboratory manuals" for the use primarily of the health officer and for the student of public health topics. In the main it is intended for and will best meet the needs of the American worker and student.

Judged from the book alone, it is perfectly clear that Dr. Wood is well qualified to write upon the subject he has taken up. Although some of the subjects are dealt with sketchily enough, he gives the impression that he has had experience; that he has worked in the field; that he has kept his eyes open and knows generally what should be done and how to do it. The American health officer and student of public health topics may very safely take him as a guide. The English health worker even may find something of value in what he has to say, though he has no reference to English works and workers, and his viewpoint is purely American, and his methods, most of them, not such as are or could be applied in this country.

The book is not a large one, but Dr. Wood covers the greater part of the field of health work, dealing with such subjects as statistics; control of communicable diseases; child welfare; school hygiene; pure foods, etc.

The treatment throughout is practical, and the writing is good and attractive. The same may be said of the illustrations, of which there is a fair number. As already hinted, it is unlikely that Dr. Wood's book will have more than a limited appeal in this country, but it will probably receive a good welcome from and be found useful by health workers in the United States.

The Study of the Weather. By E. H. Chapman. (The Cambridge Nature Study Series.) Pp. xii+131. (Cambridge: At the University Press, 1919.) Price 3s. 6d. net.

THIS little book on elementary meteorology will be welcomed by the school-teacher, to whom it makes its primary appeal. Though the serious student of the science may at first feel that it has no place on his shelves, yet, should he at some time be called upon to lecture to a non-scientific audience, he will find a perusal of its pages of no small value. The matter dealt with is mainly confined to features of the weather which can readily be observed by young people without special apparatus, and it is presumably for this reason that any reference to pressure and temperature conditions in the upper air is omitted. With the foregoing rather notable exception the groundwork of meteorology is well covered. One of the chief features of the book is the series of exercises, of which more than 250 are given. These vary from some very simple questions to others which the teacher would be well advised to think out carefully before putting to his class if he wishes to avoid finding himself in an awkward position. Many of these questions are calculated to arouse a most healthy interest in the minds of the pupils. One example must suffice. "What kind of weather is it that causes the inside walls of a building to stream with moisture?"

The Cambridge University Press is to be congratulated on the clearness of the printing and the excellence of the get-up of the book. The frontispiece is particularly pleasing. Numerous illustrations and charts are included in the text.

J. S. D.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Percussion Figures in Isotropic Solids.

IN the issue of NATURE for October 9, Prof. C. V. Raman, of Calcutta, illustrated the conical fracture produced by the impact of a steel ball on a plate glass surface.

The following observations, which may be regarded as supplementary, were made by the writer some time ago with the object of finding what really happens when a glass surface is being ground, or, as it is technically termed, smoothed by an abrasive such as carborundum. Individual grains of a good abrasive have a nodular form, and the abrasion of glass appears to arise from the impact or pressure of the grains.

Two polished surfaces of glass were placed face to face with a few grains of carborundum between them, and the specimen was compared with a similar one in which steel balls of 1 mm. diameter were substituted for the carborundum. Pressure was applied uniformly over the whole surface, and while the pressure was being applied, the plates could be translated one over the other, thus producing the actual machine conditions. The observations were made by means of a polariscope. As the appearances were identical, steel balls were used throughout the later experiments, thus enabling the conditions to be better controlled.

It will be assumed that the polished appearance of glass is due to an amorphous surface layer. When the surface particles are acted upon by mechanical forces, the molecules, or possibly groups of molecules, rearrange themselves, the result being akin to the surface of a liquid. This conception was first advanced by Lord Rayleigh, and there is now a large mass of supporting evidence. When a piece of glass is worked mechanically, the surface molecules are so profoundly agitated that they are able to rearrange themselves under the action of intermolecular forces.

Fire glazing similarly consists in thermally agitating the molecules. Very small forces are sufficient to weaken the molecular cohesion by the required amount. Chemical action may produce a similar result. An optical surface may be reduced quite uniformly by the action of HF, provided the fluorides as formed are not allowed to crystallise and the bath is kept in continuous movement. When a piece of glass is fractured comparatively slowly, the forces at the edge of propagation of the fine crack must be very great, and, as before, the molecules are able to flow or rearrange themselves to form a polished surface layer. But when the fracture takes place suddenly, and almost explosively, as, for example, in the cooling of a pot of optical glass, portions of the surface may have a matt appearance to the unaided eye. This type of matt surface has been discussed very fully by M. Charles de Freminville, of Paris, who regards it as a type of multiple fracture. This explanation is more probable than the alternative one that the time of fracture is too small to permit of viscous flow.

When a steel ball is pressed lightly on the polished surface of a glass block, the appearance, when viewed between crossed Nicols, is as in the diagram (Fig. 1). The central black cone has an angle of about 20°, which remains practically independent of the pressure of the ball. The cone of strain *b, b* has an angle of about 90°. Some surface light is visible at d and d. At low pressures the dark cones c and a merge softly into b. As the pressure is increased, the interfaces become more intense and clearly defined, but the angles do not appreciably alter. The central cone proceeds from the surface first as a rod or filament of a remarkably black intensity.

Further gentle increase of pressure causes the surface layer to rupture as indicated in Fig. 2, which is

FIG. 1. FIG. 3. FIG. 4. FIG. 5. FIG. 6.

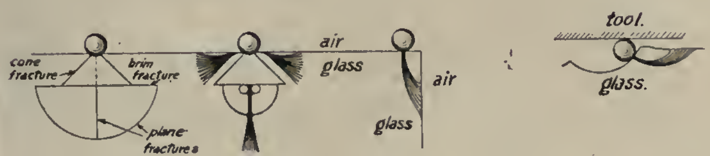


FIG. 7. FIG. 8. FIG. 9. FIG. 10.

a photograph of a surface repeatedly ruptured by gentle impact. If the Nicols are paralleled, black rays will be seen proceeding from the edge of the crack as in Fig. 3, their direction indicating that the crack is normal to the surface and merely superficial. The Fig. 1 appearance remains unaltered.

A new phenomenon makes its appearance when the pressure is again increased. Immediately under the ball there appears, as in Fig. 4, a sphere pierced by the filament of the cone a, and having a black outline tinged with red on the outside. The interior is filled with green-blue light, otherwise the general appearance of Fig. 1 remains unaltered. If now the Nicols are paralleled, the conical fracture (Fig. 5) previously illustrated by Prof. Raman will be seen, and by examination at intermediate positions of the Nicols, it will be evident that the cone fracture which takes place along the surface of b is tangential to the sphere which it encloses. The fracture can be extended up to a limit which it is difficult to exceed, even by a great increase of the rate of application of the pressure.

If the pressure is increased again, the crushing point is soon reached. The glass under the ball collapses almost explosively, a faint click being audible, and the ball sinks deeply through the surface. The cavity thus produced is lined with a snow-white layer of powdered glass.

On the polariscope at the moment of fracture several interesting developments may be observed. First, as the result probably of the greater area of pressure contact, the cone of light b broadens out laterally; secondly, the cone fracture may extend horizontally like the brim of a hat, thus definitely terminating the depth below the surface; and thirdly, the space within the cone becomes cleft by two fracture planes apparently normal to one another, and having their line of intersection on the axis of the dark cone a.

If only one diametral plane appears, the other may be developed by an increase of pressure. Sometimes the second plane is terminated at the axis, but it can always be extended across the first plane. The appearance of the fractures is now as indicated in Fig. 6. If the diametral plane fractures terminate at the base of the cone, they may be extended by pressure to the end of the rim, as in Fig. 7.

Under crossed Nicols two new coloured spheres identical with the original one may make their appearance just under the base of the cone fracture, as in Fig. 8, indicating the existence of subsidiary fractures.

But if a polished transverse section of a glass plate smoothed with carborundum is observed microscopically, it will be seen immediately that surface conchoidal fractures predominate, and that, if cone fractures do exist, they are very shallow.

In the workshop process of smoothing preparatory to polishing, the smoothing tool moves over the glass surface, but movement of the experimental plates did not alter the general characteristics outlined above, nor did the presence of water afford an explanation of the results obtained in practice.

Evidently mere pounding of a glass plate cannot result in a smoothed surface of a technical order.

As in all the previous experiments the pressure was applied at the centre of the block, where the horizontal forces were balanced, a new series was carried out near the margin of the plate. The new appearance, corresponding with the stage illustrated in Fig. 1, is indicated in Fig. 9, from which it will be seen that the central cone is now deviated towards the side, its axis following the characteristic conchoidal section. In other respects the sequence of phenomena was as before. Thus, after the cone fracture which was of a shallower order took place, and the crushing point was reached, the diametral plane fracture followed the axis of the deviated central cone, and the cavity from which the splinter was removed had the characteristic conchoidal appearance.

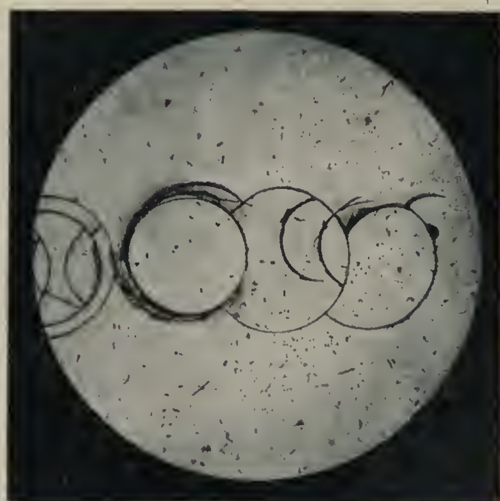


FIG. 2.—Surface percussion cracks on glass. Magnification 42×.

It is presumably the impact of the carborundum grains on the edges of cavities on the glass to be ground that produces the conchoidal splinters as indicated in Fig. 10. It would appear, therefore, that it is the diametral plane fracture that is of primary importance, and that, in the processes of smoothing, the horizontal movement is required to force the abrasive grains against the sides of the cavities. From actual tests it is found that the rate of abrasion is directly proportional to the pressure and to the relative speed of translation.

JAMES WEIR FRENCH.

Anniesland, Glasgow, October 13.

The Breeding of the King Penguin.

THE Zoological Park at Edinburgh has had the good fortune to possess, almost from its inception, a small group of king penguins. Three of the birds were received in January, 1914, from South Georgia, a second consignment, of which three survived, arriving in the spring of 1917. A hope was excited that they might breed when two of them were observed to be mating in the autumn of 1915, but nothing further occurred at that time. In the late summer of 1917 one of the birds became broody, and sat in the posture of incubation for about a month, but no egg was apparently laid, nor was this bird one of the two which had been observed to be paired. It was not until 1918 that the paired birds really settled down in earnest, and much interest was aroused when, on July 8 of that year, one of them was found to have an egg.

The king penguin, like its near relative the emperor penguin, makes no nest, but carries the single egg on its feet, where it is held in place and covered for warmth and protection by a fold of the skin and feathers of the abdomen, which, being furnished with a constricting muscle, grips the egg tightly. The brooding penguin can not only travel about with the egg in position, but even scratch its head with one foot while still holding the egg securely. Both sexes share in the work of incubation, the transfer of the egg having been observed on the second day. The parental instinct is very strong in the king penguin, not only in mated, but in the unattached birds as well. The group at this time contained three other birds, and their presence, or perhaps nothing but the very obvious conflict of desire for simultaneous possession of the egg between the husband and wife, may have been the cause of the misfortune which followed; at any rate, it was disappointing to find, after about two weeks, that the egg had been broken and that its custodian was believed to be relieving the tedium of duty by occasionally sipping its contents.

The floor of the enclosure consists of shelving rock, and to reduce the risk of breakage if an egg were produced this year, a large bed of sand was laid down. The next incident was again disappointing, for in July an egg was laid, but within an hour or so it had disappeared. As none of the birds showed any disposition to incubate it, I formed the opinion that it had been laid by one of the unmated birds, and this seemed to be confirmed when, on September 1, the female of the pair was found to have an egg. The other three birds were at once removed from the enclosure so that they should not interfere, and for two days all went well, the male bird taking the egg at night and the hen during the day. On the third day, however, the calling of one of the other birds—the third of the three originally imported—seemed to disturb the male, and he left his wife, refused to have anything more to do with the egg, and spent the day (and probably the night) in calling to the third bird and trying to get to it. After some days, as the female seemed to be suffering from the unrelieved care of the egg, and neither bird would feed, it was decided to put the third bird back. When this was done they all settled down together, and the male resumed his share in the labour, the third bird usually standing near.

The time during which each bird had the egg varied from a day to a week or more. The female when she had the egg always remained in the same place, where she made a slight hollow in the sand, but when the male had it he occasionally went for a walk round the enclosure, shuffling along with the egg on his feet. He even descended from one ledge of rock to another by turning round and working himself down backwards—a performance which led to several narrow escapes for the egg.

As the period of incubation elapsed the result was awaited with some anxiety, and it was in no small degree gratifying to find, on October 22, that the egg was chipped and the chick inside alive. It was not, however, until two days later that the chick was clear of the shell, the period of incubation thus being seven weeks and four days. The chick when hatched was comparatively small, and the skin was bare, but in a few days it increased considerably in size. The young bird, like the egg, is kept between the feet of the parent and covered by the fold of skin; it is fed at frequent intervals with semi-digested fish disgorged by the parent. As in the case of other birds which feed their young by this method, the chick places its head in the parent's mouth and takes the food from the gullet.

Apart from accident, there seems every likelihood that the young bird will be reared. It may be claimed which feed their young by this method, the chick king penguin has bred outside those islands of the Antarctic seas on which it has its home, and the record is a unique one.

T. H. GILLESPIE.

Zoological Society of Scotland, Edinburgh, October 29.

A Helium Series in the Extreme Ultra-Violet.

IT has been shown that the helium series first discovered in a terrestrial source by Fowler can be represented by the formula

$$V = 109750\left(\frac{1}{\left(\frac{n_1}{2}\right)^2} - \frac{1}{\left(\frac{n_2}{2}\right)^2}\right),$$

where n_1 has the value 3 or 4 (Evans, *Phil. Mag.*, vol. xxix., p. 284, 1915).

If n_1 be given the value 2, and n_2 the successive value 3, 4, and 5, lines result at wave-length 1640·1, 1214·9, and 1084·7. My previous investigations of the helium spectrum did not afford much evidence as to the existence of these lines (*Astrophys. Journ.*, vol. xliii., p. 92, 1916); a recent search, however, has been more successful. With a powerful disruptive discharge in helium, a sharp, fairly strong line appears at 1640·2; no trace of it is found in hydrogen under the same electrical conditions, and it does not occur in helium when the discharge circuit is free from capacity. Under the same violently disruptive condition the line at 1216, always present in helium and hydrogen, develops a satellite on its more refrangible side; this satellite is not well resolved, but its wave-length appears to be about 1215·1. The region that should be occupied by 1084·7 is obscured by a strong pair at 1085, probably due to an impurity.

Owing to the difficulties of vacuum spectroscopy, it is perhaps unwise to claim that the evidence in this case is conclusive. I regard it as very probable, however, that two members of this series in helium have been found in the extreme ultra-violet.

THEODORE LYMAN.

Harvard University, October 25.

Variations of Refractive Index.

EXPERIMENTS conducted in the research laboratory of the firm of Adam Hilger, Ltd., by Mr. G. M. Fleming show that, in certain circumstances, distinct differences of refractive index may occur in certain liquids at the separating surface between the liquid and a polished glass surface. In a few exceptional cases the differences are very great; in the case of ether, for instance, they may amount to as much as 0·02 in the refractive index.

These results appeared to me of considerable importance, and it was intended that the investigations should be continued here.

As a first hypothesis, I proposed to assume that the effect was due to variations of pressure in the neighbourhood of the interface, such variations of pressure being due to cohesion, and occurring according to the intimacy of contact between liquid and glass. Very attractive lines of thought suggest themselves when the phenomenon is contemplated from this point of view.

Unfortunately, more urgent preoccupations intervened, and the results have therefore been communicated to the director of the British Scientific Instrument Research Association, in the hope that he may find a place in the programme of work for further study in this direction. Meanwhile, I should be grateful if any of your readers could refer me to any prior observations of the kind. F. TWYMAN.

Research Department, Adam Hilger, Ltd., 75A Camden Road, N.W.1, November 7.

The Audibility of Thunder.

FROM reading a recent letter in NATURE (October 16) discussing the distance that thunder can be heard, I am induced to send you the following observation:—On the evening of February 26, 1912, when camped on North Chincha Island (off the west coast of South America), a brilliant display of lightning in the distant high interior to the east attracted our attention. The cloud-stratum from which the storm evidently issued lay far behind the clear coastal zone and the lower foothills, but hid from my camp the upper regions of the Cordillera. Both I and a Peruvian friend heard quite clearly the low distant peals of thunder. As I had been told that thunder was an almost, if not a quite, unknown phenomenon on the coast—this was the first thunderstorm, indeed, that my companion, a man of more than forty years of age, had experienced—I purposely made a record, during the best part of an hour, of the intervals elapsing between the flashes and the peals, and from my journal I find the average to have been 320 seconds. HENRY O. FORBES.

Beaconsfield, Bucks, November 7.

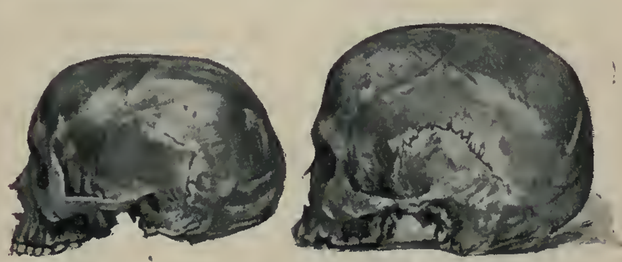
Linkage in the Silkworm: A Correction.

IN referring to Tanaka's work on silkworms I made (NATURE, November 6, p. 216) a mistake which should be corrected. His discovery was not that two characters linked in the male were not linked in the female, but that in a case of linkage common to both males and females it is only in the males that crossing-over occurs. Since, on the analogy of Abraxas, the female is presumably in the silkworm the heterozygous sex, this observation is complementary to and consistent with Morgan's evidence that in Drosophila there is no crossing-over in the male, which in that animal is heterozygous in the sex-character. The paper is in Journ. Coll. Agr., Tohoku Imp. Univ., vii., 1916, pt. 3. Also the forms found by Patterson associated with males and females should have been called "asexual," not "inter-sexes." W. BATESON.

November 14.

THE PREHISTORY OF SOUTH AFRICA.[1]

THE bulk of Dr. McCall Theal's book is as valuable now as it was when first issued, twenty years ago. But though "illustrated and enlarged," it is not "improved" so much as one would have expected. Dr. Theal does not make much use—though he alludes to its publication in 1911—of Dr. Péringuey's important study of the Stone age in South Africa, though the theories of Péringuey and Shrubsall would have materially helped him in his attempts to picture the first peopling of South Africa by Man. Also, in the scanty evidence he has gathered together of the origin and wanderings of the Bushman race he—as do most other historians of Africa—overlooks the statement of the Italian traveller, Ludovico di Varthema, who in his 1508 voyage across the Indian Ocean stopped at Mozambique, and, journeying a short distance inland to some table-topped mountain, described a short-statured savage people living on the mountain-top whose language consisted largely of "clicks," "like the sounds used by Sicilian mule-drivers." I have myself gathered up and recorded legends in South Nyasaland of a yellow-skinned, Bushman-like tribe that lived down to a few hundred years ago on the inaccessible upper parts of Mts. Mlanje and Chiperone.



(a) (b)

FIG. 1.—Drawings of the skulls of two Strandlooper types: (a) the oldest and most like to the Hamite or the Cro-Magnon of Europe; (b) a Strandlooper skull that is very Bushman-like. The originals are approximately the same size.

So far as we can trace the race movements in Africa south of the Zambezi prior to the definite entry of South Africa into recorded history, we find them to be something like this: At a comparatively remote period—say, thirty to twenty thousand years ago—there was living in southernmost Africa a human type now named or nicknamed the Strandloopers ("shore-runners"), whose skulls show a slight resemblance to the Bushman type, but whose brain capacity was much higher (1600–1500 c.c. in the male, compared with an average of 1200 c.c. in the Cape Bushman, and an average of 1480 c.c. in the Bantu-speaking Negroes). The higher type of Strandlooper skull (*a* in Fig. 1) in fact reminds one of the Hamitic skulls of North-east Africa or of the Cro-Magnon type of Europe thirty thousand

[1] "Ethnography and Condition of South Africa before A.D. 1505." By Dr. George McCall Theal. Second Edition in the Present Form (Illustrated), Enlarged and Improved. Pp. xx+466. (London: George Allen and Unwin, Ltd., 1919.) Price 8*s*. 6*d*. net.

years or so ago. These scarcely Negroid Strandloopers, according to Péringuey, were the earliest humans in South Africa, so far as our very slight evidence can be applied to the making of theories. But apparently, though they brought with them the European arts of their time, and especially

FIG. 2.—A photograph of the Nile Delta pygmy type of (?) 8000 years ago from a pre-dynastic "slate palate."

their gift of drawing, they imparted some of these to the Bushman mind and then died out.

Another question hinted at, but not adequately discussed, in Dr. McCall Theal's book is that of the different physical types of Bushmen. There is a Bushman language and culture common to all these (degraded or primitive) peoples, but the

FIG. 3.—A photograph of a very old Cape Bushman.

shape of the head differs considerably. Some—Dr. Theal gives a photograph of a woman—exhibit a greater degree of prognathism than any other known human race. I could supplement Dr. Theal's example by several others, not, unfortunately, at my disposal for reproduction at this moment. The North Kalahari Bushmen have sometimes projecting brows; the Cape Bushmen, on the other hand, are usually neither prognathous nor prominent-browed. Some Bushmen have fairly long skulls; others have head-forms markedly round and brachicephalic. Possibly these varieties in the shape of the skull may indicate a fusion of Negroid types, some of which stood low in the scale of humanity, especially in language. There are apparently two features (besides steatopygy) characteristic of the Bush race which all these varying types hold in common: one is the configuration of the ear, and the other is peculiarities in both the male and female external genitalia. I do not know whether the "Bushman ear" has been definitely noted in other Negro or Negroid races, but the peculiarities of the genitalia can be noted here and there up the eastern side of Africa until the eastern Mediterranean is reached.

The Bushmen, indeed, seem to have entered

FIG. 4.—Head of a North Kalahari Bushman.

Africa—no doubt very anciently—from the direction of Arabia or Syria, and to have wandered down the eastern side of the continent until they settled in South-east and South-west Africa.

The Hottentots came very much later—the forest Negroes and the Nilotics may have preceded them in East and South-west Africa. They arose probably from a blending somewhere in eastern equatorial Africa between the Bushman type, the Hamitic or Nilotic Negroids, and the forest Negroes. Their push southwards seems to have been diagonal, first from the regions south of the Victoria Nyanza to the Nyasa-Tanganyika plateau, and thence to South-west Africa. Finally, they advanced along the coast of South-west Africa to the lands south of the Orange River. Like the Bushmen, they formed tribes that differed much in facial appearance. Those that the Portuguese and Dutch found established in Cape Colony were lighter in colour and far less ugly than the Hottentots farther to the north-west or inland, and their culture was higher, as though they had preserved more of the Nilotic or Hamitic intermixture.

The pygmies of the Nile Delta, of prehistoric Egypt, seem certainly to have been Negroid, but more like the Asiatic Negroes, and presenting few resemblances to the Bushmen. The steatopygy of Bushmen and Hottentots developed into a local exaggeration (chiefly in the women), but occasionally appears in the Congo pygmies, the East African Bantu, the Nilotic Negroes, and even the Whiteman races of the Mediterranean.

I cannot quite share Dr. Theal's theories concerning the origin of the Bantu languages, but as I have already exceeded the space allotted to me, I must deal with my points of difference elsewhere.

Fig. 5.—Portrait of a Cape Bushman of the orthognathic type.

On the other hand, I am obstinately in agreement with his views on the subject of the earlier stone buildings of South-east Africa, of the Zimbabwe type; they were never (the earlier and more elaborate) built by Negroes, Bantu or Hottentot; they were—so far as we can be certain on any subject that has not at present conclusive proof—built by a non-Negro people, possibly the Phœnicians coming from some base in southern Arabia. The secondary and much later work was very likely done by Arab gold-seekers prior to the Islamic period. All that the more intelligent Bantu peoples, such as the Karaña or their allies, did on the verge of their entry into the history of South Africa was to carry on very clumsily surface gold-mining and the use of stone for building rough, low walls and circular huts.

The accompanying reproductions illustrate my own as well as Dr. Theal's theories. The first is copied from Péringuey and Shrubsall's "Stone Age in South Africa"; the second was given me by Prof. Flinders Petrie; the third by Mr. Leo Weinthal; the fourth is from a photo by Dr. Leonhard Schultz; and the fifth is from the collection of the Royal Anthropological Institute.

H. H. Johnston.

LT.-COL. B. F. E. KEELING.

By the death of Lt.-Col. Keeling Surveyor-General of Egypt, that country has lost one of its ablest officials. Lt.-Col. Keeling was born in 1880, and educated at Bradford Grammar School and at Trinity College, Cambridge, where he took firsts in the Natural Sciences and Mechanical Science (Engineering) Triposes. On leaving Cambridge he went to the Royal Arsenal, Woolwich, and then to the National Physical Laboratory, where he worked especially on metrology.

In 1904 Keeling joined the Egyptian Survey Department, where he took charge of the major triangulation, and in the next year of the Helwan Observatory also. Here he designed and built the comparator houses for the comparison of the standards of the Survey, and organised the geodetic survey of Egypt, in connection with which a gravity survey of the Nile Valley and neighbouring regions was undertaken. He also started precise levelling in Egypt, and under his direction a network of bench-marks has been formed in the Delta of the greatest value to irrigation. An investigation into the subsoil water-level of the Nile Valley, and its effect on the cotton crop, came also under his direction, while his work on standards of length led to the formation of the Weights and Measures Office under his direction.

In meteorology Keeling introduced research on the upper air at Helwan Observatory, where kites and pilot balloons were regularly used, and in 1908 he made a journey to the Upper Nile for the study of the upper-air currents during the rainy season. In 1913 the more scientific branches of the work carried out in the Survey Department were amalgamated to form the Physical Service, with Keeling as director, and in 1915 this service was transferred to the Ministry of Public Works as a separate Department.

In December, 1914, Keeling left Egypt in order to take up military duties, and received a commission in the Royal Engineers. He was at first attached to the Ordnance Survey, and placed in charge of the map publication department; but it was his keen desire to serve at the front, and in February, 1916, he joined a Field Survey company in France. He was wounded in the autumn of 1916, and did not return to France until 1917, when he commanded first the Depôt Field Survey Company, and then the 3rd Field Survey Battalion; he was promoted to the rank of lieutenant-colonel. The Survey battalions were now organising new methods of ranging by sound and observation, and by his force of character Keeling was particularly successful in gaining the confidence of the artillery in these methods, and it would be difficult to over-estimate the effect on many operations which he thus exercised. He was present at the Somme battle, the attack on Cambrai, the great German attack in 1918, and the subsequent British advance.

Keeling returned to Egypt in April, 1919, as head of the Survey of Egypt, having also been appointed chairman of the newly formed Board of Cotton Research, and with his accustomed zeal had already started to develop geodetic and other lines of work in the Department. He was a man of unbounded energy, who combined foresight and skill in administration with a sound scientific training, and his loss is a serious one to Egypt. He had only recently been married, and the sympathies of all are with his widow.

H. G. LYONS.

NOTES.

A CONFERENCE of delegates representing the Mediterranean nations is about to meet at Madrid to organise an international scheme of fishery investigations and to set up a central office for the co-ordination of the results and their publication in French, Spanish, Italian, and English. Four exploring ships are to be at the disposal of the office—the *Hirondelle II.* belonging to the Prince of Monaco, a specially built Italian ship, and two other vessels provided by France and Spain. In the meantime, while the full scheme is being elaborated, the Italian Government is beginning investigations in the Dardanelles. In the main, the object of the researches will be the development of the sea-fishing industries, and the results primarily sought will relate to the life-histories of edible fishes. Hydrographic work will also be carried out. Several big expeditions have made investigations of this nature in the past, but there is still much to be discovered, and sustained research is, of course, imperative in the study of variability of the productivity of the fisheries.

WE note with great regret that Mr. S. D. Chalmers died on Friday, November 7. Born at Wallsend, near Newcastle, New South Wales, Mr. Chalmers had a brilliant career at the University of Sydney, whence a travelling fellowship took him to Cambridge. There he graduated as thirteenth Wrangler in a very strong year. After holding lecturerships in mathematics at Owens College, Manchester, and at the Royal Naval College, Greenwich, he became the first head of the newly organised department of technical optics at the Northampton Polytechnic Institute at Clerkenwell, a post which he held until his premature death at the age of forty-two. Since 1903 Mr. Chalmers's work had been entirely devoted to optics, and his activities were largely identified with the Optical Society of London, of which he was for a time honorary secretary, and in 1909–10 president; and also with the two Optical Conventions of 1905 and 1912. His published work, his teaching, and his personal advice and example have done much for the optical industry of this country, and it is greatly to be regretted that one of the ablest workers in this field has been lost to us at a time when that industry needs all its strength. During the war Mr. Chalmers not only assisted the industry by personal advice and help, and by a large amount of responsible testing work, but he also organised and supervised a special training workshop in which girls were trained to become skilled grinders and polishers of lenses. There can be no doubt that his untimely death is to be ascribed to the excessive strain of these activities, followed by the further strain arising from a combination of a pressure of many students and an inadequacy of staff.

ALL those interested in the afforestation question in this country, and cognisant of the vital economic and social problems bound up with it, will have been relieved at the answer given by Mr. Bonar Law, in reply to Sir Philip Magnus, on the subject of the Commissioners to be appointed under the Forestry Act. It will be remembered that the Forestry Bill was passed by the House of Commons in August last, having been previously accepted by the House of Lords. The Act provided for the appointment of a Central Forestry Commission, consisting of eight Commissioners who should be responsible for the forest policy in Great Britain and Ireland, and anxiety as to the non-appointment of the Commissioners was being felt. The names of the eight Commissioners were announced in last week's NATURE. The member of the Commission who has had a technical and scientific forestry training is Mr. R. L. Robinson, the Cabinet having accepted the principle that at least one Commissioner should possess a scientific training in forestry. We should like to have seen a representative of the purely scientific side of forestry upon the Commission, and also a second expert member possessing a practical and wide knowledge of forestry conditions throughout the British Empire and other parts of the world outside western continental Europe. The advice such a member could tender on many points of vital importance in connection with the afforesting of the great waste areas in this country would prove invaluable. This is a weak spot in the Commission, a disability which, it may be hoped, will be quickly realised by such a broad-minded, energetic, and capable administrator as the chairman, Lord Lovat, has already proved himself to be. In other respects the selection of the Commissioners gives every promise of assuring the fulfilment of the desired results.

WE much regret to record the death, on November 14, at eighty years of age, of Dr. John Aitken, F.R.S., a frequent contributor to our correspondence columns, and distinguished for his lifelong researches on the nuclei of cloudy condensation and related subjects of meteorological physics.

THE ninety-fourth course of juvenile lectures founded by Faraday at the Royal Institution will be delivered this Christmas by Prof. W. H. Bragg on "The World of Sound."

ANNOUNCEMENT is made in the *Times* that Prof. M. Planck, Berlin University, and Prof. H. Stark, Griefswald University, have been respectively awarded the 1918 and 1919 Nobel prizes for physics, and Prof. F. Haber, Berlin University, the 1918 Nobel prize for chemistry.

PROF. WM. BERRYMAN SCOTT, president of the American Philosophical Society, sends us the following congratulatory message from Princeton:—"I am very glad to congratulate you, officially, upon the completion of the first half-century of NATURE's career, to express the cordial wish and hope that that career may long continue in ever-increasing honour and usefulness, and to give some appreciation of the very great services which the journal has rendered to scientific men throughout the world, especially to those of the English-speaking lands."

THE second annual general meeting of the British Association of Chemists was held on November 15 in Manchester, Prof. J. W. Hinchley, the president, presiding. The council is giving much thought to the important question of the representation of chemists and technical workers generally on the joint industrial councils formed under the Whitley scheme, and was able to report that, as a result of the labours of its special sub-committee, a federation of scientific and technical organisations has been formed for the purpose of advancing the claims of brain-workers to representation alongside capital and labour.

APPLICATIONS are invited by St. Bartholomew's Hospital Medical School for election to the Rose research fellowship, which is of the yearly value of 600*l.*, exclusive of laboratory expenses. The subject of the research is "The Pathology and Treatment of Lymphadenoma." The person appointed must devote the whole of his time to the fellowship. Applications, with not more than three testimonials, the names of three referees, and particulars of the lines upon which the applicant's proposed research is to be carried out, must reach the Dean of the school not later than December 15 next.

THE retirement of Mr. George A. Macmillan from the honorary secretaryship of the Society for the Promotion of Hellenic Studies should not be allowed to pass without notice in these columns. It was on Mr. Macmillan's initiative, due to the enthusiasm for Greek art and archæology kindled by a visit as a young man to Greece, that the society was founded forty years ago, and during those forty years he has acted as its secretary and been the mainspring of its activities. He has worked in close partnership with all the leading Greek archæologists of this generation, encouraged numberless young men, and afforded generous financial assistance to many enterprises. He is a shining example of one who, having put his hand to a task, does not weary in well-doing, but carries it on through the working years of a lifetime. Even now Mr. Macmillan is not wholly withdrawing from the work of the society, for in vacating the secretaryship he has accepted the honorary treasurership, and his counsel will still be available for the cause for which he has done so much.

BARON ROLAND VON EÖTVÖS, Hungary's greatest man of science, died on April 8 last in Budapest. The son of the Hungarian writer and politician, Baron Josef von Eötvös, he was born at Buda on July 27, 1848. He began his university career at the University of Budapest, and continued his studies under Kirchhoff, Helmholtz, and Bunsen at the University of Heidelberg. He also spent a short time at Königsberg under Franz Neumann. Having obtained the degree of doctor of philosophy at Heidelberg, von Eötvös became a *Dozent* in physics at Budapest University, and in 1872 he was elected to the chair of theoretical physics at that university. Some years later he was also elected to the chair in experimental physics, and for a short period was Minister of Education in Hungary. Von Eötvös occupied the position of president of the Hungarian Academy of Science for many years, and in 1891 he founded the Hungarian Mathematical and Physical Society, the presidency of which he held until his death. He was also the Hungarian representative of the International Commission for earth measurement.

THE Hunterian Society celebrated its centenary on November 12 by a dinner at the Trocadero Restaurant. Dr. Langdon Brown, the president, was in the chair, and Sir Norman Moore (the president of the Royal College of Physicians), Dr. Addison, Sir George Newman, Sir Archibald Garrod, and Sir Frank Dyson (the Astronomer Royal) were among the guests. The society's annual silver medal was presented to Mr. John Adams for his work in connection with the Corporation of London's Thavies Inn clinic for the treatment of expectant mothers and their infants affected by syphilis. The Hunterian Society was founded in 1819 by Sir Thomas Blizard, an admirer of the Hunters, and especially of John Hunter, and has numbered among its presidents Dr. Bright (from whom Bright's disease derives its name), John Hilton (the surgeon), Hughlings Jackson, and Sir Thomas Crosby (a former Lord Mayor). In earlier days consultants resided mostly within the City boundaries, and the society has always kept in touch with the City of London, and resolved to make to Mr. Adams a special centenary award of its medal.

THE British Cotton Industry Research Association was formed some months ago to promote scientific research in connection with the cotton industry, in co-operation with the scheme of the Government Department of Scientific and Industrial Research. The first problem before the association after its incorporation was to secure the services of a man of the highest attainments, who would be able not only to undertake the direction of the association's researches, but also in the difficult initial stages to construct sound foundations for the building up of the institute of the future. As mentioned last week, the council has made this appointment, and by securing the services of Dr. A. W. Crossley, C.M.G., F.R.S., Daniel professor of chemistry at King's College, London, as director of research, the association is making a very fortunate and promising start. In his new post Dr. Crossley will be responsible to the council for the direction of all the research and for the whole internal management of the institution. It will probably not be possible for him to devote his whole time to the work before Easter, but he will no doubt be able to give the association preliminary assistance before then.

THE President of the Board of Agriculture and Fisheries (Lord Lee of Fareham) has now approved of the reorganisation of the Board and the regrouping of its functions into five main Departments, each under an executive head responsible, in the case of the three Agricultural Departments, to the President direct, and in the case of the Fisheries and Welsh Departments to the President through the Parliamentary Secretary (Sir A. Griffith-Boscawen, M.P.). Sir A. Griffith-Boscawen, in addition to his duties as Parliamentary Secretary, has been appointed Deputy-Minister of Fisheries. The following appointments have also been made:—Sir A. Daniel Hall, Chief Scientific Adviser to the Board and Director-General of the Intelligence Department; Mr. Lawrence Weaver, Chief Commercial Adviser to the Board and Director-General of the Land and Supplies Department; Mr. F. L. C. Floud, General Secretary to the Board and Director-General of the Finance and Economics Department; Mr. H. G. Maurice, Fisheries Secretary and Principal Assistant Secretary to the Board; and Mr. C. Bryner Jones, Welsh Secretary, in special charge of the Welsh Office. Mr. R. J. Thompson and Mr. H. L. French have been appointed Assistant Secretaries to the Board to fill the vacancies created by the promotions of Mr. F. L. C. Floud and Mr. H. G. Maurice.

IN continuation of the excellent work left unfinished by the late Major Bendire on the life-histories of North American birds, there has recently been issued by the United States National Museum (Bulletin 107, Washington: Government Printing Office) an instalment devoted to the Nearctic diving birds of the order Pygopodes, prepared by Mr. Arthur Cleveland Bent with the co-operation of numerous well-known ornithologists. This volume affords much valuable and up-to-date information relating to the courtship, nesting, eggs, period of incubation, young, plumages, food, behaviour, breeding range, winter range, migrations, egg-dates, etc., of thirty-six species, one-third of which are members of the British avifauna. Among the mass of important and interesting information afforded only a few items can be referred to. It may be mentioned that the comparatively little known large-billed puffin, the haunts of which are confined to a limited portion of the Arctic Ocean, has recently greatly increased in numbers on the north-west coast of Greenland, which is regarded as being the westerly limit of its range. Welcome particulars are given relating to the life-history of the yellow-billed loon or Adam's diver, the eggs and nest of which are figured. There is also an excellent summarised history of the extinct great auk, and a figure of the egg, now in America, which was formerly in the collection of the late Sir William Milner, Bart. The author is to be congratulated on the able manner in which he has presented the results of his studies of the extensive and valuable material at his disposal, and also on the interesting series of pictures of bird-life, about eighty in number, from photographs taken direct from Nature. The volume is further enriched by thirteen coloured plates of eggs.

MESSRS. MACMILLAN AND CO., LTD., have in preparation a "Dictionary of Applied Physics," to be issued probably in four volumes, under the editorship of Sir Richard Glazebrook, who will have the assistance of a number of distinguished contributors. The work is intended to include the range of physical science in its application to engineering and manufacture; it will cover, therefore, a wide ground, and needs the co-operation of many writers. It should appeal to many workers, for the fact that scientific investigation and inquiry form the foundations of new methods of manufacture and are required before any marked advance is possible is now very fully realised. It is hoped, in the various sections of the Dictionary, not only to supply up-to-date information as to what has been done in the past, but also to give some indication of pioneering directions for further progress. The present is a suitable time for such a work; new industries are springing up, old industries are being reconstructed, and there are few which do not involve some process or processes based on the discoveries of physics. Pure science, as the president of the Royal Society stated some little time back, may cause a revolution in an industry. It will be the object of the Dictionary to indicate in a concise form the application of the most recent advances of physics to trade and manufacture.

WE have received a catalogue of X-ray and electro-medical apparatus from Messrs. Watson and Sons, Ltd., comprising 369 pages, well illustrated. The whole range of appliances, radiological and electrical, now in use for therapeutic and diagnostic purposes is covered, together with numerous parts of apparatus suitable for research purposes. Prominent among the latter are high-tension transformers which the modern investigations in radio-metallurgy have demanded. Useful information is also to be found in these pages as to the careful use and appropriate technique of many of the appliances, as witness the remarks upon intensifying screens and the management of the various types of Coolidge tubes now available. A considerable section is devoted to stereoscopy; fluoroscopic examinations embodying stereoscopic vision are now possible with comparatively little addition to the installations generally found in a hospital department.

MR. ROGER T. SMITH gave his presidential address to the Institution of Electrical Engineers on November 13. As the railways of this country are shortly to be subjected to fresh legislation, the choice of a railway electrical engineer as president was a happy one. Mr. Smith considered the question of superseding the steam locomotive by the electric locomotive both for passenger and goods services. The coal necessary to produce a given hauling effect on the railway by means of an electric locomotive is at the most 40 per cent. of the coal burnt in the furnace of a steam locomotive to produce the same result. This would mean a saving of between 7,000,000 and 8,000,000 tons of coal each year. It has been estimated that to electrify all the railways in Great Britain would cost 300,000,000*l.* If coal ever rose to 45*s.* per ton, the saving of fuel would itself pay 5 per cent. on the investment. The average cost of running a locomotive in 1913 was 1240*l.*, the cost of coal and water being about 37 per cent. of the total cost. The average capital cost of a steam locomotive this year is 7000*l.*, but the average cost of an electric locomotive, including electric equipment of line, but exclusive of power-house and high-tension lines, would be about 35,000*l.* Mr. Smith calculated that to enable the electric train to earn the present revenue per train-mile, the passenger electric train would have to weigh more than half as much again as the steam train, and the electric goods train would have to be at least 1000 tons in weight, which is much heavier than the average steam train for goods. He considered only main-line electrification, and he admitted that some of his data are controversial. He emphasised the importance of standardisation in main-line electrification, and, judging from our present knowledge, he suggested that the direct-current system, working at 1500, or possibly 3000, volts, would be the most economical for use over the whole country. The problem is of the greatest national importance. In the future the demand for scientifically trained traction engineers will be very great.

THE annual report of Lloyd's Register of Shipping for the year ending June 30 last is discussed in the *Engineer* for October 31. During the year 1251 vessels of 3,801,221 tons gross were classified by the committee, including 294 vessels for Government service. The United States headed the list with 470 vessels of 1,883,759 tons. Included in the total were 156 vessels of 943,487 tons built upon the Isherwood system of longitudinal framing, of which 35 were intended for carrying oil-fuel in bulk. It is of interest to note that, owing to the difficulty of obtaining a sufficient number of cylindrical boilers, the greater portion of the vessels built in America and all the wood vessels built in Canada during the war were fitted with water-tube boilers. Also a large proportion of the vessels built in America were fitted with geared turbines, most of them being of the double-reduction type. Besides their ordinary work, the surveyors rendered great assistance to the Admiralty in the design, construction, and production of special types of vessels, and also to the French Government in the inspection of shell steel, of which 1,401,114 tons were passed by the society's surveyors. More than 200 German vessels taken over under the peace terms have been surveyed by the committee's surveyors. The collective capacity of new cold stores and extensions carried out under Lloyd's survey amounts to 7,500,000 cub. ft. The committee has also undertaken research work at its own expense, one of the subjects at present engaging the attention of the special sub-committee on research being the effect of a fluid cargo in the form of oil in bulk on the behaviour of a ship in a seaway, and the manner in which energy passes between the ship and the fluid in the holds. The report is voluminous, and it is only possible to touch upon a few of the leading items of interest.

THE new monthly *Conquest*, of which the first number has just been issued, will fill a want long felt by the British public for a magazine giving, in popular language, an account of the scientific and technical achievements of the day. Readers having a technical bent were obliged to glean what information they could from the technical journals proper, or, if they read French sufficiently well, to subscribe to a well-known French periodical which fulfils the same function. The first number contains well-written and illustrated articles on the running of the London tubes, the technique of film-making, the internal structure of metals (by Dr. Walter Rosenhain), and other interesting contributions.

The Cambridge University Press hopes to have vol. iii. of the "Cambridge British Flora" ready for publication before the end of the year. Other announcements of the same publishers are a new edition of Prof. A. H. Keane's "Man, Past and Present," completely revised and largely rewritten by Mrs. Quiggin, with the assistance of Dr. A. C. Haddon; "Pleasure—Unpleasure," an experimental investigation on the feeling-elements, Dr. A. Wohlgemuth; "Chemistry for Textile Students," Prof. B. North and N. Bland; "Machine Drawing for Electrical Engineers," E. Blythe; "Food Poisoning and Food Infections," Dr. W. G. Savage; "Practical Exercises on the Weather and Climate of the British Isles," W. F. Stacey; "The Physiology of Farm Animals, Part i. (General)," Dr. F. H. A. Marshall; "General Psychology," W. S. Hunter; "Practical Geometry," C. Godfrey and A. W. Siddons; and "The Elements of Analytical Conics," Dr. C. Davison. *The Library Press, Ltd.*, has nearly ready for inclusion in its Manufacturing Problem Series "The Management Problem," E. T. Elbourne, and in preparation "The Reorganisation Problem," J. E. Powell, and "The Workers' Problem," W. Wilkinson. *The S.P.C.K.* will publish "Woodcraft Scouting in Town and Suburb," the Rev. W. Bren ("Silver Wolf").

A CATALOGUE (No. 78) interesting not only by reason of its contents, but also from the fact that many of the volumes offered for sale are from the libraries of the late Prof. T. McKenny Hughes and Mr. W. E. Balston, and that the geological portion of the library of Dr. Henry Woodward is included, has just been circulated by Messrs. Dulau and Co., Ltd., 34-36 Margaret Street, W.1. The 1018 works listed range over the subjects of zoology, botany and horticulture, geology and palæontology, astronomy, physics, etc., geography and travel. Many scarce books are on sale, but the majority of the volumes offered are obtainable for reasonable prices.

READERS of NATURE on the look-out for bargains in books for personal use or for presents would do well to see the Catalogue (No. 183) just issued by Messrs. W. Heffer and Sons, Ltd., Cambridge. All the works listed are new copies, and the reductions in price from those at which they were originally published are in many cases remarkable. Most branches of literature are represented, and many well-known books of science of comparatively recent publication are included.

MR. F. EDWARDS, 83 High Street, Marylebone, W.1, has just published an illustrated Catalogue (No. 395) of valuable early English and foreign books. The sections most likely to appeal to readers of NATURE are those referring to works dealing with Africa, America, Medicine, Herbals, Husbandry, and Natural History.

THE Society of Glass Technology should have been included in the list of scientific societies founded in the last fifty years given in the jubilee issue of NATURE. The society was founded in November, 1916, and has 550 members. Its work has frequently received favourable notice in our columns.

OUR ASTRONOMICAL COLUMN.

LARGE FIREBALL.—On November 2, at 7.6 p.m., a fireball of considerable brilliancy was seen by Mr. C. P. Adamson, of Wimborne, Dorset. Its observed flight was from $40°+7°$ to $51°+4°$, and it had an extremely slow motion, its visible duration being carefully estimated as five seconds. The nucleus left a short train behind it.

The same object was observed by Dr. Cowper at Shanklin, Isle of Wight. The meteor was comparable with a football in regard to apparent size and shape. It fell in due east in a nearly vertical direction.

From these details it is not possible to deduce exact values for the height, etc., and further observations are required. Probably the radiant was at $312°+14°$; and the height, 56 to 29 miles; path, 39 miles; and velocity, 10 miles. The object was over France in the region 45 miles east of Boulogne.

COMETS.—Mr. Sassaki, of Kyoto, Japan, discovered a comet on October 25 in R.A. 20h. 17m. 20s., south declination 27° 11′, the G.M.T. being October 24d. 23h. It was reobserved on November 9 by M. Schaumasse at the Nice Observatory, and was then found to be identical with Finlay's periodic comet, for which the Nice Observatory had already published a search ephemeris. As the comet's period is close to 6½ years, it is well placed every thirteen years, and usually escapes observation at the intervening return. On November 11 it approached the earth within some 15,000,000 miles, its apparent magnitude being 9·0. The following is an ephemeris for Greenwich midnight:—

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Nov. 21 ...	0 35 0	5 15	0·0606	9·3149
25 ...	1 4 20	9 24	0·0713	9·3657
29 ...	1 28 4	12 38	0·0818	9·4166
Dec. 3 ...	1 48 4	15 7	0·0920	9·4658
7 ...	2 6 12	17 1	0·1020	9·5140

The following is a continuation of the ephemeris of Schaumasse's periodic comet 1911 VII. for Greenwich midnight. The magnitude is about 12·5:—

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Nov. 19 ...	13 15 41	2 32	0·1081	0·2671
23 ...	13 28 47	1 28		
27 ...	13 41 30	0 26	0·1198	0·2710
		S. Decl.		
Dec. 1 ...	13 53 51	0 34		
5 ...	14 5 49	1 32	0·1329	0·2745

The above ephemerides do not claim great accuracy, and some sweeping may be necessary to find the comets.

Later.—The Finlay ephemeris needs corrections of -24m. R.A., $-3°$ decl.

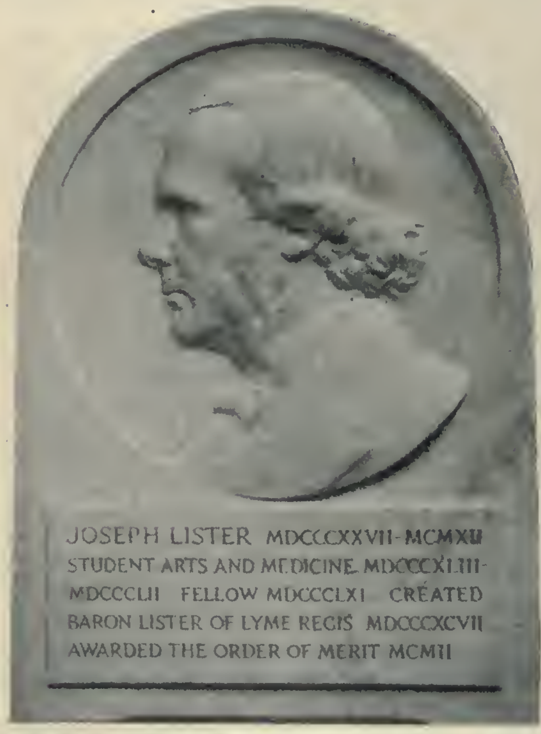
M. Ebell gives the following orbit of Kopff's comet 1919*a*, from observations 1919 July 31, August 20, September 16 (*Ast. Nach.*, 5016):—

T = 1919 June 28·210 G.M.T.	$\phi = 30° \ 56' \ 40{\cdot}6''$
$\omega = 19° \ 43' \ 51{\cdot}0''$ } 1919·0	$\mu = 538{\cdot}904''$
☊ $= 263° \ 48' \ 51{\cdot}4''$ } 1919·0	$\log a = 0{\cdot}545664$
$i = 8° \ 41' \ 30{\cdot}1''$ } 1919·0	Period = 6·5841 years

The mean observed period between 1906 and 1919 is 6·5766 years.

UNVEILING OF LISTER MEMORIAL TABLETS.

BRIEF mention was made last week of the unveiling at University College, London, of two bas-relief tablets in memory of Lord Lister, one of the most distinguished *alumni* of the college. There were present the Duke of Bedford (president of the Lister Memorial Committee), the president of the Royal Society, the president of the Royal College of Surgeons, Sir William Lister, the Misses Lister, and Miss Godlee (relatives of the late Lord Lister), the



Lister Memorial Tablet at University College, London. A similar tablet has been secured for University College Hospital, where Lister was student and house surgeon in 1843–52.

Vice-Chancellor of the University, the Provost of University College and Lady Foster, Sir John Bradford, Sir George Thane, Sir Thomas Barlow, Sir John Tweedy, Sir Ernest Hatch, and many others. The proceedings were opened by the Duke of Bedford, who referred to Lister's connection with University College, and commented upon the great value of Lister's presence in the House of Lords. Before unveiling the tablet destined to be erected at University College Hospital, where Lister was once house surgeon, Sir George Makins outlined the main events of Lister's life, the success of which was due to his thorough training as a student. Sir Joseph Thomson unveiled the tablet for University College. He said that Lister, one of the glories of British science, began his connection with the Royal Society at the early age of thirty-three, when he was elected a fellow. During Lister's five years' tenure of the presidency of the society much excellent administrative work was carried out, and this epoch saw the inception of several famous biological investigations organised by the society. The Provost (Sir Gregory Foster) then invited Sir Edwin Cooper Perry (the Vice-Chancellor), Sir George Thane, Sir Ernest Hatch, and Mr. Raymond Johnson to accept the tablets on behalf of the bodies they represented. Sir George Thane, in reply, mentioned that University College had that day been presented with one of Lister's prizes received whilst a student, and he expressed the hope that owners of Lister mementoes might present them to the college. On behalf of the memorial committee Sir John Tweedy conveyed the thanks of the subscribers to the sculptor, Prof. Havard Thomas.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS (ABSTRACTED) BY PROF. D. NOËL PATON, M.D., F.R.S., PRESIDENT OF THE SECTION.

IN the advance of every science certain difficulties and dangers which must be encountered tend to make the progress of knowledge somewhat devious, somewhat zigzag in character.

(1) The study of the metabolism of proteins in the animal body, especially when they are considered as a source of energy, illustrates this in a striking manner. Liebig's teaching insisted on their prime importance. The investigations of Voit and of Fick and Wislicenus—unsatisfactory as the latter were—caused a swing to the other extreme, to the view that carbohydrates, not proteins, are the main source of energy. The work of Pflüger and of his school brought about a temporary swing back to Liebig's teaching. Only when it became possible to study the respiratory exchanges along with the excretion of nitrogen was a true knowledge gained of the relative importance of proteins and of the other two proximate principles.

(2) As regards the use of proteins in the building and repair of the tissues, progress has been more direct, and has ultimately led to the recognition of the importance of the constituent amino-acids as the "building stones" of the proteins. In this connection the importance of the diamino-acids lysin, histidin, and arginin must be recognised. Their presence has been shown to be necessary for growth. The presence of guanidin in the arginin molecule requires more attention than it has yet received.

(3) An aspect of protein metabolism which has been more recently elucidated is the physiological activity of the constituent amino-acids in explaining the stimulating action—the specific dynamic action—of proteins upon the general metabolism and upon heat production.

The evidence of whether guanidin may be a product manifesting a physiological action in the body is worthy of study. The investigations of Kossel and Dakin and the earlier work of Thompson do not negative the probability of the liberation of guanidin from arginin in muscle, while the more recent work of Inouye and of Thompson indicate that guanidin may be split off from arginin. The formation of guanidin, either free or combined, from non-protein sources was demonstrated by Burns to occur in the hen's egg during the first twelve days of incubation up to the time of the appearance of creatin. That the cholin of the lecithin of the yolk is the precursor is rendered probable by the evidence adduced by Reisser and by Baumann Hines and Marker that creatin is formed from cholin.

That free methyl-guanidin is a normal constituent of muscle has been shown by the work of various investigators, and these results have been confirmed recently by Henderson. It is a normal constituent of the urine, even of such animals as the horse, which lives upon a creatin-free diet.

Guanidin and methyl-guanidin have marked physiological actions. They stimulate the efferent neurons of the spinal cord, causing tremors, jerkings, and extensor tonus. In large doses applied to the spinal cord, they paralyse. On the nerve-endings in muscle they have first a stimulating effect, so that the electrical excitability is increased, but later and in large doses they have a curare-like action. The symptoms are similar to those following ablation of the parathyreoids and to those of idiopathic tetany in children. In the blood and in the urine of parathyreoid ectomised dogs and in the urine of children with tetany, Burns and Sharpe demonstrated an enormous increase in the amount of guanidin present, an increase to which Koch had previously directed attention.

The conclusion seems to be that, under normal conditions, free methyl-guanidin maintains a tonic action on the efferent neurons and so on the muscles, and that the amount of guanidin is controlled by the parathyreoids.

The few observations so far made point to the excretion unchanged of only a part of injected guanidin. A possible explanation of this seems to be that part is linked with acetic acid and so converted to creatin and then rendered inert.

Previous work on the formation of creatin from glycocyamin, guanidin acetic acid, renders this probable. Recently in my laboratory Wishart has found a distinct increase in the creatin content of the muscles after the injection of guanidin sulphate, thus proving the conversion.

The nature of the combination of creatin in muscle is not yet known. Folin maintains that creatin is an integral part of the muscle substance, and that it is liberated as muscle dies and disintegrates. Evidence of this is lacking, and some recent experiments by Wishart show that in muscle frozen during life and extracted near the freezing-point the creatin content is the same as in muscle treated in the usual way. Folin's own work on the concentration of creatin in muscle does not seem to support his theory.

In the light of these results and of this view of the mode of formation of creatin from guanidin, what is the significance of the creatin which appears in the urine? This problem may best be investigated in animals in which the question of the relationship of creatin to creatinin need not be considered. Meissner in 1868 maintained that this is the case in birds, and his conclusion I verified in 1910. It has since been further substantiated by the work of Thompson. In birds during fasting the excretion of creatin is increased, just as in mammals the excretion of the combined creatin and creatinin is generally increased. Myers and Fine claim that the creatin excreted is derived from the creatin present in muscle at the beginning of the fast, while Stanley Benedict and Osterberg maintain that there is a constant fresh formation of creatin. The experimental basis of the latter conclusion seems to be unsubstantial, since they administered protein containing arginin and therefore guanidin, from which the creatin might have been formed.

In 1910 I maintained that, from the amount of creatin excreted by the bird during a fast, the amount of muscle disintegrated might be calculated. Whether the liberated creatin is simply excreted, or whether its resynthesis into muscles is prevented, the amount in the urine indicates the breakdown and non-regeneration of muscle, *i.e.* the *actual* disintegration. Hence a study of the relationship of the creatin nitrogen to the total nitrogen excreted enables a conclusion to be drawn as to whether the loss is falling chiefly upon muscle or upon other organs of the body. A study of the metabolism of the bird in fasting shows that such conclusions may be drawn, and, accepting Folin's most recent view of the significance of urinary creatin and creatinin, the excretion of the nitrogen in these substances, taken along with the total excretion of nitrogen, affords a means of elucidating further the progress of protein metabolism in fasting.

The work of Cathcart and others seems to show that creatin, in the presence of carbohydrates, may be resynthesised into the muscle substance. This in no way invalidates the view that it is formed to detoxicate guanidin. Lecithin, which is undoubtedly used in the construction of the tissues, plays a like part in detoxicating cholin.

As regards the relationship of creatin to creatinin, in spite of the very considerable literature which has appeared upon the subject, our knowledge has advanced little since the time of Meissner. The mass of evidence seems to favour the view that the creatinin daily excreted is derived from the creatin of muscle, but that the power of conversion is very limited, and that it varies in different individuals and in different species of animal.

The considerations here adduced seem to point to the conclusions:—(1) That creatin is formed from excess guanidin or methyl-guanidin in order to limit the toxic action of these; (2) that it is to a limited extent stored in muscle, any excess being excreted in the urine, either unchanged as in the bird, or in the form of creatinin in the mammal; (3) that during fasting and in the absence of carbohydrates it is liberated as the muscle disintegrates; and (4) that it may be recombined into the muscle molecule if the supply of carbohydrates is adequate.

RADIOTELEGRAPHY DURING THE SOLAR ECLIPSE OF MAY 29.[1]

In connection with the solar eclipse of May 29 the committee arranged for the carrying out of experiments on the effect of the eclipse on signals transmitted across the central line. The British Admiralty stations at Ascension and the Azores transmitted continuously during the transit of the umbra across the Atlantic Ocean. Observing stations north of the equator were for the most part asked to listen to Ascension for at least an hour round about the time when the umbra passed between themselves and Ascension; observers south of the equator were asked for the most part to listen to the Azores. Certain selected stations north of the equator were also asked to listen to the Azores, so as to afford check observations upon the variations which might be observed in signals passing across the central line of the eclipse, and, similarly, selected stations south of the central line were asked to listen to Ascension. The American station at Sayville also transmitted a programme during a portion of the period of the eclipse, and arrangements were made for special experiments between Darien and the Falklands, and between an Egyptian station and a South African station.

[1] Report of a Committee of the British Association presented to Section A at the Bournemouth meeting, September 1919.

The main portion of the experiment hinged upon Ascension. The umbral cone passed from west to east, and was expected to affect in succession the strength in which signals were received at such stations as Demerara, Jamaica, the stations on the coast of the United States and Canada, stations in Ireland, England, France, Italy, the Mediterranean, and Egypt.

The shadow of the moon struck the earth first at dawn on the coast of South America and swept across the continent in the course of half an hour, at first with enormous velocity, but losing speed as the Atlantic Ocean was approached. About the middle of the Atlantic Ocean and near the equator the speed of the shadow was about one-third of a mile per second. On crossing the African continent from the Gulf of Guinea to the Mozambique Channel the speed gradually increased, and the eclipse finished at sunset near Madagascar. The effects of the moving shadow were investigated under three heads:—

(1) Strays.

(2) Signals not crossing the denser parts of the shadow.

(3) Signals crossing through or near the umbra.

Strays.

These were bad on the day of the eclipse and on the preceding day in Europe, North America, and temperate latitudes on the Atlantic Ocean. They were very few in Central and South America and in the central equatorial Atlantic. In Central America the conditions were exceptional meteorologically, the day having less rain than nearly every day of the preceding three weeks. The preliminary survey of the results recorded throughout the part of the globe reaching from Constantinople to Rio de Janeiro suggests that there was no outstanding occurrence in regard to frequency or intensity of strays that could be directly ascribed to the passage of the shadow.

Signals not Traversing the Dense Shadow.

Many observations were made in northern Europe and America on the signals from the Azores, which were arc-signals of 4700 metres wave-length. The observing points extended from Berlin through Holland, France, Italy, Spain, and Great Britain to stations near the Atlantic coast of the United States. There were no unusual variations in the strength of the signals from the Azores.

Another class of experiment comes under this heading. It was suggested by the effect sometimes observed at sunset or sunrise, in which the twilight band when on one side of a transmitting station appears to strengthen as if by reflection the waves received at a station on the other side of the transmitting station. In order to test whether such reflections occurred during an eclipse certain stations on the south of the central line of the eclipse were asked to listen to Ascension, which was also south of the central line. The stations at Durban and Port Nolloth (South-West Africa) found no trace of the effect, and, in fact, the former concluded that the signals from Ascension were rather worse after the eclipse began. An analogous experiment on the northern side was carried out by one of the Malta stations and also at Rosyth, listening to Cairo, with similar conclusions.

Effect of Signals Passing across the Central Line.

Arrangements were made for the transmission of signals from the Darien station of the Panama Canal zone, and several stations in South America attempted to receive the signals. The report from the Falkland Islands has not yet come to hand, and the other stations in South America did not succeed in picking up the signals. The only observation made on the earlier stages of the eclipse are those of Demerara listening to Ascension. Fluctuations in signal strength are reported, but no steady increase or decrease in strength. Ships at sea within the penumbra report a strengthening of all signals during the eclipse. The most striking results were obtained at some of the stations in France, Malta, and Teneriffe. At Meudon and at Rousillon the signals from Ascension were received practically only while the eclipse was in progress. Both Malta and Teneriffe found that the eclipse produced a great improvement in the strength of signals. On the other hand, Durban was unable to pick up Cairo, though this is usually possible, but Aden was picked up with greater intensity than normal. On the whole, the records show that the improvement in signal strength reached its highest value long before the umbra intervened between the stations, and this value persisted after the umbra had passed; that is to say, if ionising processes are the cause of the change in the strength of signals, the results indicate that the processes are practically fully accomplished in a given region of the air before the arrival of the umbra at that place, so that there appears to be nothing left for the umbra to do in the few minutes of complete shadow it brings.

The thanks of the committee are due especially to the Admiralty for arranging that their stations at Ascension and the Azores should transmit the necessary signals, and also to the American Government for making similar arrangements regarding Savville and Darien. Thanks are due also to the American, French, and Italian Governments, the Admiralty, the War Office, the Air Ministry, and Marconi's Wireless Telegraph Co., Ltd., for undertaking observations and recording the variations in signal strength.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The council of the Senate reports that, after consultation with Sir W. J. Pope, it is considered desirable to establish a professorship of physical chemistry, the stipend of 1000*l.* per annum to be furnished out of the benefaction of the British Oil Companies.

The General Board of Studies has recommended the appointment of Mr. A. Amos, of Downing College, as University lecturer in agriculture. This appointment is proposed in view of the new scheme of study in agriculture, extending over three years, and the large increase of students in the department of agriculture.

GLASGOW.—President Poincaré was installed as Rector of the University on November 14, and delivered his rectorial address in English to an assembly of four thousand students and other members and friends of the University in St. Andrews Hall. The proceedings were conducted in admirable order, the students recognising that M. Poincaré was not only their Rector, but also the honoured chief of an Allied State, visiting this country as his Majesty's guest. The Vice-Chancellor, Sir Donald MacAlister, K.C.B., conferred on him the degree of LL.D. *honoris causa* before the installation. The Vice-Chancellor wore the Cross of Commander of the Legion of Honour, with which the President had privately invested him before the public ceremony.

At a meeting of the University Court held afterwards, the Rector in the chair, a number of important gifts to the University were announced. Among them were contributions amounting to about 20,000*l.* for the erection of a memorial chapel in commemoration of graduates and students who had fallen in the war; and 2000*l.* from Mr. Bonar Law and other heirs of the late Mr. J. R. K. Law, of Glasgow, for the foundation of a post-graduate studentship in applied science, to be held by bachelors of science pursuing advanced study or research at universities or scientific institutions in Canada, the United States, or France. The Rector was also asked to accept, on behalf of the French Government, a collection of about 500 volumes, chiefly Scottish, illustrative of the ancient Franco-Scottish alliance. These had been contributed by members of the University as a fraternal gift to the University of Nancy, in M. Poincaré's native province of Lorraine, the library of which had been completely destroyed by a German incendiary bomb in October, 1918, a few days before the armistice. The Rector accepted the gift, and presented to the University of Glasgow a fine Sèvres vase for the Hunterian Museum as a souvenir of his visit. In the afternoon President Poincaré was made an honorary freeman of the City of Glasgow.

Mr. John T. Cargill has offered the University a gift of 20,000*l.* to found a chair of applied physics.

DR. R. H. PICKARD, F.R.S., principal of the Municipal Technical School, Blackburn, has been appointed principal of the Battersea Polytechnic.

MRS. MARIA LOUISA MEDLEY has bequeathed 20,000*l.* to the University of Oxford to be applied for a George Webb Medley scholarship for the promotion of the study of political economy.

LORD MILNER, Secretary of State for the Colonies, has appointed a Committee to consider whether the staff of the Agricultural Departments in the Colonial Services is adequate, and, if necessary, to recommend increases of staff; to consider whether the rates of salary offered to the agricultural staff are adequate, and, if necessary, to suggest improvements; and to make recommendations for improving the arrangements for recruiting agricultural staffs for the Colonies. The members of the Committee are:—Sir Herbert Read, Assistant Under-Secretary, Colonial Office (chairman); Lt.-Col. Sir David Prain, director of the Royal Botanic Gardens, Kew; Sir Henry Birchenough, chairman of the Empire Cotton-growing Committee; Prof. J. B. Farmer, professor of botany, Imperial College of Science; Sir Francis Watts, Imperial Commissioner of Agriculture for the West Indies; Major R. D. Furse, Assistant Private Secretary (Appointments), Colonial Office; and Mr. F. L. Sidebotham, of the Colonial Office (secretary).

THE KING has approved the appointment of Royal Commissioners to consider the applications which have been made by the Universities of Oxford and Cambridge for financial assistance from the State, and for this purpose to inquire into the financial resources of the Universities and of the colleges and halls therein, into the administration and application of these resources, into the government of the Universities, and into the relations of the colleges and halls to the Universities and to each other, and to make recommendations. The Commissioners constitute one body, but are authorised to sit for purposes of inquiry in three separate committees. They consist of the following:—*Chairman of Commission:* Mr. H. H. Asquith. *Oxford Committee:* Mr. H. H. Asquith (chairman), Lord Chalmers, Sir John A. Simon, the Very Rev. T. B. Strong (Dean of Christ Church, Oxford), Sir H. A. Miers (Vice-Chancellor of Manchester University), Prof. W. H. Bragg (Quain professor of physics in London University), Prof. W. G. S. Adams (Gladstone professor of political theory and institutions, Oxford), Miss Emily Penrose (Principal of Somerville College, Oxford), and Mr. Albert Mansbridge. *Cambridge Committee:* Mr. G. W. Balfour (chairman), Mr. Arthur Henderson, Sir W. Morley Fletcher (fellow of Trinity College, Cambridge), Sir Horace Darwin, Mr. G. M. Trevelyan, Dr. H. K. Anderson (Master of Gonville and Caius College, Cambridge), Miss B. A. Clough (Vice-Principal of Newnham College, Cambridge), Dr. Montagu R. James (Provost of Eton College), and Prof. A. Schuster (secretary of the Royal Society). *Committee on Estates Management:* Lord Ernle (chairman), the Hon. Edward Strutt, Sir Howard Frank, Sir J. H. Oakley (past-president of the Surveyors' Institution), and Mr. H. M. Cobb (fellow and member of the council of the Surveyors' Institution). The secretary of the Commission is Mr. C. L. Stocks. There are three assistant secretaries, namely:—For the Oxford Committee, Mr. Marcus N. Tod, fellow and tutor of Oriel College, Oxford; for the Cambridge Committee, Mr. Edward Bullough, fellow of Gonville and Caius College, Cambridge; and for the Estates Committee, Mr. C. B. Marshall. The offices of the Commission are at 2 Queen Anne's Gate Buildings, Queen Anne's Gate, S.W.1.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 24.—Prof. C. H. Lees, president, in the chair.—Dr. N. W. **McLachlan**: The effect of pressure and temperature on a meter for measuring the rate of flow of a gas. The theory of an instrument for measuring the rate of flow of a gas is outlined, the effects of variation in the temperature and pressure of the gas being taken into consideration. This theory is tested experimentally for pressures varying from 1250 to 250 mm. Hg, and for temperatures from 10° C. to 100° C. It is found to be fairly accurate. The results are applied to the measurement of the rate of flow of gas on an aeroplane in the upper atmosphere, where a reduction in temperature and pressure is encountered. It is shown that the instrument reading for a certain N.T.P. volume of gas depends on the altitude, but that this volume can be obtained by using a correction factor.—Capt. J. H. **Shaxby**: A cheap and simple microbalance. The instrument, devised for bacteriological use, had to be cheap and moderately robust. It consists of a long horizontal fibre joining the lower ends of two vertical beams, each pivoted very little above its centre of mass. A small weight acting at the middle of the fibre thus causes a considerable depression. This is read off by arranging a slider on a vertical millimetre scale about 2 ft. in front, so that the middle of the fibre and a second short fibre placed just behind it are in line with a "peephole" on the slider. Adjustment is provided for quickly and largely altering the sensitiveness. The deflections are converted to masses by the use of calibrating weights. The apparatus is built up from a "Meccano" set.—J. W. T. **Walsh**: The resolution of a curve into a number of exponential components. The paper gives a method for the resolution of a curve of the compound exponential form $B = \sum_{1}^{n} a_1 e^{-\lambda_1 t}$ into its components, the values of a and λ for the n different exponential terms being found from $2n$ values of B equidistant along the axis of t. A method is also given for finding the most probable values of these constants from any number ($>2n$) of observed values of B taken at irregular intervals of t.

Aristotelian Society, November 3.—Prof. James Ward, president, in the chair.—The **President**: Inaugural address: In the beginning . . . The problem that the universe sets us is an inverse problem. But the two most distinguished philosophers amongst us, starting from the Absolute as their criterion, declare the whole world as we know it, including ourselves, as infected with contradictions, which are only resolved in the Absolute. Precisely how resolved we do not know, and never can know. But at least everything is blended and transformed into one perfect experience in which no finite centres of experience as such are respected or retained. Is the Absolute, then, making sport of us, it is asked, since the untransformed, discrepant "appearances," it would seem, must ever remain to perplex us? No, it is replied; for these appearances are the Absolute's revelation to us. Moreover, in the unification of our originally disjointed experiences which underlies all human development, and again in the ever-increasing mutual "transparency" of formally distinct individuals—who are thereby ever more and more enabled to think and feel and act as one—we can see the beginning of the process that in the Absolute is eternally accomplished. But, it was rejoined, the progress of knowledge shows no sign of reducing the categories of thought to the mere "adjective" with which, perhaps, it began. Nor does our advance to a higher unity show any tendency to replace stability and originality of character by mere "connections of content." In conclusion, it was urged that it is hopeless to attempt to begin from the point of view which only a *completed* philosophy could occupy. To advance continuously and be coherent—that should be our golden rule. The whole procedure would be tentative—that must always be the case with inverse problems. Crises, too, there would be again, as in the past; but such crises, after all, would only be cases of "sloughing an outgrown skin," not of radical disease. Philosophy on the whole had progressed; and so long as it followed the method which Nature herself observes—to make no leaps—why should it not progress still?

Mineralogical Society, November 4 (Anniversary Meeting).—Sir William P. Beale, Bart., president, in the chair. —Dr. W. R. **Schoeller** and A. R. **Powell**: Villamaninite, a new mineral. The new mineral, which occurs, disseminated in black grains and plates, with a distinct cleavage, and in small nodules with a radially fibrous structure, in a crystalline dolomite near Villamanin, Cármenes district, León province, Spain, has probably a composition corresponding with $(Cu,Ni,Co,Fe)(S,Se)_2$. Its streak is sooty-black, hardness 4½, and specific gravity 4·4–4·5; it is opaque.—A. **Russell**: The occurrence of phenakite and scheelite at Wheal Cock, St. Just, Cornwall. The author found good specimens of these minerals in 1914 at Wheal Cock, which is the locality whence came the crystal (undoubtedly phenakite) described by Sowerby in 1804 as argilla electrica or white tourmaline. Phenakite was not known until 1833 as a distinct species.—L. J. **Spencer**: New crystal-forms on pyrites, calcite, and epidote. On pyrites the dyakis-dodecahedron (641) occurs as large, well-developed faces on five specimens, one of them from Traversella, Piedmont, and the others from coal-shales of unknown locality. On 424 crystallised specimens of pyrites in the British Museum collection, 35 crystal-forms were noted. Faces of the cube are present on 76·6 per cent. of the specimens, the octahedron on 62·7 per cent., the pentagonal-dodecahedron (210) on 54·7 per cent., and the dyakis-dodecahedron (321) on 36·1 per cent. As simple forms, not in combination with other forms, they are represented by 12, 2, 2½, and ½ per cent. respectively. The decomposition of specimens of pyrites in collections was discussed. Calcite, a clear scalenohedral crystal, probably from Iceland, consists of a combination of the two scalenohedra (201) and (12.0.7), both largely developed, and with an angle of only 4½° between corresponding faces. Epidote, a crystal, probably from Ala, Piedmont, closely resembling in appearance the yellow prismatic crystals of anatase, carries a minute face (134) (Dana's orientation) in addition to twenty other crystal-forms.—Dr. G. F. Herbert **Smith**: A curious crystal from the Binnental. The crystal, which was found with a few loose sartorite crystals in the Trechmann collection, is twinned and tabular in habit, and shows signs of corrosion. The symmetry is peculiar, since, although a face occurs at right angles to the prism edge, it is neither a plane nor a pole of symmetry, and the crystal appears to represent a new species of sulpharsenite.

MANCHESTER.

Literary and Philosophical Society, October 7.—Mr. Francis Jones, vice-president, in the chair.—Sir Henry A. **Miers**: The future of the Manchester Literary and Philosophical Society. Attention was especially directed to the urgent need in societies for informal discussions, a work performed by such societies in their pioneer days. With the increase of scientific knowledge the tendency has been for scientific people to segregate into special groups. As a result of this, the papers read at modern specialist societies are calculated to appeal only to experts. A reaction is indicated by recent attempts at co-operation between the humanities and sciences. Great work could be done by making the most recent advances in science understood by those who were not experts, and by promoting meetings at which new ideas can be expressed in language intelligible to all. There is danger of a scientific hierarchy, and of a cleavage between specialists and amateurs. Investigators might be encouraged to give popular expositions of their own discoveries to a general audience, in addition to the more severely scientific paper intended for publication.

PARIS.

Academy of Sciences, October 27.—M. Léon Guignard in the chair.—C. **Moureu** and A. **Lepape**: The stabilisation of acrolein. An empirical method of stabilisation. The crude aldehyde is shaken with 10 per cent. of its weight of dry sodium bicarbonate. The acidity is reduced to 5 per cent. of its original value, and the acrolein so produced is practically stable.—A. **Chatelet**: Hypercomplex numbers with associative and commutative multiplication.—E. T. **Bell**: Particular representations by some quadratic forms of Liouville.—P. **Chevenard**: The viscosity of steels at high temperatures. A chrome-nickel steel wire was maintained at a constant temperature in an atmosphere of nitrogen, and the elongation under a fixed load measured photographically as a function of the time.—H. **Vanderlinden**: Observations of Borrelly's comet 1919*c*. Measurements were made at the Royal Belgian Observatory at Uccle on October 18, 22, and 23. On October 22 the comet appeared as a nebulosity of 1′ diameter. The nucleus was clear, and of magnitude about 9.—J. **Volmat**: The application of aerial photography to hydrographic surveys. Photographs from an aeroplane of the sea-floor in the neighbourhood of Brest proved the great possibilities of this method of marine surveying. Several points of rock which had escaped previous careful surveys were discovered with ease.—L. **Majorana**: Experiments on gravitation.—E. **Perucca**: Plane waves laterally indefinite, with pendular vibrations, which reflection and refraction associate with one or two given analogous systems of incident waves.—H. **Muraour**: The comparison of explosion temperatures calculated starting from the specific heats with those calculated starting with the explosive pressures.—M. **Chelle**: The transformation of hydrocyanic acid into thiocyanic acid in the course of cadaveric putrefactions; experiments made *in vitro*. In putrefactive phenomena hydrocyanic acid is in part transformed into thiocyanate. In some experiments *in vitro* with known quantities of cyanide added to normal blood, after ten days the hydrocyanic acid had apparently disappeared, but could be almost wholly recovered by oxidising the thiocyanate formed.—L. **Joleaud**: The tectonic of the neighbourhood of Tilouanet (Oran).—C. E. **Brazier**: The relations of the wind with gradient in the lower layers of the atmosphere.—J. **Ubach**: Observations made at Buenos Aires during the annular eclipse of the sun of December 3, 1918. Details of variations of the magnetic declination observed during the eclipse.—E. **Sollaud**: The influence of the conditions of the medium on the larvæ of *Palaemonetes varians microgenitor*.—J. **Nageotte**: Osteogenesis in grafts of dead cartilage.—A. **Paillot**: Karyokinetosis; new facts and general considerations.—A. **Marie**, C. **Levaditi**, and G. **Banu**: New attempts to transmit the treponeme of general paralysis to the rabbit.

BOOKS RECEIVED.

The Physiology of Muscular Exercise. By Prof. F. A. Bainbridge. Pp. ix+215. (London: Longmans and Co.) 10s. 6d. net.

A Course of Practical Chemistry for Agricultural Students. By H. A. D. Neville and L. F. Newman. Vol. ii., part 1. Pp. 122. (Cambridge: At the University Press.) 5s. net.

The Story Book of Science. By J. H. Fabre. Pp. 299. (London: Hodder and Stoughton.) 7s. 6d. net.

Modern Science and Materialism. By H. Elliot. Pp. vii+211. (London: Longmans and Co.) 7s. 6d. net.

Elements of Physics. By Dr. R. A. Houston. Pp. viii+221. (London: Longmans and Co.) 6s. net.

Mensuration for Marine and Mechanical Engineers. By J. W. Angles. Pp. xxvii+162. (London: Longmans and Co.) 5s. net.

Chemical Calculation Tables. By Prof. H. L. Wells. Second edition. Pp. v+43. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6s. 6d. net.

Food: Its Composition and Preparation. By M. T. Dowd and J. D. Jameson. Pp. viii+173. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6s. net.

Popular Oil Geology. By Prof. V. Ziegler. Pp. viii+149. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 11s. 6d. net.

Commercial Oils: Vegetable and Animal, with a Special Reference to Oriental Oils. By I. F. Laucks. Pp. viii+138. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6s. net.

Vital Statistics. By Prof. G. C. Whipple. Pp. xii+517. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 18s. 6d. net.

Lectures on Ten British Physicists of the Nineteenth Century. By A. Macfarlane. Edited by M. Merriman and R. S. Woodward. Pp. 144. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 7s. 6d. net.

Bacteriology and Mycology of Foods. By Dr. F. W. Tanner. Pp. vi+592+10 plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 28s. net.

A Text-book of Hygiene for Training Colleges. By M. Avery. Pp. xv+324. (London: Methuen and Co., Ltd.) 7s. 6d. net.

Unified Mathematics. By Prof. L. C. Karpinski, Prof. H. Y. Benedict, and Prof. J. W. Calhoun. Pp. viii+522. (London: G. G. Harrap and Co., Ltd.) 10s. 6d. net.

Groundwork of Surgery. (For First-Year Students.) By A. Cooke. Pp. viii+183. (Cambridge: W. Heffer and Sons, Ltd.)

Rückläufige Differenzierung und Entwicklung. By A. Cohen-Kysper. Pp. 85. (Leipzig: J. A. Barth.) 3 marks.

Handbook of Mineralogy, Blowpipe Analysis, and Geometrical Crystallography. By Prof. G. M. Butler. Pp. ix+311; v+80; viii+155. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 16s. 6d. net.

An Introduction to Theoretical and Applied Colloid Chemistry. By Dr. W. Ostwald. Translated by Prof. M. H. Fischer. Pp. xv+232. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 11s. 6d. net.

The Chemistry of Colloids. By Prof. R. Zsigmondy and Prof. E. B. Spear. And a Chapter on Colloidal Chemistry and Sanitation. By Dr. J. F. Norton. Pp. vii+288. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13s. 6d. net.

A Handbook of Physics Measurements. By E. S. Ferry and others. Vol. i. Pp. ix+251. Vol. ii. Pp. x+233. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 9s. 6d. net each.

Engineering Education: Essays for English. Selected and edited by Prof. R. P. Baker. Pp. ix+185. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6s. net.

A Handbook to the Vertebrate Fauna of North Wales. By H. E. Forrest. Pp. v+106. (London: Witherby and Co.) 6s. net.

Thalassiophyta and the Subaerial Transmigration. By A. H. Church. Pp. 95. (London: Oxford University Press.) 3s. 6d. net.

A Synoptical List of the Accipitres. By H. Kirke Swann. Part ii. (London: J. Wheldon and Co.) 4s.

Chemistry from the Industrial Standpoint. By P. C. L. Thorne. Pp. xvi+244. (London: Hodder and Stoughton.) 4s. 6d. net.

Applied Botany. By G. S. M. Ellis. Pp. viii+248. (London: Hodder and Stoughton.) 4s. 6d. net.

Elementary Biology. By B. C. Gruenberg. Pp. x+528. (Boston and London: Ginn and Co.) 7s. net.

Radio-Diagnosis of Pleuro-Pulmonary Affections. By F. Barjon. Translated by Dr. J. A. Honeij. Pp. xix+183. (London: Oxford University Press.) 10s. 6d. net.

Elements of Vector Algebra. By Dr. L. Silberstein. Pp. vii+42. (London: Longmans and Co.) 5s. net.

Researches in Physical Optics. By Prof. R. W. Wood. Part ii. Resonance Radiation and Resonance Spectra. Pp. viii+184+x plates. (New York City: Columbia University Press.)

Practical Leather Chemistry. By A. Harvey. Pp. viii+207. (London: Crosby Lockwood and Son.) 15s. net.

A Practical Handbook of British Birds. Part 5. Pp. 273–336+2 plates. (London: Witherby and Co.) 4s. net.

Le Mythe des Symbiotes. By A. Lumière. Pp. xi+209. (Paris: Masson et Cie.) 6 francs net.

Manuel Pratique de Météorologie. By J. Rouch. Pp. viii+145+xiv plates. (Paris: Masson et Cie.) 6.50 francs net.

Toxines et Antitoxines. By M. Nicolle, E. Césari, and C. Jouan. Pp. viii+123. (Paris: Masson et Cie.) 5 francs net.

Anesthésie à la Stovaïne en Chirurgie et en Médecine

Vétérinaire. By G. Perol. Pp. 31+vi plates. (Paris: Masson et Cie.) 3 francs net.

Arcachon Ville de Santé. Monographie Scientifique et Médicale. By Dr. F. Lalesque. Pp. viii+798. (Paris: Masson et Cie.) 25 francs net.

The Oliver-Sharpey Lectures on the Feeding of Nations. By Prof. E. H. Starling. Pp. ix+146. (London: Longmans and Co.) 5s. net.

Chemistry and its Mysteries. By C. R. Gibson. Pp. 246. (London: Seeley, Service, and Co., Ltd.) 4s. 6d. net.

Submarine Warfare of To-day. By Lieut. C. W. Domville-Fife. Pp. 304. (London: Seeley, Service, and Co., Ltd.) 7s. 6d. net.

W. and A. K. Johnston's Modern Atlas of Commerce. Pp. 48. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1s. 10d. net.

The Realities of Modern Science. By J. Mills. Pp. xi+327. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10s. 6d. net.

Profit and Sport in British East Africa: Being a Second Edition, Revised and Enlarged, of "A Colony in the Making." By Capt. the Lord Cranworth. Pp. xvi+503. (London: Macmillan and Co., Ltd.) 21s. net.

Accounts Rendered of Work Done and Things Seen. By J. Y. Buchanan. Pp. lvii+435+3 plates. (Cambridge: At the University Press.) 21s. net.

Palæontology: Invertebrate. By H. Woods. Fifth edition. Pp. viii+411. (Cambridge: At the University Press.) 12s. 6d. net.

A Geographical Bibliography of British Ornithology from the Earliest Times to the End of 1918. By W. H. Mullens, H. Kirke Swann, and Rev. F. C. R. Jourdain. Part i. Pp. 96. (London: Witherby and Co.) 6s. net.

The Art of Anæsthesia. By Dr. P. J. Flagg. Second edition. Pp. xviii+367. (Philadelphia and London: J. B. Lippincott Co.) 18s. net.

Atlas of Operative Gynæcology. By Prof. B. C. Hirst. Pp. vi+202. (Philadelphia and London: J. B. Lippincott Co.) 30s. net.

The Mystery of Easter Island: The Story of an Expedition. By Mrs. Scoresby Routledge. Pp. xxi+404. (London: Sifton, Praed, and Co., Ltd.) 31s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 20.

ROYAL SOCIETY, at 4.30.—W. J. Johnston: A Linear Associative Algebra suitable for Electro-magnetic Relations and the Theory of Relativity.—Sir Joseph Larmor: Note on Mr. W. J. Johnston's Calculus for Generalised Relativity.—G. E. Bairsto: On the Variation with Frequency of the Conductivity and Dielectric Constant of Dielectrics for High Frequency Oscillations.—F. J. W. Whipple: Equal Parallel Cylindrical Conductors in Electrical Problems.—G. A. Schott: The Scattering of X- and γ-Rays by Rings of Electrons. A Crucial Test of the Electron Ring Theory of Atoms.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 4.30.—*Cases*: Dr. Bunch: Case of Linear Morphœa.—Dr. MacLeod: (1) Melanotic Lesion on Sole of Foot; (2) Case for Diagnosis.—Dr. Barber: (1) Case for Diagnosis-Blastomycosis (?); (2) Erythrodermie Congenitale Ichtyosiforme.

LINNEAN SOCIETY, at 5.—K. Patten: Plants collected in Mesopotamia and in Southern India.—C. C. Lacaita: *Orchis maculata* from Monte Gargans, Italy.—Dr. G. C. Druce: Two New British Plants.—Miss Trower: Paintings of British *Rubi*.—Prof. R. C. McLean: Sex and Soma.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—H. L. Sulman: A Contribution to the Study of Flotation.

CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. D. Forsyth: The Pre-School Girl.

CHEMICAL SOCIETY (and Informal Meeting), at 8.

FRIDAY, NOVEMBER 21.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—H. Tilley: Presidential Address—A Plea for the Better Education of the Medical Student in Oto-Rhino-Laryngology.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—C. G. Conradi: The Present Position of Mechanical Road Traction.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—A. P. Trotter: Opening Address.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. G. B. Batten: Apparatus for Obtaining Morton Wave Current and Static Modalities from a Coil.—Major G. Cooper: The Artificial Stimulation of Muscle, with Demonstration of a New Form of Faradic Coil.

MONDAY, NOVEMBER 24.

INSTITUTE OF ACTUARIES, at 5.—Dr. C. E. Howell: The Reversionary (or Prospective) and Collective Methods of Valuing Widows' Funds, with some Notes on the Valuation of the Church of Ireland Widows' and Orphans' Fund.

TUESDAY, NOVEMBER 25.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 5.30.—L. Gaster: The Works of Lambert.—The Hon. Secretary: Report on Progress.

INSTITUTION OF CIVIL ENGINEERS (Extra Meeting), at 5.30.—H. H. Gordon: Metropolitan Road and Rail Traffic.

ROYAL ANTHROPOLOGICAL INSTITUTION, at 8.15.—Dr. W. Strong: Some Personal Experiences in British New Guinea.

WEDNESDAY, NOVEMBER 26.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Maj.-Gen. Sir George Aston: Combined Operations.

ROYAL SOCIETY OF ARTS, at 4.30.—Dr. H. B. Morse: British Trade in China.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—J. Scott-Taggart: A System for the Reception of Continuous Waves.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—G. Brewer: Some Kite-Balloon Experiments.

THURSDAY, NOVEMBER 27.

ROYAL COLLEGE OF SURGEONS, at 3.—Annual Meeting of Fellows and Members.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—C. C. Paterson, J. W. T. Walsh, A. K. Taylor, and W. Barnett: Carbon Arcs for Searchlights.

FRIDAY, NOVEMBER 28.

PHYSICAL SOCIETY, at 5.—Discussion on Lubrication. To be opened by Dr. T. E. Stanton. Speakers include Principal Skinner, W. B. Hardy, F. W. Lanchester, and H. M. Martin. Visitors are invited to this Meeting.

CONTENTS.

PAGE

Vertebrate Embryology. By S. J. H. 309
The Rarer Elements. By J. H. Gardiner . . . 310
Race and Nationality. By Prof. A. Keith, F.R.S. . 311
Our Bookshelf . . . 311
Letters to the Editor:—
Percussion Figures in Isotropic Solids (*Illustrated.*)—James Weir French 312
The Breeding of the King Penguin.—T. H. Gillespie 314
A Helium Series in the Extreme Ultra-Violet.—Prof. Theodore Lyman 314
Variations of Refractive Index.—F. Twyman . . . 315
The Audibility of Thunder.—Dr. Henry O. Forbes 315
Linkage in the Silkworm: A Correction.—Prof. W. Bateson, F.R.S. 315
The Prehistory of South Africa. (*Illustrated.*) By Sir H. H. Johnston, G.C.M.G., K.C.B. . 315
Lt.-Col. B. F. E. Keeling. By Col. H. G. Lyons, F.R.S. 317
Notes 318
Our Astronomical Column:—
Large Fireball 321
Comets 321
Unveiling of Lister Memorial Tablets. (*Illustrated.*) 322
The British Association at Bournemouth:—
Section I—Physiology—Opening Address (Abstracted) by Prof. D. Noël Paton, M.D., F.R.S., President of the Section 322
Radiotelegraphy during the Solar Eclipse of May 29 323
University and Educational Intelligence 324
Societies and Academies 325
Books Received 327
Diary of Societies 328

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THURSDAY, NOVEMBER 27, 1919.

THE ROYAL COMMISSION ON THE UNIVERSITIES OF OXFORD AND CAMBRIDGE.

SEVERAL months ago, Mr. H. A. L. Fisher, President of the Board of Education, made the important announcement that the Government had decided to appoint Commissions to inquire into the position of the Universities of Oxford and Cambridge. At both Universities the existing resources have proved inadequate to meet the increased cost of maintenance of the various departments, and the authorities of each independently applied to the Government for financial aid. It was understood that in due course comprehensive inquiries into the whole resources of the Universities and their colleges, and the use made of them, would be instituted; and preliminary grants of 30,000*l.* to each University were accepted on this condition. With reconstruction in the air and Government inquiries in the fashion, it is not surprising, therefore, that a Royal Commission (under the chairmanship of Mr. Asquith), with separate Committees for Oxford and Cambridge, and a further Committee dealing with estate management, has now been appointed to inquire into the financial resources of the two Universities and of the colleges, into the administration and application of these resources, into the government of the Universities, and into the relation of the colleges to the Universities and to each other.

It is more than forty years since the last Royal Commission on the Universities of Oxford and Cambridge was appointed, and the advisability of a new Commission has frequently been suggested in recent years. The question was debated in the House of Lords in 1907, but it was believed at the time that it would be better for the Universities to institute reforms from within; and at Oxford the Chancellor, Lord Curzon, made an extensive inquiry into the possibility of such reforms, following it up by an open "letter" addressed to the University, containing a number of valuable suggestions. Some of these have since been acted upon, but others, such as the abolition of compulsory Greek in the entrance examination, have temporarily succumbed to the conservatism of certain members of the University, more especially the non-resident members of Convocation. Still other questions, such as that relating to degrees for women, have been postponed owing to the war, but they are likely to come up for consideration in a very short time. Hence there would not have been any very cogent grounds for the immediate appointment of a fresh Commission, had it not been for finance. At Oxford, whilst the income of the University has fallen, its expenses have greatly increased. Science in particular, owing to the increase in the number of its students and to the range of their studies, has been forced to make special demands for further laboratory accommodation and for increased grants for teaching purposes.

Considering the special needs of science, the composition of the Oxford Committee is not altogether satisfactory. Of the nine members of the Committee, only two are men of science, whilst in the Cambridge Committee science has been assigned twice as great a representation. However, there can be no question of the suitability of the scientific representatives themselves. One of them, Sir Henry Miers, when professor of mineralogy at Oxford, was of invaluable assistance, by his moderation and persuasiveness, in bringing the just claims of science before the resident members of the University. Prof. W. H. Bragg will bring to the inquiry the freshness and width of outlook of one who has had experience of research and professorial teaching in two hemispheres. Miss Penrose, the principal of Somerville College, is a worthy exponent of the claims of women, while Labour is presumably represented by Mr. A. Mansbridge.

The Cambridge Committee is one to which, at any rate as individuals, and from the point of view of the University itself, little exception can be taken. It contains one woman (Miss Clough), one representative of Labour (Mr. Arthur Henderson), six (or, including Miss Clough, seven) members of the University, and four distinguished fellows of the Royal Society, namely, Sir W. Morley Fletcher, Sir Horace Darwin, Dr. H. K. Anderson, and Prof. A. Schuster. It is, however, a pity that the younger generation should be so inadequately represented. The Committee has an average age of about sixty years, and although there are many really distinguished members of the University between the ages of twenty-eight and forty-three, and it is these men who will have mainly to bear the brunt of the next twenty years, there is nobody on the Committee to emphasise their point of view. The absence also of an expert in finance, industry, or economics is noteworthy, and—one would imagine—will make the task of the Committee more difficult.

Apart from these objections, however, it is clear that Cambridge has nothing to fear, and may have much to gain, from its Committee's activities. The four scientific members are known as men of sound judgment, wide knowledge, and an enthusiasm for scientific progress, while they have been as much concerned with the importance of science to the well-being and prosperity of the community as with its value in education and in the improvement of human knowledge. All of them are men who personally have done valuable original research, and shown the capacity for affairs and the sound judgment necessary in these days of organised scientific work.

The terms of reference of the Commission relate, not only to questions of finance, but also to the government of the Universities and the relations of the colleges to the Universities and to each other; hence the inquiry is likely to be an extensive one. In the course of the inquiries to be made, many anomalies will doubtless be revealed. Our educational structure is curiously unbalanced. It has grown up cathedral-like, and bears witness to the loving, if sometimes misguided, benefactions of many generations. We trust that the Commissioners, while retaining all that is good—and there is much that is worthy of preservation—will ensure a more economical and equitable distribution of the fruits of past benefactions for the encouragement of religion, learning, education, and research.

In particular, we would direct attention to the need for greater facilities for research, not only in pure science, but also in modern philosophy. It is almost incredible that Oxford, the home of classical learning, cannot boast of a single exponent of modern philosophy who might be expected to explore the regions of thought revealed by recent scientific research on space and time. The discontinuities of modern physics should surely not appeal in vain to the heirs of the wisdom of the Greek philosophers.

Further, the hard-worked science tutor should be afforded time and facilities for research. A critical study by the Commissioners of the distribution of tutors in the various subjects and of the relative number of pupils allotted to each tutor would form an instructive lesson on our educational methods. Some relief could be given to science tutors if it were made compulsory for candidates for degrees in science to obtain exemption from preliminary physics and chemistry before admission to the University. This would also relieve the already overburdened laboratories.

Other questions relating to natural science with which the Commission must deal are: (*a*) The urgent need for further buildings and equipment, and for increased staff, if the present rush of students is to be met, and if research is to be maintained; (*b*) the sufficient remuneration of the teaching and research staffs, and the recognition of the fact that the research worker is no less entitled to payment for his labours than the business man, the teacher, or the labourer; (*c*) the better support of natural science by the colleges (in proportion to its importance, natural science is inadequately assisted by many colleges in the matter of scholarships, fellowships, and lectureships); (*d*) the provision of pensions for professors and other officials, and the introduction of a definite age for retirement. This last matter is particularly important in natural science, where the professors have administrative and organising duties, as well as those of lecturing and directing research, and there is no reason why a university should be an exception to the general rule in any large undertaking, national or private, that an executive appointment should be subject to an age limit.

The Committee on Estate Management will have to consider the more efficient administration of college property, and may recommend the adoption universally of the system already agreed to by three important colleges at Cambridge of employing a common estate office connected with the School of Agriculture. The present system of awarding scholarships, the subject of women's degrees, the finances of the women's colleges, and the cost of living of the average undergraduate are among the more controversial matters to be decided. Whatever may be the course of their deliberations, however, it is clear that Cambridge will not be encouraged, as it might have been under another type of Commission, to cease its national function as a home of "religion, learning, and research," and to become a place merely of technical instruction. Whatever faults the Commission may have will lie, not in a lack of sympathy for education and research in the best sense, but in a rather conservative outlook and an inability to understand the urgency of really radical changes, in an insufficient appreciation of the needs and demands of the great labouring classes of the country, and in lack of understanding of the point of view of the younger generation.

PRINCIPLES OF RADIO-COMMUNICATION.

The Principles underlying Radio-communication. Radio Pamphlet No. 40. December 10, 1918. Signal Corps, U.S. Army. Pp. 355. (Washington: Government Printing Office, 1919.) Price 55 cents.

THIS book has been prepared by the Bureau of Standards, Washington, under the direction of the Chief Signal Officer of the Training

Section of the United States Army. It gives an accurate survey of the theory of electromagnetism with special stress on its application to practical radio-communication. Very little mathematical knowledge is assumed on the part of the reader, and the familiar analogies given will be a great help to beginners.

The first and second chapters give a clear *résumé* of elementary electricity and the working of dynamos. In the third chapter radio-circuits are described, stress being laid on coupled circuits, oscillations, damping and effective resistance. The fourth chapter describes electromagnetic waves, and the academic theorist will be surprised at the simplicity and accuracy of the transmission formulæ used in practice. Descriptions of the best types of antennæ and of open and closed coil aerials are also given. In chap. v. the apparatus used in transmission and reception is described, and it is carefully stated which is suitable for damped and which for undamped waves. Chap. vi., the final chapter in the book, will be very helpful to many, as it gives an excellent account of the various types of vacuum tubes now in use. By means of the characteristic curves the working of the three-electrode tube is simply explained. Its use as an amplifier, modulator, and generator of oscillations is fully described. The method of connecting vacuum tubes in cascade is also given.

Many fail to recognise how easy it is to detect radio-waves, and how simple is the necessary apparatus. For damped waves, all that is required is a telephone receiver, a rectifier (crystal "detector," or, better, a vacuum tube), and a tuning coil. It seems to us to be foolish for the Post Office to keep up the comedy of pretending to regulate the use of such sets. Now that the licences to technical colleges have been formally withdrawn it would be politic to issue new ones without any further delay.

The latest developments of radio-communication make the subject of absorbing interest to the engineer and the man of science. For instance, the power involved in the sound-waves generated in ordinary speech is of the order of the hundred-millionth of a watt, and yet in radio-telephony this controls several thousands of watts, the alternating currents being at radio frequency. In the pre-war days the use of crystal rectifiers introduced an element of uncertainty into everyday working. This was overcome by the Fleming valve, which is now replaced by the three-electrode vacuum tube. For measurement purposes the vacuum tube is far superior to the "buzzer" as a source of oscillations. If several tubes are used in the same circuit, and each tube has its own battery, then the amplitude and frequency of the current-waves can be made practically constant.

There are very many interesting and novel facts given which will be of great value to the radio engineer. The book can be heartily recommended to every man of science who wishes to know the latest practical developments. A. R.

ROUND THE WREKIN.

Shropshire: The Geography of the County. By Prof. W. W. Watts. Pp. x+254. (Shrewsbury: Wilding and Son, Ltd., 1919.) Price 2*s*. 6*d*. net.

SHROPSHIRE, in its combination of mountain and plain, in the varied flow and scenery of its river, for which the whole county serves as catchment basin, in the extent of its stratified rocks from pre-Cambrian to Lias, in their yield of coal, building-stones, metals, and workable clays, lends itself admirably to treatment by a geographer who is also a geologist, and it is needless to say that Prof. Watts, whose geological studies of the county alone or in conjunction with Prof. Lapworth have been a guide to so many, avails himself thoroughly of the opportunity. The rich and beautiful forests, the meres, and the rocky uplands support a multiform assemblage of birds. The more important among these and other animals are noted, but it might have been mentioned that a complete series of the vertebrate fauna has been collected and placed on exhibition by Mr. H. E. Forrest in the Shrewsbury Museum. The diversified agriculture and the numerous industries down to the making of "churchwardens" are briefly correlated with rocks and soil.

But Prof. Watts recognises that the great interest of Shropshire lies in its human inhabitants and their history. Though Palæolithic man has left no trace in the county, his Neolithic successors are known, not merely from their weapons, stone circles, and barrows, but from their many descendants in the present population. The Brythons, who became the Cymry to themselves, the Welsh to their enemies, are now represented by about one-tenth of the inhabitants. Their coracle is still used by Severn fishermen. It was the struggle between them and the English compound of Angles and Normans that so long made Shrewsbury a city of prime importance. All this eventful history and its relation to the physical features is clearly summarised by Prof. Watts.

The beautiful half-timbered houses of the fifteenth, sixteenth, and seventeenth centuries are famous, but such stone mansions as those of Benthall and Condover, such castles as Stokesay, Ludlow, and Shrewsbury, and the fine ecclesiastical architecture of Buildwas, Wenlock, Ludlow, and Shrewsbury, receive description and illustration so far as space admits. A chapter on the place-names is of peculiar interest, and the sections on communications and the origins of the chief towns are excellent lessons in political geography. Coloured physical and geological maps form the end-papers of the book.

There is an index, but it has not helped a reviewer fresh from his home-county to find the explanation of "Meole," the meaning of the "Weeping Cross," the origin of Bomer and similar "pools," or any reference to the "Burries" or Burgs of Bayston Hill. Farquhar's "Recruiting Sergeant" might be worth a line. A Salopian also may suggest that the hills once studied by Prof. Watts should be called "the Breidden," not "the Breiddens." But these remarks are not criticisms. The book will prove a charming and trustworthy companion to any observant traveller in the beautiful native county of Charles Darwin.

OUR BOOKSHELF.

Tri-lingual Artillery Dictionary. By E. S. Hodgson. With introduction by Col. J. H. Mansell. In three volumes. Vol. i., *English-French-Italian.* Pp. viii+92. (London: Charles Griffin and Co., Ltd., 1918.) Price 5s. net.

WITH the progress of every department of engineering, new technical terms are being continually introduced into the languages of various nations. In the case of artillery, the difficulty of intercommunication which thus arises is considerably increased owing to the conditions under which international relations become necessary in the progress of military operations. Any reader who thinks himself to be a good French or Italian scholar will receive a rude awakening if he opens any page of this book. Even among the most commonplace technical terms he will find the French and Italian equivalents to be quite different from anything that would naturally have been imagined. It is quite evident that much of the work of preparing such a book falls within the definition of original research.

It might be possible for officers of various nations to make each other understand their meaning by pointing to a gun or a model or a drawing, but the use of the telephone renders this method inadequate. By making this dictionary of the size of a quarter-plate photograph, Mr. Hodgson has given officers a book which they can easily carry about and use in communicating with their French and Italian colleagues. The latter ought, of course, to have corresponding books also. It is, moreover, quite certain that a companion volume for German will be urgently needed under any conditions which the future may have in store.

Apropos of dictionaries, the following suggestion is not without a certain significant aspect, namely, that a dictionary is wanted between the language of the Tripos type of mathematical examination paper and the language of the engineering factory. The difference of language certainly does harm. G. H. BRYAN.

The Mycetozoa: A Short History of their Study in Britain; an Account of their Habitats Generally; and a List of Species Recorded from Essex. By Gulielma Lister. (Essex Field Club Special Memoirs, vol. vi.) Pp. 54. (Stratford, Essex: The Essex Field Club; London: Simpkin, Marshall, and Co., Ltd., 1918.) Price 3s. net.

THE Essex Field Club has done well to reprint as a whole the subject-matter of Miss Lister's two presidential addresses, and in this way to render them available to a larger public than the readers of the *Essex Naturalist.*

The list of species recorded from Essex is mainly of county interest, but it is the county to which Miss Lister and a number of friends who have been inspired by her work and that of her father have devoted special attention, and therefore serves as an object-lesson to naturalists in other counties. The tabulated lists at the end of the book of the species recorded from similar areas in the Home Counties, the West of England, and the North of Scotland respectively, indicate what may be done by a few enthusiasts in the study of this interesting little group at the base of organised life.

But the greater part of the volume is of wider interest. The first section, on the study of Mycetozoa in Britain, is an historical *résumé* of their study in this country, from the time of John Ray, who refers to one of our commoner species in his "Synopsis of British Plants" in 1696, and of Dillenius, who figures several species in an enlarged edition of the "Synopsis" in 1724, to the classic "Descriptive Catalogue of the Mycetozoa," by Mr. Arthur Lister, in 1894. This monograph, in the preparation of which Miss Lister shared, and the handy little "Guide to the British Species" have done much to extend the study of the group, both in Great Britain and abroad, as is indicated by the rapidly increasing number of species in successive editions of the "Guide," the fourth of which is now being issued by the Trustees of the British Museum.

The second section, on the habitats of the Mycetozoa, will be of great service to workers in indicating where to look for these organisms, and what species are likely to be found in special environments. The habitat varies remarkably, including woodlands, alpine pastures, moorland, rocks, bare earth, sawdust- and straw-heaps, manure, and even bone. A useful list gives a selection of the habitats with the associated species.

Guide to the Study of the Ionic Valve: Showing its Development and Application to Wireless Telegraphy and Telephony. By W. D. Owen. Pp. vii+59. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2s. 6d. net.

THIS little book is divided into fifteen chapters, each chapter consisting of three or four paragraphs of large print describing the historical development of the ionic valve, the principles on which it works, and the various types of valve that are now used in wireless telegraphy. The diagrams are clear, of large size, and not overcrowded with details. References are given to the original papers describing the various forms of valves and their developments. The book can be recommended to all who intend to take up the serious study of radio-telegraphy, as it will impress the main facts about the ionic valve on their minds.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Holland and International Rivers.

IN NATURE of October 16 is published an address on "The International Rivers of Europe," read at the British Association by Prof. L. W. Lyde. A large part of the address is concerned with the proposition that Holland is the only European country which has so far failed to accept the salutary principle that a great navigable river cannot be monopolised by a single political unit against riparians—a proposition which Prof. Lyde tries to prove, amongst other things, by an analysis of the case of the Ghent-Terneuzen Canal.

In order not to occupy too much of your space I shall deal only with that question (although some extraordinary remarks of Prof. Lyde's on the Maas and the Rhine invite comment), and only with the most important aspect of it, which is that of the dimensions of the canal in Dutch territory. Prof. Lyde denies the truth of the Dutch assertion that Belgium has enjoyed freedom of navigation on the ground that the dimensions of the Terneuzen-Ghent Canal are too small in Dutch territory. He then gives an outline of the history of the enlargements, which, if his statement about freedom of navigation means anything, should prove that Holland is responsible for those dimensions. Now not only does Prof. Lyde not prove this, but it is contrary to well-established fact. Holland has never put any difficulties in the way of Belgian desires for the enlargement of a waterway which, as a commercial communication, serves mainly, if not exclusively, the interests of the port of Ghent. Prof. Lyde calls italics to his aid to emphasise that eight years were wasted in the 'seventies before the Convention of 1879 was concluded, which arranged for the first enlargement. Wasted by whom? If one reads up the story in Guillaume, "L'Escaut," vol. ii., p. 439 (the authoritative work on this matter, published in 1902 by the then Belgian Minister at The Hague), one sees that in 1874 already the Dutch and Belgian Governments had reached an understanding, but that the Belgian Parliament, moved by an agitation which had its origin in Antwerp (where Ghent was feared as a possible competitor), threw over the Belgian Government.

The Convention of 1895 was concluded, as Guillaume puts it, "aisément" ("easily")—that is to say, the Dutch acceded at once to the requests put forward by the Belgians. In the same way, when, in 1902, while the enlargement was still being executed, the Belgian experts decided that a further enlargement was desirable, the two Governments agreed almost at once on a new convention in which the dimensions were laid down which the canal has at the present moment. If those dimensions are smaller in Dutch than in Belgian territory, it is because the works of 1895 were in 1902 in a more advanced state in the Dutch than in the Belgian part of the canal, so that in the latter they admitted more easily of readjustment. But the dimensions in the Dutch part are those which the Belgians asked for, and no other, nor have they since then asked for any further enlargement which Holland has refused. On the contrary, if, as a result of the negotiations now proceeding in Paris, new works of enlargement are undertaken, it will be found that the Dutch Government has already acquired ground at Terneuzen in order to facilitate the enlargement of the locks.

Where, in this history, is the justification for complaints about obstacles in the free navigation of Ghent? Prof. Lyde says that under international control improvements would be adopted on their merits—so they have under the existing *régime*; and that under international control the successive enlargements would have been completed much sooner—this is an assertion quite unsupported by any evidence. Prof. Lyde says also that under international control the cost of the enlargements should have been met out of the profits on the traffic. Under the existing *régime* navigation is quite free, and there are no such profits. But I believe that Prof. Lyde advocates the establishing of tolls under an international authority. I doubt whether this extraordinary idea would recommend itself to international commerce or to Ghent!

Far from being unique in denying a neighbour's right of free access to the sea, Holland has in modern times consistently respected it. There has been nothing "stupid" or "selfish" about her attitude. It is perfectly true that she might have acted very selfishly and still remained within the bounds of legality; if that shows that the existing legal *régime* should be amended, it is all the more unfair to blame Holland, who never took advantage of it to harm her neighbour's interests.

P. GEYL.

London, October 25.

I AM obliged for your courtesy in sending me Dr. Geyl's letter. Most of it is concerned with the dimensions of the Terneuzen Canal, which Dr. Geyl calls "the most important aspect of the question." I considered it so unimportant that my only comment on it was: "As the *accidental* difference in dimensions is a real handicap to Belgium, Holland should have been scrupulous to compensate by all possible courtesy and other facilities."

Dr. Geyl goes on to say that my denial that Belgium has had freedom of navigation is based "*on the ground* that the dimensions in Dutch territory are too small"! A glance at the address in your issue of October 16 will prove the inaccuracy of this attempt to divert attention from the actual facts on which I based my assertion that Belgium had not freedom of navigation.

To anyone who would care to know exactly how Holland has acted on these international waterways, I venture to say that Kaeckenbeeck's purely legal "International Rivers" (published by the *Grotius* Society) is more illuminating than Guillaume's account of what is, after all, his own success as Belgian Minister at The Hague.

"Where, in this history," Dr. Geyl asks, "is the justification for complaints about obstacles in the free navigation . . .?" In Dr. Geyl's history, nowhere. Mine was more discursive and gave precise instances, with dates and references, of facilities being denied and delayed by the Dutch; and I notice on p. 319 of the current R.G.S. Journal, in a legal review of Kaeckenbeeck's book, the words: "Germany [on the Rhine] joins hands with the Dutch in setting up restrictive regulations against foreigners." One relatively trivial case illustrates both the denial and the delay. In January, 1906, the Belgian Government formally asked the Dutch Ministry of Finance to forgo customs formalities—with all their delay and inconvenience—on boats moving only and directly between Ghent and Antwerp. The Dutch Ministry replied in January, 1907, and refused.

The profits on the canal trade are so great that Terneuzen has relatively heavier tonnage than any other Dutch port, even including Rotterdam; and the "extraordinary idea" of putting a toll on boat and cargo for the upkeep and improvement of the waterway is as old as the Roman Empire, and was the actual *régime* on the Rhine in the most prosperous days of its commerce—under the French.

I entirely agree with what Dr. Geyl says about the canal dimensions and their origin, but it does not touch my really serious and deliberate assertion that Belgium has suffered, and is suffering, from gross "international servitude." L. W. LYDE.

University College, London.

The Colours of Racehorses.

IN my "Origin and Influence of the Thoroughbred Horse" (1905, pp. 441 *ff.*) I supported my other arguments to prove that the "blood" horse originated in Libya (North-West Africa), and that his primal colour was bay, by giving in one table the results of my examination of the colours of the winners of the Derby, the Oaks, and the St. Leger, and in another table the colours of the first three horses in each of these races in the three decades from 1870–99. Grey does not appear in them at all, and black only twice, whilst chestnut—which (like brown, black, and grey) I maintain is not an original colour, but due to crossing the bay Libyan horses and the ancient dun horses of the Upper European-Asiatic area—shows a steady decrease.

In view of the discussion aroused by the winning of the Derby by a grey (Tagalie) in 1912, and by a black (Grand Parade) in the present year, it may interest some of your readers if I give my tables brought up to date for the last fifty years:—

TABLE I.—*Winners.*

	b.	b. or br.	br.	ch.	br. or bl.	bl.	gr.
1870–79 ...	15	0	2	12	1	1	0
1880–89 ...	16	0	5	8	0	1	0
1890–99 ...	17	0	7	6	0	0	0
1900–09 ...	15	4	6	5	0	0	0
1910–19 ...	18	0	5	5	0	1	1

TABLE II.—*First Three Horses.*

	b.	b. or br.	br.	ch.	br. or bl.	bl.	gr.
1870–79 ...	36	1	13	34	4	2	0
1880–89 ...	42	1	16	28	0	2	0
1890–99 ...	54	2	17	16	1	0	0
1900–09 ...	47	5	17	19	0	2	0
1910–19 ...	51	2	18	16	0	2	1

It will be seen that in the first three decades chestnut gave way steadily to bay and brown; that in the fourth decade chestnut dropped 1 in the winners, but regained a little in the lower horses (19 against 16); that in the present decade, whilst it retains the same number of winners as in the last, it has lost the slight gain made in the lower horses; and that in the fourth decade bay dropped in the winners from 17 to 15, and in the total from 54 to 47, but the loss in the winners is more apparent than real, since four bay-or-browns were amongst the winners. In the present decade, in spite of the reappearance of black and grey amongst the winners, bay has more winners (18) than ever before, though in the total number of horses it has not quite regained its old position (54).

Thus, in defiance of the sporadic reappearance of black and grey, bay seems steadily bent on superseding all other colours. WILLIAM RIDGEWAY.

Flendyshe, Fen Ditton, Cambridge,
November 4.

Gravitation and Light.

IT may or may not have been noticed that the refractivity $(\mu-1)$ at any point, required to produce the Einstein deflection, is the squared ratio of the velocity of free fall from infinity to the velocity of light. OLIVER LODGE.

Mariemont, Edgbaston, November 24.

Variation of Refractive Indices.

MR. TWYMAN (NATURE, November 20, p. 315) will find in Trans. Chemical Society (1906, vol. lxxxix., p. 417) an account of some observations by Miss Florence Isaac and myself which indicate that the refractive index of a solution of sodium nitrate at the surface of contact with glass is slightly greater than that of the same solution in contact with calcite.

It was our intention to continue and extend these observations, but we have never been able to do so. HENRY A. MIERS.

The University, Manchester, November 22.

Neon.

IN response to inquiries, may I use your columns to make two announcements in reference to the above?

First, by making use of a new and more powerful method of positive-ray analysis (the description of which is now in the press), I have succeeded in obtaining measurements of mass and other evidence of sufficient accuracy to prove beyond all dispute that atmospheric neon (atomic weight 20·200, O=16) is a mixture of two isotopes of atomic weights 20·00 and 22·00 correct to about 1/10th per cent.

Secondly, permission to publish being now granted, a full account of recent experiments on "Neon Lamps for Stroboscopic Work" will shortly appear in the Proceedings of the Cambridge Philosophical Society. F. W. ASTON.

Cavendish Laboratory, Cambridge,
November 19.

Bird Migration.

THE captain of the Portuguese steamer *Bolama*, recently touching here on her voyage from Cape Verde Islands to Lisbon, reports that near the Canary Island, Las Palmas, his ship was visited by an immense cloud of swallows settling in thousands upon every part of the vessel and resting until early dawn, when almost every bird departed. Nothing is known as to the direction in which the birds were travelling or why they should be found far away over the open sea in such a southerly latitude. Two swifts are perennially present and nest at Madeira, but the chimney-swallow is only known as a rare straggler; and in the last fifty-five years I have not known of the passing of any migrating flock, though our latitude is five hundred miles north of the locality indicated in the *Bolama* occurrence. So strange an incident might be taken from the pages of Pliny or Ambroise Paré, and cannot fail to interest those of your readers who are working on the subject of migration. MICHAEL C. GRABHAM.

Madeira, October 27.

Luminous Worms.

FROM the communications which reach me I learn that this subject is creating a great deal of interest. At the same time all the information is vague and unsatisfactory, and I am unable to obtain specimens of the creatures themselves. The vagueness of the information is due in great measure to the lack of knowledge which still prevails respecting the Oligochæte fauna of this country. A few local names are in use, such as dew-worm, brandling, lob-worm, and cockspur, but these are as valueless for scientific purposes as cuckoo-flower or bachelor's buttons would be to a botanist.

It will be some time before my volume on British earthworms is published by the Ray Society. In the meantime, will not some publisher undertake to issue a small popular handbook of British worms, with illustrations, at a shilling? We have about fifty earthworms in this country, but only a dozen or so are by any means common, and it would be very easy for our working naturalists to get a grip of the subject, and thereby render immense service to a branch of science which is of the utmost practical value. Though I have written a large number of articles on our Annelids during the past thirty years, there is nothing on the subject which is available in a popular and handy form for would-be students, and in this matter such a handbook is sadly overdue.

May I venture once more to appeal to readers of Nature for specimens of luminous worms or other creatures, as well as for rare, unusual, or abnormal forms, that would merit attention in my Ray Society monograph? Hilderic Friend.

Cathay, Solihull, November 6.

The Doubly Refracting Structure of Silica Glass.

In an interesting letter on the above subject in Nature of October 23 Lord Rayleigh mentions that, when used with accurately crossed Nicols, "a circular disc of optical quality silica showed a spiral structure." Upon reading this letter I was reminded of a very interesting colour effect I saw several years ago in fused quartz which had been acted on by the rays from radium. As is well known, crystalline quartz assumes a uniform yellowish-brown or brownish-red colour when "rayed" by the rays of radio-active substances; the formation of coloured streaks and of patches similar to the markings of marble has also been observed. On the other hand, fused quartz generally assumes a uniform brownish-violet colour when exposed to radium rays.

In his work preparatory to the determination of the atomic weight of radium, Hönigschmid (*Wien. Ber.*, cxx., 1617, 1911) used fused quartz evaporating basins for recrystallising large quantities of radium chloride, and these afterwards showed a remarkable spiral coloration. Radiating from the centre of each basin was a series of spiral-shaped streaks of a dark violet colour, which continued in many cases almost to the top of the basin. Their upper extremity would undoubtedly be limited by the height to which the radium chloride solution had occupied the vessel. The space between the streaks showed little or no coloration. As is usual in such cases, the coloration disappeared on heating the dishes in a Bunsen flame, a brilliant bluish-violet luminescence being produced.

It has generally been assumed that the conditions in the quartz which give rise to these "streaks" are connected with the mode of manufacture of such vessels, and I believe the above colouring effects may be of interest in view of Lord Rayleigh's interesting observation of the "optical heterogeneity" of silica glass. Robert W. Lawson.

The Physics Laboratory,
Sheffield University,
October 31.

The Antiquity of Man.

In the altogether excellent jubilee number of Nature (No. 2610, vol. civ.) there is, I notice, a short paper entitled "The Antiquity of Man" contributed by Dr. A. Smith Woodward. We are told in this paper (p. 212) that "as discoveries progress it becomes increasingly clear that true man, of the family Hominidæ, *cannot* [the italics are mine] be earlier than Late Pliocene or the dawn of the Pleistocene." We learn also that "so long ago as 1880" Sir William Boyd Dawkins, "for other reasons," came to the same conclusion.

As your readers are doubtless aware, the question as to when man first appeared upon this planet has always been of what may be termed the "vexed" order, and generally regarded as unsettled.

But though it may be the opinion of Dr. Smith Woodward and of Sir William Boyd Dawkins that "true man" cannot be of a greater antiquity than "Late Pliocene or the dawn of the Pleistocene," it does not necessarily follow that such an opinion is correct. The chief evidence upon which the idea of the great antiquity of the human race is based—evidence not mentioned in Dr. Smith Woodward's article—is that afforded by the various implements of flint and other rocks which have been found embedded in certain Pliocene and Pleistocene strata. These humanly fashioned stones are comparatively numerous, and afford evidence of a more complete type than is provided by the "few fragments of apes and man" which have hitherto been recovered from ancient deposits.

In view also of certain discoveries made in Suffolk since 1909 (described by Sir Ray Lankester and by myself), and the results of the excavations carried out during the last twelve months in the Red Crag at Foxhall, near Ipswich, I would venture to regard it as highly probable that a type of man capable of flaking flints in a clearly dexterous manner was present in that part of the country not later than Middle Pliocene times, and possibly even earlier. Further, these discoveries have demonstrated that, as would be expected, these Mid-Pliocene individuals were preceded by an earlier race or races of people who fashioned their flints in a less skilful manner. But whether these ancient flint-flakers were "true" men or not I am quite unable to say. I should imagine, however, that, judging from the kind of implements found, they had attained to a status far above that of any known ape.

It is clear, then, that Dr. Smith Woodward's views, as expressed in the jubilee number of Nature, upon the antiquity of man do not coincide with those of many of us who have made a study of early flint implements. Moreover, the fact that such widely divergent views upon this question are possible shows the urgent need for further research, especially as the present palæontological evidence, upon which Dr. Smith Woodward's opinions are founded, is, from its very nature, largely negative in character.

J. Reid Moir.

I think our present knowledge of the facts and principles of palæontology justifies the statement I made. I intentionally omitted all reference to chipped flints because I regard them as inconclusive evidence.

A. Smith Woodward.

WESTERN TURKESTAN.

Western Turkestan has been, for all practical purposes, a closed land ever since the final subjugation of the Turkomans by Skobeleff in 1880. Political conditions made it difficult for Europeans, and particularly for British, to travel in the province. It was reserved for the expedition organised in 1905 by an American, Mr. Pumpelly,[1] to make the first scientific exploration of the region between the Pamir and the Caspian. Since then little or no exploration has been carried out.

During 1918 and 1919 opportunities occurred of visiting Turkestan, unhindered by the old restrictions, and much valuable experience was gained by the members of the British forces which at one time and another penetrated the province. A voyage across the Caspian in March, 1919, took me to Turkestan to a point within eighty miles of the Oxus, near Charjui, and the unusual facilities of the journey enabled me to see much that would not have been very accessible under prewar conditions.

Once the Caspian is crossed and the Caucasus left behind, one is in a region where the subjection of the routine of life to physical limitations is very marked. Krasnovodsk, the port of Western Turkestan, a cluster of drab houses on the foot of arid and treeless hills, lives solely on what the ships and the railways bring to it. The route to inland Turkestan passes south-east from the town, skirting the long arm of Balkhan Bay, and passing between a gap in the hills—a gap which, it is generally agreed by geologists, was more than once in historical times the passage through which the Aral and the Caspian were joined; the northern junction of these waters is believed by Kropotkin and others to have been round the north end of the Ust Urt Plateau into the bay of Mortvy Kulduk.

Once through this gap, the route runs nearly due east, and the plain of Kara Kum opens out to the north with the long *sierra* ridge of Kopet Dagh screening off Persia on the south. From Kizil Arvat to Askhabad, a distance of about 130 miles, the railway and caravan route to the east runs between the desert and the foothills. Numerous prehistoric mounds, mostly of the flat-topped variety, are found along the foothills and bear testimony to the antiquity of the route.

Except for occasional oases, the Kara Kum plain is a vast and continuous desert, almost entirely flat, and with camel-thorn as its only vegetation. But though now it is for the most part desert, the fertility of the oases, round which cotton- and corn-fields are abundant, suggests infinite possibilities, as the desert, at least between Kizil Arvat and New Merv, is of rich clay, and not of sand. Here and there a simple system of converging trenches leading down from the foothills has provided the irrigation the general absence of which is the chief obstacle to agriculture.

Russian rule, prior to the revolution, by encouraging and subsidising the growth on a large scale of cotton and cereals, had largely contributed to transforming the Tekke Turkomans into a sedentary and agricultural race. In place of the temporary camps of forty years ago, one now sees large villages, which comprise groups of two or more *Kibitkas*, enclosed in a mud wall. Sometimes even the *Kibitkas* are replaced by permanent single-storied flat-roofed houses of the Caucasian type—the whole resembling the type of walled farm common in Macedonia. Recent upheavals, however, have revived the nomadic spirit. The Tekke Turkomans, largely at the instigation of the Yomut Turkomans, who are in a less fertile area, have shown signs of a movement *en masse* to less troubled areas in the south.

Askhabad, situated well out on the plain, is in the most fertile region of all Western Turkestan. It serves as the chief internal commercial centre of the province, while Kizil Arvat is rather the clearing-house for exports and imports. Dried fruits, carpets, fish from the Caspian, and furs are always to be found in its large and prosperous market. Afghans from the south, Sarts from Bokhara, Persians from over Kopet Dagh, and even Greeks from Baku and Batum, make up, with the Tekkes and Yomuts, the cosmopolitan crowd typical of a market-place of the Middle East. Whether the produce of the little-known but prosperous seal fisheries of the North Caspian penetrate these regions I was unable to find out, but the museum at Askhabad contains a collection of interesting photographs and implements illustrating this industry.

The main trade connections of New Merv are with the East and South, and carpets and silks form the staple produce of the town. The town itself is on the banks of the Murghab river, which is here no inconsiderable stream, being on an average about 50 ft. in width and well protected with dykes.

Old Merv, the ancient Antiocheia, the mediæval "Queen of the Earth," is situated some twenty miles east of New Merv. It is a sombre and impressive ruin, covering about thirty square miles. The ancient walls of the citadel still stand, hardly damaged by the passage of time, close by the woods and fields of the model estate of the late Tsar at Bairam Ali. The prosperous nature of this estate is proof of what the soil of Turkestan is capable when dealt with scientifically.

Between Old Merv and the Oxus are only rolling sand-dunes, unproductive and desolate. The process of desiccation is still continuing in Western Turkestan, and the geological causes that have affected in so many and various fashions the course of history in these regions are still operative. The Oxus, which originally flowed due north to Aral, later changed its direction, running a south-westerly course into Lake Sarykamish and the Uzboi Channel of the old Aralo-Caspian Sea. Later it reverted to its original northern flow. The Aral has been alternately marsh and sea. The causes of these changes are still the ruling factors in a land where the human element is not active. The province, left to itself, is passing through another cycle in which a shrinkage of water supply is the most marked feature. In 1842 the Abougir Gulf of Lake Aral comprised 3500 square kilometres of water surface; to-day it is practically dry. The province is essentially

[1] See Pumpelly, "Explorations in Turkestan." (Published by the Carnegie Institution of Washington in 1905 and 1908.)

an inland region dependent on adjacent mountains and lakes for its water. Methodical irrigation might yet reclaim much that in the near future will be absorbed into desert. S. CASSON.

THE BRITISH ASSOCIATION AND SCIENTIFIC RESEARCH.

THE valuable work done for science by the research committees of the British Association is well known in the scientific world, but few people outside are familiar with its nature, extent, or influence. It is not commonly understood that all members of such committees render their services without fee of any kind, or even receive travelling expenses to attend meetings; indeed, as a general rule, a member not only gives his time and knowledge freely, but also adds somewhat to his personal expenditure. The association makes grants of a few pounds annually to some of the research committees, but others are without grants; and in many cases the chairmen and secretaries meet the necessary expenses out of their own pockets.

The committees thus represent at its highest and best united work for the promotion of natural knowledge, and their constitution could not well be improved. The subjects and members are put forward by the various sections of the association, and any grants desired have to pass the scrutiny of the Committee of Recommendations, which is made up of representatives of all the sections. The organisation is, in fact, one in which men of science themselves decide upon subjects of research, and allocate the slender funds at their disposal to aid selected inquiries and reports. Obviously, this system is both efficient and economical, and its general adoption would be in the best interests of progressive knowledge.

The amount of money which the association can allocate as grants in aid is, however, only about 1000*l.* per annum, and this has to be shared between thirty or more research committees. As other funds are now available for scientific research, it has been suggested that the association should limit its aid to committees to the payment of secretarial and like expenses, instead of attempting to provide for actual investigations by the small grants it is able to afford.

The work of the research committees has, however, been of such high value throughout the existence of the association that no one would wish to make any change which would diminish its importance; and there is not the slightest doubt that whatever funds the association has available for research will be usefully applied. The present position is clearly stated in the subjoined communication from Prof. John Perry, treasurer of the association, being mainly remarks made by him before an evening discourse on September 11 at the recent Bournemouth meeting of the association. No general appeal is made for funds, but it is to be hoped that wealthy benefactors will follow the example of Sir James Caird and others interested in the promotion of scientific knowledge, for no more effective machinery for attaining this end could be devised than that provided by the British Association committees.

"You are aware that, after paying printing and office expenses, the funds of the British Association are devoted to scientific research. For more than eighty years we have spent more than 1000*l.* a year on research, long before ordinary people had heard of research.

"Every year we form many research committees; each of them is formed of the foremost men of science of Great Britain, who receive none of the money themselves, and their accounts for mere out-of-pocket expenses are carefully audited. These researches in the past have created some entirely new sciences, have led directly and indirectly to the creation of many new industries, and they have largely produced the world's present natural knowledge. And now to my point. Yesterday a very prominent member of the association asked me about our finances. I had to admit that even before the war we were meeting with difficulties due to the increased cost of printing and other things, that since the war we have been behindhand to the extent of more than 1000*l.* every year, and that we have never yet asked for the help of moneyed men. The only gift we have ever received from a moneyed man was a voluntary gift from Sir James Caird, who handed me 11,000*l.* at the Dundee meeting. My questioner said we ought to ask for help, and that he was willing to start a fund with a sum of 1000*l.* At this moment he does not wish to have his name mentioned.

"I need not dwell on the importance of our research work, as I feel sure that every person here who has himself done original work shares my opinion that when we limit our expenditure on research, and especially on pure scientific research, we shall begin to be a bankrupt association—bankrupt, that is, morally from the point of view of science, if not actually in the financial sense.

"The moneyed men of Great Britain are most willing to help any good object when they get proof that it really is a good object. We cannot complain of want of their help, for they did not know the facts. At the same time, the treasurer of an association with such a record as ours does not feel happy at the prospect of begging for help."

In the two days of the meeting following that on which I made this statement, the fund was raised to a total of 1475*l.* I intend to publish in due course a list of names of donors and donations.

To illustrate by many instances (as I might) our claims as to the importance of our researches would unduly prolong this letter, and any selection of a few examples would be unrepresentative. I will cite a single illustration:—The National Physical Laboratory, the scene of researches of which the importance to the nation during the war and earlier cannot be overestimated, had its origin (if its antecedents be traced backward) in the Kew Observatory, which was maintained by the British Association from 1842 to 1872, in which period the association spent some 12,000*l.* on its upkeep.

DR. JOHN AITKEN, F.R.S.

DR. JOHN AITKEN, widely known for his unique researches in meteorology, died at Ardenlea, Falkirk, on Friday, November 14, at the ripe age of eighty years. Although he served his apprenticeship as a marine engineer, Dr. Aitken's intellectual interests drew him into the fields of physical research, for which he received a stimulus as a student under Sir William Thomson (Lord Kelvin) in Glasgow University. He lived a retired life in Falkirk in a house which was largely fitted up as a laboratory, whence he would emerge from time to time to communicate some novel experiment or observation to the Royal Society of Edinburgh. Dr. Aitken frequently visited the Continent, partly for his health's sake, and never failed to utilise his opportunities in studying at first hand the varied meteorological conditions of our globe. He published scientific papers in the *Philosophical Magazine* and through the publications of the Royal Societies of London and Edinburgh, but it was mainly through the latter society that his important investigations were laid before the scientific world.

In his classical memoir on dust, fog, and clouds (1880) Dr. Aitken broke entirely new ground, and by his later paper on dew (1885) he consolidated his reputation as a natural philosopher of the first rank. Those who were privileged to see his demonstrations before the Royal Society of Edinburgh in 1880 can never forget the effective simplicity of his apparatus and the clearness of the argument by which he established the great truth that invisible dust particles are the nuclei on which water vapour condenses to form mist, fog, and cloud in all their infinite variety. By successive slight exhaustions of saturated air in a glass receiver, and by infiltration through cotton-wool of ordinary air from the outside, he gradually cleared it of dust particles; and when this purification had been effected, expansion with cooling of the enclosed air was, in general, unaccompanied by the formation of cloudy condensation. He noted, however, in these early experiments, that after the air had been thus purified of dust particles, a more rapid and somewhat greater expansion was sometimes accompanied by cloudy condensation. The explanation of this was afterwards given by Mr. C. T. R. Wilson, who showed that in dustless saturated air suddenly expanded electric ions acted as nuclei on which drops of water were deposited. This ionic condensation requires a distinctly greater diminution of pressure than is needed to effect the cloudy condensation in ordinary unfiltered air, and in his last paper on the subject of cloudy condensation (Proceedings R.S.E., 1917) Dr. Aitken gave many experimental illustrations of his belief that under ordinary atmospheric conditions the nuclei on which fog, mists, and clouds form are fundamentally the dust particles, although the effect may be occasionally intensified by the presence of ions.

Dr. Aitken followed up his main investigations in many ingenious ways, inventing, for example, an instrument for counting the number of particles in a given specimen of air, and applying it to the study of the conditions under which the number of dust particles varied according to locality, wind, barometric pressure, or time of day. In all these discussions he displayed unusual powers of accurate observation, great skill in devising crucial experiments, and singular gifts in interpreting natural phenomena. His researches led him into questions of colour in cloud, sky, and sea, and into the dynamical laws of cyclones and anticyclones. In this last branch of meteorology he found himself at variance with other leading meteorologists. Dr. Aitken was elected a fellow of the Royal Society of Edinburgh in 1875, and of the Royal Society of London in 1889. By the former he was awarded the Keith medal and prize (1886), and the Gunning jubilee prize (1895), and by the latter a Royal medal in 1917. In 1899 he received the degree of Doctor of Laws from Glasgow University. He was a lovable personality and of great modesty of disposition. Much though his many friends desired it, he would never allow himself to be nominated for high office in the Royal Society of Edinburgh. This, he maintained, was not his *forte*. He was a humble student of natural phenomena, and his one desire was to elucidate the workings of Nature in her everyday moods.

C. G. K.

NOTES.

THE Electricity (Supply) Bill, which passed the report stage in the House of Commons on Tuesday, is a laudable attempt by the Government at constructive economy. In almost every business, combination and standardisation lead to great economies, and this applies in a very special manner to the supply of electricity. An attempt was made on Monday to prove that the Bill in its present form was a breach of the agreement made in the Act of 1888 whereby a term of forty-two years was granted to the companies to carry on their supply without Government interference. This is perhaps technically right, but the companies have no real grievance. The Bill leaves their distributing business undisturbed, and guarantees to supply them with electricity as cheaply as they could generate it for themselves. Lord Moulton and others have laid great stress on the economy, from the point of view of the conservation of coal, of using gas for heating instead of electricity. Many electrical engineers will agree with this view. But although electrical supply companies will provide energy for heating—generally at prohibitive rates—when they are specially asked, they regard the heating load as of minor importance. Electrical heating forms only one of the manifold uses of electricity. Every engineer knows that cheap power is essential to many of our most important industries. Our supremacy as a commercial nation depends on a plentiful supply being available. A cheap and abundant supply would soon effect an industrial revolution, and be a special boon to the manual workers. Another objection that has been urged against the Bill is the danger of strikes. If a national system of supply were adopted, and if the electric workers went on strike, the work of the nation could be held up at any moment and the nation forced to grant the demands of the workers, however unreasonable they were. The experience gained by the workers, however, during the recent railway strike ought to discourage similar action against the community in the future.

UNDER a Bill introduced by the Government last week, power is given to the Board of Trade to safeguard "key" industries in this country by prohibiting the importation of certain articles. Of chief scientific interest among these are analytical reagents, photographic and various other "fine" chemicals, optical glass, laboratory porcelain, scientific and optical instruments, synthetic drugs and perfumes, coal-tar dyes, and dyestuff intermediate products. The method of prohibition is by means of an Order of the Board, but such Orders are to be subject to the approval of a Trade Regulation Committee, consisting of four political heads of Departments, three permanent officials, and ten Members of Parliament. Licences for the importation of any of the prohibited articles may be granted, either generally or in respect of specific quantities or shipments. The proposals appear to be carefully and fairly devised to meet what is admittedly a difficult situation. They have been referred to as measures injurious to scientific teaching and research, but if the industries producing the articles in question are not to be strangled out of existence in this country they must for a time be protected against "dumping"; while the power to allow importation when this appears necessary should act as a check upon excessive prices and prevent scarcity of particular products. The measure in question is eminently one in which very much will depend upon judicious administration.

AMONGST the younger generation of naturalists in this country there would seem to be a great dearth of men well qualified by training and experience to study entomology, not merely as a pastime or for the pleasure and delight they may find in it, but as one of those sciences of life which are of the greatest present value to the State and to humanity at large, and full of potentialities for the future. There was a time when, to one seeking a profession or other means of livelihood, the prospect presented by entomology looked very black indeed, but, according to a letter from Sir Alfred Keogh which appeared in the *Times* of November 20, a number of reasonably well-paid posts are now open to trained young entomologists. The difficulty in finding men properly qualified to fill them need not be a cause of surprise when it is considered that until recently there was scarcely a professional post of the kind in this country outside the British Museum, and that the few in the museum were by no means well-paid. They appear to be no better paid now. Another correspondent, whose letter signed "F.R.S." was published by our contemporary on Saturday last, points out that the pay of an assistant in the museum begins at little more than one-third of the pay of a lieutenant in the R.A.M.C., and never, while he remains an assistant, does it reach a higher level than the pay at which that lieutenant begins. He might have added that an assistant in the Natural History Museum very rarely has a chance to get beyond that stage, since the higher appointments are so extremely few in both number and proportion compared with those in other branches of the Civil Service. There is one only in entomology, which is the second largest department, and the other departments in the same branch of the British Museum are scarcely better off in that respect. It is astonishing that, at a time when the value of science is becoming daily more and more appreciated even by the general public, this state of affairs should continue to exist in one of our leading scientific institutions.

AT the invitation of Lord Glenconner, a very distinguished company assembled at his house in Queen Anne's Gate on Monday last to hear an exposition of the subject of relativity by Sir Oliver Lodge. To give a non-mathematical explanation of the principle and show how it leads to the prediction of changes in the perihelion of Mercury's orbit, which are unexplained by Newtonian theory, the deflection of a ray of light from a star passing near the sun, and the displacement of lines of solar and stellar spectra towards the red, was obviously impossible, and Sir Oliver did not attempt it. He limited himself to a statement of the close agreement between the predicted and measured deflections of star places derived from the photographs of the total solar eclipse of May 29 last, and to an explanation of the effect on dynamical principles. If gravitation is assumed to affect the refractive index of the æther, so that at every point $\mu - 1 = v^2/c^2$, where μ is the refractivity, v the velocity of free fall from infinity, and c the velocity of light, this condition would give the Einstein deflection. Gravitation cannot increase the velocity of light, but Sir Oliver thought that there might be a kind of gyrostatic effect upon a beam coming from infinity the result of which would be a deflection such as has been observed. He preferred to endeavour to explain the observations on dynamical principles before bringing in a new theory. Prof. Schuster, however, at the close of the address, urged that the best way to deal with a theory was to accept it as a working hypothesis and put all its consequences to the test. The announcement of the eclipse results has brought the relativity principle into prominence in the general Press, and many people have consequently become interested in it. For several years scarcely a volume of NATURE has been without contributions on the principle, and we would direct particular attention to two articles in our columns of June 11 and 18, 1914, by Mr. E. Cunningham, a Royal Institution discourse by Prof. A. S. Eddington in the issues of March 7 and 14, 1918, and one by Sir Oliver Lodge in those of September 4 and 25 last.

As was to be expected, the results of the Eclipse Expedition confirming Einstein's theory of gravitation have called forth discussion, support, and opposition from those who find their own particular point of view, physical or metaphysical, in agreement with or in opposition to Einstein's. On the physical side further contributions to the question of the displacements predicted in the solar spectrum are eagerly looked for, and we are glad to note that Sir Joseph Larmor had something of value to communicate to the Royal Society on this point last week. On the metaphysical side the columns of the *Times* have been opened to Mr. Frederic Harrison, reminding us of the views of Comte on the relativity of space and his opposition to the conception of an æther filling all space. At the same time Mr. Thomas Case stoutly defends the view that Newton's definitions and comments on absolute space and time are sound philosophy and firm foundations of his fame; while Prof. Wildon Carr points out that all the modern relativist arguments can be found in Descartes' "Principles." At a meeting of the Cambridge Philosophical Society on November 24 Prof. Eddington gave an exposition of Einstein's theory to a crowded and eager audience of students. In the discussion following, Prof. Hobson remarked that the abstractness of a theory of the physical universe is in no sense an objection to its validity, any theory or hypothesis being in its essence an abstract scheme built up by the mind to fit those phenomena which have been examined up to date.

THE chairman of council of the Royal Society of Arts, Sir Henry Trueman Wood, in an interesting and thoughtful address at the annual meeting on November 19, reviewed the progress which has been made in the development of our natural resources and in the application of science to industry since the foundation of the society more than a hundred and sixty years ago. He pointed to one outstanding fact, that "all our progress was accomplished by individual action, not by State organisation or control."

Latterly, of course, owing to the increase of scientific knowledge, there had been considerable modification of procedure, the introduction of new methods, and the rise of new industries. Now, partly as a result of witnessing the advantages of organisation and of State aid in relation to German industries, there is an increasing demand in this country for similar organisation and help. The State in its attitude towards invention has been, until quite recent times, merely obstructive to progress. Now there seems some risk of running to the opposite extreme. However, as remarked by Sir Henry, it appears to be "the nature of man to swing from one extreme to another like a pendulum," and we have "to remember that if the pendulum swings to and fro, making no advance, still, all the same, the clock goes steadily on." He directed attention to the work of the Department of Scientific and Industrial Research (already described in NATURE), and spoke hopefully of the work carried out under its auspices by the industrial research associations which have been established in connection with various trades. One of the most important, which seems at last to be about to start effective operations, is the Association for Cotton Research, the headquarters of which will be in Manchester.

THE council of the Royal Meteorological Society has awarded the Symons memorial gold medal for 1920 to Prof. H. H. Hildebrandsson for distinguished work in connection with meteorological science.

SIR HENRY A. MIERS, Vice-Chancellor of the Victoria University of Manchester, has been elected president of the Manchester Literary and Philosophical Society.

DR. J. E. STEAD has been nominated by the council of the Iron and Steel Institute as president for next year in succession to Mr. Eugene Schneider. The date of the annual meeting of the institute has been fixed for Thursday and Friday, May 6 and 7, 1920.

PROF. J. C. MCLENNAN, professor of physics and director of the physical laboratory in the University of Toronto, has since 1917 been lent to the Admiralty by the University, and since January last has been acting as Scientific Adviser to the Board of Admiralty. It is now announced that the Lords Commissioners of the Admiralty have received with much regret Prof. McLennan's resignation of this post.

SIR NATHANIEL DUNLOP, whose death in his ninetieth year is recorded in the *Engineer* for November 21, entered early the service of the Allan Line Co., and rose to be deputy chairman. He was also chairman of the Clyde Trust from 1905 to 1907, and received his knighthood shortly after the opening of the Rothesay Dock. Amongst his other activities he was the first chairman of the British Corporation for the Registry of Shipping, and was its honorary president until the last. He served on a number of Royal Commissions appointed to inquire into shipping questions, and was frequently a witness before other Commissions.

CAPT. P. R. LOWE has recently been appointed by the Principal Trustees of the British Museum to be assistant in charge of the bird-room at the Natural History Museum in succession to Mr. W. R. Ogilvie-Grant. Capt. Lowe has for many years devoted himself to ornithological research at the Natural History Museum, the Royal College of Surgeons, and Cambridge University, and has made extensive collections of, and observations on, birds in Madeira, the Canaries, the Azores, the Cape de Verde Islands, the West Indies, Mexico, Florida, the Mediterranean islands and coasts, South Africa, and the British Islands. He has published numerous papers on ornithology, and is the author of "Our Common Sea-Birds," "A Naturalist on Desert Islands," and of the forthcoming works "In the Track of Columbus" and "The Waders." During the war Capt. Lowe served in the R.A.M.C., and was for two and a half years in command of Princess Christian's hospital train.

WITH the object of promoting the technical and practical development of commercial aeronautics, an Institute of Aeronautical Engineers has been founded. It will be developed largely in the interests of aeroplane mechanics and pilots. Like certain existing institutes of a similar character in other branches of engineering and in chemistry, admission to the various grades of membership is to be by examination, in which piloting experience will be a qualification as well as laboratory work and knowledge of mechanical science. The work of the institute is to commence with next year, when an opening address will be delivered by Prof. Bryan, the president-elect for 1920. The secretary is Capt. Douglas Shaw, and the offices are at 32 Charing Cross, Whitehall, London.

ACCORDING to a Bulletin issued by the National Research Council of the United States, and reproduced in *Science* for October 24, the Council has decided, with the co-operation of the American Physical and Chemical Societies, to compile and issue an American Compendium of Physical and Chemical Constants. It is to be both critical and up-to-date, and to this end the universities and research laboratories of America are to be asked to supply the constants at present known. The business and industrial concerns are then to be asked what other constants are required in their work, and the joint committee charged with the issue of the Compendium will see that they are determined and included in the work. The cost is estimated at 20,000*l.*, and this will, it is expected, be obtained from private sources. We need not emphasise here the great value such a Compendium would have for scientific and industrial research in this country. Tables of constants from which untrustworthy values were excluded have been much needed in the past half-dozen years.

THE Secretary of State for the Colonies has, with the approval of the Cabinet, appointed a Committee to prepare a complete scheme of Imperial wireless communications in the light of modern wireless science and Imperial needs. The Committee will (1) consider what high-power wireless stations it is desirable on commercial or strategic grounds that the Empire should ultimately possess; (2) prepare estimates of the capital and annual costs of each station—the life of the plant and buildings, as taken for the calculation of depreciation, to include an adequate allowance for obsolescence; (3) examine the probable amount of traffic and revenue which may be expected from each station; and (4) place the stations recommended in their order of urgency. The Committee is composed as follows:—The Right Hon. Sir Henry Norman, Bart. (chairman), Mr. F. J. Brown, Rear-Admiral F. L. Field, Sir John Snell, Prof. J. E. Petavel, Dr. W. H. Eccles, Mr. J. Swinburne, and Mr. L. B. Turner. The secretary is Brig.-Gen. S. H. Wilson, and the assistant secretary Lt.-Col. C. G. Crawley. All communications in connection with the Committee should be addressed to the Secretary, 2 Whitehall Gardens, S.W.1.

THE work of the National Union of Scientific Workers is described in the first annual report of the executive for the year ending September 30, 1919. The union consists at present of 603 members distributed among a large number of local branches, and shows evidence of great activity in various directions. Among the more interesting are those concerned with the steps taken whereby the union may be registered as a trade union and secure representation on the Whitley councils set up by the Government for its own employees. The status and payment of a living economic wage to research workers have been the subject of consideration, and the union may in this direction prove a much-needed corrective to the growing exploitation of junior workers and their diminishing power to protect themselves. As a healthy revolt against a situation that has become intolerable, and in which the official spokesmen of science have taken only desultory interest, the formation and work of this union are among the most characteristic signs of the times, and its further career will be watched with keen interest. Experience from the early history of other trade and professional unions shows that it is the first step that counts, and the report seems to indicate that the initial difficulties are in course of being surmounted.

IN a recent Smithsonian publication (Smithsonian Miscellaneous Collections, vol. lxix., No. 11) Dr. Aleš Hrdlička, curator of physical anthropology in the U.S. National Museum, Washington, sums up the results of a study of historical and anthropological data relating to the population of Russia. From the point of view of an anthropologist Dr. Hrdlička concludes that, although the "Russian giant may have his Delilahs internally as well as externally," nothing can prevent the population of Russia from coming by its potential powers. He bases his forecast on the fact that there are more than 100,000,000 Russian Slavs, and that every year their birth-rate adds 1,700,000 to their total numbers. "Such a rate of increase of this strong and able portion of the white stock means a biological momentum which in the end must prevail over all opposition." Dr. Hrdlička also notes the fact that there is neither anthropological nor linguistic reasons for the separation of the Ukrainians from the other Slavs of Russia. This is only another example of the fact that claims for national recognition need have no basis in racial differentiation.

A CORRESPONDENT of the *Morning Post* (November 12–13) describes the results of a series of excavations in Mesopotamia conducted by officers of the British Museum. At the beginning of the war the work was in charge of Capt. Campbell Thompson, and it was intended that on his departure on leave he should be replaced by Prof. King, but on the lamented death of that scholar the veteran explorer, Mr. H. R. Hall, took his place. The result is that thirty-two huge cases of antiquities have safely reached England, and throw new and welcome light on Sumerian culture. The most remarkable discoveries were made at Tell Obeid, close to the Biblical Ur of the Chaldees, and include a basalt statue of a king or viceroy who lived five hundred years before Gudea, about 3000 B.C., and a wonderful copper plaque representing a lion-headed eagle, the symbol of the city of Lachish. At Maqayya or Ur a royal palace built about 2400 B.C. has been excavated, and Capt. Campbell Thompson has unearthed a remarkable series of bricks and other artefacts at Abu Shahrein, the city of the Sumerian deity En-ki, god of earth and water. With this material available English archæologists have no longer to depend on the discoveries made by American and French explorers. It may be hoped that strong pressure will be put on the Office of Works to vacate the museum galleries and permit a public exhibition of these valuable antiquities.

IN the *Kew Bulletin* (No. 8, 1919) M. N. Owen gives an account of one of the minor diseases of potato-tubers, which has never been thoroughly investigated. It is known as skin-spot, the tubers becoming dotted with small dark spots during storage. It is found to be due to a minute species of mould-fungus hitherto undescribed (*Oospora pustulans*). The author describes in detail the structure and development of the fungus as determined from artificial cultures. The disease is confined to the surface layers of the tubers, and, besides disfigurement, may cause serious injury by weakening or destruction of the eyes.

OF economic importance is a report on the paper-making qualities of Hawaiian bagasse, or sugar-cane refuse, by A. D. Little (Report of the American Station of the Hawaiian Sugar Planters' Association, Bulletin No. 40). The author discusses various previous attempts to use the waste fibre of the cane as paper-making material, the technique involved, and the commercial aspect of the question. As a result of the investigation it is his opinion that, technically, there are no difficulties which could not fairly easily be overcome, and from an economic point of view the use of bagasse might present under normal conditions an attractive commercial venture.

THE unfailing energy of Prof. Pearson's department at University College, London, has now resulted in the production of a series of tracts published by the Cambridge University Press. The objects of this new series are not only to publish new tables (as well as to republish old and inaccessible tables), but also in due course to issue works on interpolation, mechanical quadratures, calculating machines, and other matters of importance to the practical computer. The first of the series is before us, and is entitled "Tables of the Digamma and Trigamma Functions," by Eleanor Pairman. The work contains tables of the logarithmic derivate of the Gaussian Π-function and of its derivate, in addition to some useful miscellaneous information concerning these two functions. The functions are tabulated to eight places of decimals at intervals of 0·02 from 0 to 16, with tables of second differences. There seems no doubt that this series will be of extreme value to computers, and we must feel deep gratitude to Prof. Pearson for using the resources at his disposal in producing it. Finally, it should be said that the appearance of the first of the series is up to the standard which we have grown accustomed to expect from the Cambridge University Press.

IN making sulphuric acid by the "contact" process, sulphur dioxide is converted into the trioxide by catalytic oxidation and the product absorbed in water to form the acid. A short account of the very effective "Grillo" plant, erected for the purpose in this country by the Ministry of Munitions, is given by Mr. Raymond Curtis in the Journal of the Society of Chemical Industry for October 15. The catalyst employed is platinum, deposited on granules of calcined magnesium sulphate in the proportion of 0·3 per cent. The purified gases from the sulphur burners, heated to about 350° C., are passed through two converters in parallel, each containing 10,000 lb. of the platinised mass distributed on four trays. For absorbing the trioxide produced, towers packed with quartz are used, and practically perfect absorption can be obtained. The purification of the gases, which is important in preventing deterioration of the catalyst, is effected by passing the cooled vapours through coke columns and sulphuric acid drying-towers; arsenic is thus eliminated, and less than 0·02 per cent. of other impurity (water and inert dust) retained. Details of efficiency and production costs are given.

ALTHOUGH salvarsan (dihydroxydiaminoarsenobenzene dihydrochloride) has proved to be an effective remedy for syphilis, its use in medicine is open to the objection that its administration involves the use of a somewhat elaborate technique. Various attempts have been made to overcome this difficulty, the most successful of which is probably the substitution of the sodium *N*-methylenesulphinate (neo-salvarsan) for the parent compound. Medical opinion on the whole is, however, in favour of the view that salvarsan is more powerful and more certain in its action than neo-salvarsan, though the latter is not without its advocates. In continuation of work begun in 1907 by Prof. F. L. Pyman and his collaborators, Messrs. Baxter and Fargher, of the Wellcome Chemical Research Laboratories, described at the last meeting of the Chemical Society a number of arsenic compounds prepared in the hope that they would be suitable for direct intravenous injection in simple aqueous solution. These compounds are arsenobenzenes of a new type obtained by the reduction of benzodiazolearsinic acids, which in turn are produced by the action of acetic or formic acid on diaminophenylarsinic acid and its homologues. The new arsenobenzenes form dihydrochlorides which are soluble in water, but, though they exhibit a reduced acidity as compared with salvarsan, they still prove to be too acid for direct intravenous injection. These experiments are, however, of considerable interest, forming as they do the nucleus of further work on the replacement of amino-groups by heterocyclic nuclei in arsenobenzenes.

ONE of the latest of the many developments of the Mallet type of locomotive on American railways is a simple or non-compound engine for goods and banking service, built at the works of the Pennsylvania Railroad. From an article in the *Engineer* for November 7 we extract some particulars of this locomotive, which weighs 287 tons, or just above 400 tons with the tender. There are four cylinders, 30·5 in. by 32 in.; the driving-wheels are 62 in. in diameter; the boiler-pressure is 205 lb. per sq. in.; and with a maximum cut-off of 50 per cent. the maximum tractive effort is about 135,000 lb. The size of the boiler is notable; its overall length is 54 ft., including a 14·5-ft. fire-box, 11·5-ft. combustion chamber, 20-ft. barrel, and 8-ft. smoke-box. The barrel diameter is from 8·25 ft. to 9 ft. Expansion movements in the great length of the firebox and combustion chamber are provided for by a folded connection plate forming a **U**-shaped pocket. A mechanical stoker is used, and the fire-box has a shaking grate operated by power. The grate area is 112 sq. ft., the heating surface 6656 sq. ft., and the area of the superheater surface 3136 sq. ft. The short cut-off employed in the Mallet engine as a substitute for compounding has been criticised by writers, who consider that the system does not possess the advantages which it may realise when applied to the usual type of simple locomotive.

Messrs. Blackie and Son, Ltd., announce "Triumphs of Invention," C. Hall. *The Cambridge University Press* will shortly publish "The Foundations of Music," Dr. H. J. Watt. *Messrs. Hodder and Stoughton* are to publish "Aerial Transport," H. Thomas, and "Applied Aeronautics," G. P. Thomson. *Messrs. Longmans and Co.* announce a new edition of Prof. W. Watson's "A Text-book of Physics," revised by H. Moss. *Sir Isaac Pitman and Sons, Ltd.*, have nearly ready "Electric Lighting in the Home," L. Gaster and J. S. Dow, and "Compressed-Air Power," A. W. and Z. W. Daw. *The University of London Press, Ltd.*, promise "Africa and Europe" (being Book iii. of the New Regional Geographies Series). It will include the British Isles and the new boundaries resulting from the Peace Treaty. The section relating to the British Isles will also be issued separately.

IN the official announcement of the reorganisation of the Board of Agriculture and Fisheries which was published in last week's NATURE, it should have been stated that Sir A. Griffith-Boscawen has been appointed deputy chairman, and Sir A. Daniel Hall vice-chairman, of the President's Administrative Council.

OUR ASTRONOMICAL COLUMN.

THE LEONID METEORIC SHOWER.—Observations at the middle of the present month proved that a few of the meteors were visible, and that the display was prolonged beyond its usual duration. On the night of November 15, in $2\frac{3}{4}$ hours, Mr. C. P. Adamson, watching from Wimborne, Dorset, recorded eleven Leonids radiating from $151^\circ+22^\circ$. On November 19 he saw five Leonids near their radiant at $149^\circ+23^\circ$. The latter result corroborates an observation in 1876 November 19–22 at Bristol by Mr. Denning, who saw five Leonids from $149^\circ+22^\circ$. These figures would appear to prove that there is no decided motion of the radiant similar to that affecting the centre of the great Perseid stream. A brilliant meteor was seen by Mr. Adamson on November 19 last at 11h. 5m. It gave a series of flashes near the termination of its course, which was from $120^\circ+21^\circ$ to $140^\circ+16^\circ$, traversed in two seconds.

TWO STARS WITH LARGE PARALLAXES.—Prof. F. Schlesinger gives particulars in *Astr. Journ.* (No. 758) of two stars within 14′ of each other that both have large parallaxes and proper motions, and yet are apparently quite independent of each other. The brighter star is B.D.+4·123°, which was found thirty years ago to have an annual P.M. of 1·4″. The following determinations of parallax have been made:—

Name	Parallax ″	Prob. error ″
Schlesinger ...	... 0·15	0·008
Chase ...	... 0·16	0·048
Flint ...	... 0·18	0·040

The other star is of the twelfth magnitude, and was independently found by van Maanen and Wolf to have an annual P.M. of 3·0″. Its place for 1900 is R.A. 0h. 43m. 53s., N. decl. 4° 54·4′.

The following determinations of parallax have been made:—

Name	Parallax ″	Prob. error ″
Schlesinger ...	... 0·27	0·012
van Maanen	... 0·244	0·008

There would seem to be a fair presumption that the faint star is considerably nearer than the bright one, and hence that their close juxtaposition in the sky is accidental.

The second star is one of the twenty stars nearest to the solar system, and is evidently (like the Barnard and Innes stars) in the extreme dwarf stage. It would be of interest to determine its visual magnitude, which is likely to be brighter than the photographic one.

APHELIA OF PLANETS AND COMETS.—Mr. C. D. Perrine examines the grouping of these aphelia in Proc. Nat. Acad. Sci., U.S.A., September, 1919. The grouping of aphelia of the minor planets about a strongly marked maximum in longitude 195° has been pointed out before. It is shown that the aphelia of the forty-five short-period comets are grouped in the same manner. It is further remarked as a coincidence (it can scarcely be more) that the aphelia of the eight major planets are all situated in the same half of the ecliptic, their centre of mean position being in the longitude of the apex of solar motion. The aphelia of the long-period comets appear to be grouped about two maxima, the most strongly marked being near longitude 90°, the other near longitude 270°. Mr. Perrine notes that these are respectively the longitudes of the antapex and apex, and deduces a theory that the comets are captured from interstellar space. The obvious difficulty presents itself that the great majority of such objects would enter the sun's domain with independent velocities of the order of several miles per second, and their orbits would, in consequence, be strongly hyperbolic. Mr. Perrine escapes from this difficulty by suggesting that practically all these hyperbolic comets would pass too far from the sun for us to see them; we should only see those the independent velocity of which was practically zero. These last would, however, be only a very small fraction (perhaps one in ten thousand) of the comets entering the sun's domain, so the number of these would have to be immensely large to supply the number of parabolic comets that we see. The latter number is two or three a year, so the former number would need to be reckoned by millions every century.

THE BRITISH SCIENCE EXHIBITION, GLASGOW.

AN exhibition on similar lines to those of the British Science Guild's Exhibition of last summer is now being held by the Corporation of Glasgow, with the assistance of a scientific advisory committee. The Kelvin Hall, in which the exhibition is held, was erected for the purpose of holding a series of industrial exhibitions, and the Corporation has a special department for their organisation. The exhibits are housed in a single building and on one level, so that there is ample space for their display, and power is available for setting machinery in motion and allowing demonstrations of high-temperature operations. The exhibits are, therefore, seen under very favourable conditions, and the response to the invitation to exhibit has been very gratifying. Owing to an unfortunate combination of circumstances, several firms which were represented in London have been unable to appear, and the absence of some of the leading instrument firms is noticeable; but many of the London exhibits reappear, in some cases in an enlarged form, whilst there have been many additions, especially in regard to engineering and shipbuilding.

A very large area is covered, and an inspection of the exhibition convinces a visitor that the objects shown were well worth bringing together. The enormous progress made during the war and since the armistice in the manufacture of products for which we were entirely dependent on importation is evident, as is the ingenuity displayed in the design of new instruments and machines, both for warlike and for peaceful use. The relaxation of restrictions in regard to secrecy has made it possible to show many improvements which had been kept secret for military reasons, so that there is a most interesting series of instruments illustrating recent developments in wireless telegraphy and telephony, and a very extensive display of modern improvements in aircraft, as shown by the work of firms in the Clyde area.

Steam turbines and oil engines are well represented, as well as such interesting inventions in marine engineering as variable-speed gearing and hydraulic transmitters. Many systems of high-temperature welding, especially with the electric arc, are shown in operation, and examples of varied uses of this process are shown, including the junction of the vertical framing and the roof principals in a steel-frame building. The coal industry is represented by a full-sized model of a coal seam with electric coal-cutters at work, and there are also exhibits illustrating the utilisation of the iron ores and oil-fuel supplies of this country.

The chemical exhibits are, in the main, the same as those which were shown in London, whilst the metallurgical industries naturally receive special attention. The Health Department of the city shows a large and instructive collection of preparations illustrating the relation between micro-organisms and disease, as well as diagrams relating to the smoke nuisance. Several Government Departments and universities are represented by stands, at some of which demonstrations are carried on. A kinematograph hall is used for showing films of scientific interest in connection with engineering, shipbuilding, and metallurgy, as well as with bacteriology. The educational value of the exhibition is very great, and a most remarkable picture is presented of the capacity of British manufacturers to accomplish good work when advantage of scientific guidance is taken.

The opening ceremony was performed on Monday, November 17, by Sir Charles Parsons, the Lord Provost of Glasgow presiding, and testimony was then given as to the importance of science to industrial progress. The exhibition has the advantage of following closely on a most successful housing exhibition, also held by the Corporation, and visited by enormous numbers of people, so that there is every reason to expect results which will be beneficial to science and to industry alike by bringing the two into closer contact, and in educating the public as to the necessity for a close co-operation between them. The exhibition remains open until December 6.

A NEW ASTRONOMICAL MODEL.

THE illustrious scholar Gerbert (A.D. 940–1003), afterwards Pope under the name of Sylvester II., was apparently the first of the schoolmen who illustrated his theoretical lessons on astronomy by the use of globes, which he constructed with his own hands. About the year A.D. 1700 George Graham invented a machine to show the movements of the earth and planets about the sun, a copy of which was made for Charles Boyle, the Earl of Orrery. Hence the name of an apparatus very useful for illustrating lessons in astronomy, although Sir John Herschel did call orreries "very childish toys." But surely the difficulty in teaching astronomy is to make the young pupil think in three dimensions. What are we going to do when the relativists would have us imagine phenomena in four dimensions?

Some forty years ago the prospectuses of schools generally advertised among the subjects taught "the use of the globes and deportment." Presumably the orderly arrangement of the solar system was to be reflected in the conduct of the pupils. The "use of the globes" seems to have disappeared from the apparatus of pedagogy, although the teaching of geography and the elementary notions of astronomy are very much facilitated by their employment. But astronomy as a class subject of general education has unfortunately suffered a lamentable eclipse. Globes have been ousted by calorimeters. Hence the ignorance of even otherwise cultured people of the very elements of the science. Lately there have been welcome signs of a recognition of its educational value, both in the elementary and in the secondary schools. In the Middle Ages astronomy was one of the seven subjects in the curriculum of a liberal education. Those who were privileged to listen to the charming discourse of Prof. Nunn to the Association of Mathematical Masters last January were able to understand how much can be done with cardboard, cylinders, cubes, and other simple appliances to illustrate the chief motions of the heavenly bodies, the observations being made and recorded by the pupils themselves.

Very heartily then do we welcome, for both its scientific and its educational capabilities, the excellent model lately constructed by Dr. William Wilson, and exhibited to the Royal and Royal Astronomical Societies, the British Association, and most of the leading educational and astronomical societies. Everyone who has seen the model has given it unstinted praise. The mechanism is very good. Gearing is done away with, its place being ingeniously supplied by cords and pulleys, with tension regulators and adjustable driving-wheels. There is nothing much to get out of order in the machine. If it does, it can easily be repaired.

But the great value of the model is in the orderly sequence of the astronomical phenomena which can be illustrated by its aid. The pupil is made to advance gradually from the simple to the more complex movements of sun, earth, and moon, illustrating such topics as the year, month, seasons, phases of the moon, motions of the earth, and eclipses, until finally he reaches such phenomena as the retrograde motion of the moon's nodes, the forward motion of the line of apsides of the moon's orbit, and the nature, number, and character of the eclipses possible in any year. It would be a mistake to set up the whole model at once. The curiosity of the pupil should be aroused and his interest sustained by adding the parts gradually and in due order, beginning with the simpler parts, and then advancing to the more complex movements.

Dr. Wilson is to be heartily congratulated on having produced such a valuable, workable astronomical model. So many science masters—excellent omen!—have desired to acquire it that he has felt justified in putting it upon the market and getting it made in quantities. The price is 22*l.* net, carriage paid to any part of the United Kingdom. All communications regarding the model should be addressed to Dr. Wilson himself at 43 Fellows Road, London, N.W.3.

A. L. CORTIE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—At a graduation ceremony held on November 18, honorary degrees were conferred on the American Ambassador, Lord Weir, Sir Joseph Maclay, the Duchess of Atholl, Dame Helen Gwynne-Vaughan, and others, in recognition of war service.

LEEDS.—The following honorary degrees have been conferred:—*D.Sc.:* Admiral Sir Henry Jackson, First Sea Lord, 1915–16; Surg.-Gen. Sir Alfred Keogh; Sir Almroth Wright; Prof. W. H. Bragg; and Mr. J. G. Baker.

LONDON.—The Senate has appointed Sir Cooper Perry to the post of principal officer, which has been in abeyance since Sir Henry Miers's resignation in the summer of 1915. Sir Cooper Perry has represented the faculty of medicine on the Senate from 1900 to 1905, and again from 1915 to the present time, and has been Vice-Chancellor of the University since June, 1917. He will take up his new duties on February 1 next.

The Senate has adopted a resolution expressing appreciation of the generosity of the Worshipful Company of Goldsmiths in presenting to the London Hospital Medical College 15,000*l.* National War Bonds for the endowment of a University chair of bacteriology bearing the name of the company and tenable at that college. The thanks of the Senate have also been accorded to Lord Cowdray for a donation of 10,000*l.* towards the fund for the reconstruction and re-equipment of the engineering buildings at University College, and for a promise of an additional donation of the same amount to be given when the total sum collected in response to the appeal for this purpose reaches 70,000*l.*

A bequest of approximately 3000*l.* is made in the will of the late Mr. T. S. Hughes for the encouragement by scholarships or otherwise of original medical research at the University.

In recognition of the munificent gift of 34,500*l.* by Sir Ralph Forster, Bart., to the fund for the chemistry building and equipment at University College, it has been resolved that the organic department of the chemical laboratories should be known by his name.

The degree of D.Sc. (Economics) has been conferred upon Mr. R. C. Rawlley, an internal student, of the London School of Economics, for a thesis entitled "Economics of the Silk Industry."

The Graham Legacy Committee has, under the regulations for the administration of the Charles Graham Medical Research Fund, made the first award of the gold medal to Dr. Charles Bolton in recognition of the original work in experimental pathology which he has conducted in the medical school of University College Hospital.

OXFORD.—The twenty-first Boyle lecture was delivered by Prof. A. Keith on November 19. Taking for his subject "Race and Nationality from an Anthropological Point of View," the lecturer pointed out that racial problems properly so called came into view only at the beginning of the nineteenth century. The prehistoric record might be divided into a long period of natural subsistence, marked by little change of condition, and a shorter period of conquest of Nature, which was rapid and fateful. The outfit for the first period, both bodily and mental, being in some respects unsuitable for the second, the racial problem resolved itself in effect into a conflict between inherited instinct and present conditions. Illustrations of both racial and national feeling consequent on the contact of different peoples were given from the negroes of North America, the French-Canadians in their relation to the surrounding white population, the Europeans and Maoris in New Zealand. The mingling of blood in South America appeared to have been socially less successful than the maintenance of racial frontiers in the north. Racial feeling, concluded the lecturer, is implanted by Nature for her own purposes of evolution.

DR. J. PROUDMAN has been appointed professor of applied mathematics in the University of Liverpool.

THE Toronto correspondent of the *Times* announced on November 24 that the buildings of the Laval University at Montreal have been destroyed by fire, and the damage is estimated at 400,000*l.* The chief damage was done in the medical department of the University.

SEVERAL representatives of British universities are now in Belgium as guests of the Belgian Government, in order to examine, among other matters, an arrangement for the exchange of teachers and students between British and Belgian universities.

THE under-mentioned staff appointments have been made at the Bradford Technical College:—*Head of Department of Chemistry:* Prof. R. B. Abell. *Lecturer in Chemistry:* Mr. H. P. Starck. *Head of Department of Biology:* Mr. A. Malins Smith. *Head of Department of Dyeing:* Dr. L. L. Lloyd.

ON November 22 President Poincaré inaugurated the French University of Strasbourg. Every endeavour is to be made to attract to the University English and Scottish students who before the war found their way to Bonn, Heidelberg, and Göttingen. The Paris correspondent of the *Times* says that the Germans have left behind them credits amounting to nearly 30,000,000 francs (1,200,000*l.*), which are available for the improvement of the scientific equipment of the University.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 13.—Sir J. J. Thomson, president, in the chair.—Lt.-Col. R. **McCarrison**: The genesis of œdema in beri-beri. Conclusions previously reached by physiological methods of adrenalin estimation are confirmed by chemical methods. Deficiency of certain accessory food factors gives rise to a greatly increased production of adrenalin. Whatever the function of adrenal medulla may be, excessive production of adrenalin, under conditions of "vitaminic" deficiency, is concerned with causation of œdema.—W. **Robinson**: The microscopical features of mechanical strains in timber and the bearing of these on the structure of the cell-wall in plants. The gross and microscopic characteristics of failure in compression are described for spruce, ash, and pitch pine. It is shown that failure is initiated by the development of microscopic planes of slipping in the cell-walls of the wood. The appearance of the slip planes in the cell-walls is accompanied by profound changes in the behaviour of the latter towards many stains and reagents. These changes are discussed in relation to their possible bearing on the process of lignification of cell-walls. In addition to compression, the failures in longitudinal tension and longitudinal shearing are described.—W. B. **Bottomley**: The effect of nitrogen-fixing organisms and nucleic acid derivatives on plant-growth. The products of the nitrogen-fixing organism, *Azotobacter chroococcum*, are shown to have a marked effect in increasing the rate of growth of plants of *Lemna minor* in water culture; and the derivatives of nucleic acid, which the author has found can be extracted from raw peat, are also able to act as accessory food substances. The addition of these two separate materials to the culture solution increased the number of plants from 1817 in mineral solutions only to 96,921 and 80,179 respectively in the liquids containing these substances. Not only was the rate of multiplication increased by these organic materials, but the plants supplied with them also maintained their normal size and health. The nitrogen-fixing organism, *Bacillus radicicola*, is found to have a similar effect to that of *Azotobacter chroococcum*. A similar series of experiments was carried out with the ash of the crude nucleic acid derivatives and of the Azotobacter growth, and neither of these materials had the slightest effect on the rate of multiplication or the health of the Lemna plants. It is therefore the *organic* material which is so essential for the complete metabolism of these plants, and they cannot maintain their normal growth and vigour for any length of time without the presence of small quantities of organic substances.—Agnes **Arber**: The vegetative morphology of Pistia and the Lemnaceæ. Anatomical examination of the "limb" of the leaf of *Pistia stratiotes*, L., the river lettuce, shows that, in addition to normally orientated vascular bundles, there is a series of inverted bundles towards the upper surface. This fact is regarded as indicating that the leaf is of the nature of a petiolar phyllode. This interpretation is extended to the distal part of the frond of the Lemnaceæ (duckweeds).—W. J. **Young**, A. **Breinl**, J. J. **Harris**, and W. A. **Osborne**: Effects of exercise and humid heat upon the pulse rate, blood pressure, body temperature, and blood concentration. The results point to the fact that both exercise and humid heat play a part in producing a rise in blood pressure, pulse rate, and rectal temperature. The degree of rise, however, is controlled by atmospheric conditions, which influence the rate of cooling of the body.

Zoological Society, November 4.—Dr. A. Smith Woodward, vice-president, in the chair.—F. Martin **Duncan**: Photographs showing the actinic quality of the light from a living Pyrophorus beetle. In describing the method employed to obtain the records, the author stated that photospectroscopically the greatest intensity of light action appeared to be in the yellow-green region.—E. **Heron-Allen**: Skiagraphs of the foraminiferan genus Verneuilina from examples grown in a hypertonic tank.—Miss Joan B. **Proctor**: The variation in the number of dorsal scale-rows in our British snakes.—Dr. G. A. **Boulenger**: Some new fishes from near the west coast of Lake Tanganyika.—Dr. G. **Marshall**: The species of the Balaninus occurring in Borneo (Coleoptera, Curculionidæ).—The Hon. P. **Methuen**: Description of a new snake from the Transvaal, together with a new diagnosis and key of the genus Xenocalamus, and of some Batrachia from Madagascar.—Prof. J. P. **Hill**: The placentation of Tarsius.—R. I. **Pocock**: The external characters of Tarsius.

Geological Society, November 5.—Mr. G. W. Lamplugh, president, in the chair.—H. H. **Thomas**: Some features in the topography and geological history of Palestine. A perfectly new method of illustrating and investigating some branches of physical geology is afforded by aeroplane photography. It seems, first, to illustrate in a very striking and convincing form many geological phenomena, such as the structure of a volcano or the land-forms resulting from erosion, and may be of value in the teaching of the science. In the second place it may, in certain circumstances, become a valuable means of research, especially in connection with river development or denudation in a region which is somewhat inaccessible, or where the surface of the ground is very complicated and the main features are obscured by a mass of less important detail. The lecture dealt principally with the illustration of the physical features of Palestine, and owes its origin to the systematic photo survey made over Central Palestine during the war. The lacustrine deposits of the Jordan Valley and their weathering were shown, and also the form of the drainage channels running down into the main valley. The depression of the Dead Sea with reference to the surrounding country has resulted in cañon formation in many places. Some evidences of faulting at different periods can be distinguished. The Jordan at present forms an interesting study in river development, and many of its main features were demonstrated. The relation of the Jordan to the Orontes has been considered, and an aeroplane photographic survey of the country between the two rivers indicates that the Jordan probably originated in northern Syria in earlier times. The Syrian portion of the stream has been captured by the younger Orontes, and this has had a very important effect on the whole topography of the Jordan Valley.

Linnean Society, November 6.—Dr. A. Smith Woodward, president, in the chair.—Col. H. E. **Rawson**: Plant-sports produced at will. The author had observed near Cape Town that shrubs of Kei-apple (*Aberia caffra*) died when they were deprived of the full sun up to a certain altitude in the early morning. This led to experiments in screening plants about this hour for various periods. "Selective screening" resulted in various sports in form and modifications of colour in *Tropaeolum majus*. A special form of *Papaver rhoeas* was obtained and fixed, and other experiments were detailed. The author sums up thus:—The intensity of the light regulates and modifies the coloured bands upon all parts of the plant which have been excited by interference. In Nature selective screening prevails universally, and these experiments suggest that it is deserving of study to bring out its latent potentialities.—L. **Hogben**: Nuclear phenomena in the oocytes of Neuroterus, a gall-fly. The atypical separation of polar bodies in the Hymenoptera parasitica is a consequence of the interruption of the first polar metaphase which appears precociously before the egg is laid. There is no evidence for "amitosis" in the germ-cells of Hymenoptera.—L. V. **Lester-Garland**: A revision of the genus Baphia, Afzel. The author had studied the rich material in the herbaria of the British Museum and at Kew, the number of known species having increased from six (Bentham and Hooker fil. in 1865) to sixty in the present enumeration. The genus is practically confined to tropical Africa, one outlier reaching as far south as Natal, and another as far east as Borneo.

Royal Meteorological Society, November 7.—Sir Napier Shaw, president, in the chair.—Prof. Vilhelm **Bjerknes**: The structure of the atmosphere when rain is falling. Though a comprehensive mathematical analysis of atmospheric movements might be slow in yielding a general solution of the problem of weather forecasting, yet results of practical value were likely to be obtained during the course of the analysis. Such results had been applied to the forecasting of rain in Norway with a fair measure of success. The basis of the method consisted in drawing "lines of flow" of the air and noting where these showed regions of convergence or divergence. Such lines of flow indicated two lines of convergence in a typical depression: (1) where a warm south-westerly wind blows almost normally against the flank of a relatively cold south-easterly current (the warm air rising over the cold here leads to steady rain over a belt some hundreds of kilometres in breadth); and (2) where the cold south-easterly current, curving round the north side of the centre of depression, cuts under the warm south-westerly wind. This causes a region of squally and showery weather along a second narrower belt. Another important application of the lines of flow lies in the forecasting of thunderstorms. Experience showed that in quiet weather in Norway under the system of diurnal breezes certain points regularly become centres of convergence, and it was at these points that thunderstorms first developed, spreading later to surrounding regions.

Royal Anthropological Institute, November 11.—Sir Everard im Thurn, president, in the chair.—S. H. **Warren**: A stone-axe factory at Graig-lwyd, Penmaenmawr. Stone axes of Neolithic types were extensively manufactured out of the fine-grained (andesitic) margin of the Penmaenmawr intrusion of igneous rock. Blocks of scree, many of them of large size, which fell from the crags were gradually flaked down in successive stages until a satisfactory stone-axe blade, ready for polishing, was obtained. There are examples showing every stage of the process, arrested unfinished through accidental breakage, or because the shape being produced was unsatisfactory. Under the last heading it was excessive thickness of the blade which was the greatest source of trouble. Many of the unfinished "wasters" are broken in half, producing the segmental form to variations of which the unfortunate names of "tea-cosy" and "toe-cap" have been applied. Among the waste of the axe-making industry, which is found in great profusion on the mountain-side, the resemblances to Mousterian flake industries are very striking. Equally instructive parallels are to be observed among the "wasters" with characteristic examples of the earlier Palæolithic industries, notably with the earliest of all, or the pre-Chelles. Axes made of the Graig-lwyd rock are being identified from other localities, and further research along these lines is expected to give interesting results.

MANCHESTER.

Literary and Philosophical Society (Chemical Section), October 24.—Sir Henry A. Miers in the chair.—Sir William J. **Pope**: The photography of coloured objects. Previous to the war all the various methods of colour photography—the first of which was devised by Prof. Joly, of Dublin—the modern processes of photographic colour-printing, and the present-day panchromatic photographic methods for obtaining a correct rendering in monochrome of parti-coloured objects, were based upon the success which has been attained in imparting sensitiveness throughout the visual spectrum to the ordinary blue-sensitive photographic plate. By staining the plate with erythrosine it becomes sensitive to green and orange; plates so treated are termed orthochromatic. A number of dyestuffs belonging to the class of cyanine dyes discovered by Greville Williams in 1856 are capable, however, of sensitising a photographic plate throughout the whole range of the visible spectrum. Experimental investigation of sensitising dyestuffs was instituted in the chemical laboratories of the University of Cambridge by Dr. W. H. Mills and Sir William J. Pope at the end of 1914. Methods for producing the ordinary sensitising dyestuffs on a technical scale were devised, and all the sensitisers used by the Allies have been prepared in the Cambridge laboratories since the German importation ceased. The best panchromatic plate made in pre-war days possessed about one-third the sensitiveness to red as to blue light. At the present time a very rapid panchromatic plate is on the market which is much faster to red than to blue light; the rapidity of the plate to red light has been thus increased about fourfold.

DUBLIN.

Royal Irish Academy, November 11.—Prof. G. H. Carpenter in the chair.—Mrs. Lilian **Porter**: Floral development in *Tricuspidaria lanceolata*. Both pentamerous and hexamerous flowers occur. The calyx is quincuncial or irregularly imbricated; the corolla is usually induplicate-valvate, but shows a tendency to contortion; the stamens arise on an enlargement of the receptacle in groups of three alternating with the petals; one stamen is terminal and two are lateral, as in early stages of Tilia, thus emphasising the relationship between Elæocarpaceæ and Tiliaceæ.

PARIS.

Academy of Sciences, November 3.—M. Léon Guignard in the chair.—H. **Deslandres**: Remarks on the constitution of the atom and the properties of band spectra. The concluding paper of four communications on the same subject. A model atom is proposed, the vibrations of which would fall in with the observed regularities in band spectra.—P. **Termier** and G. **Friedel**: The structure of the coal basin of Gard.—P. **Sabatier** and A. **Mailhe**: The catalytic reduction of the halogen acetic esters. At 300° C. ethyl chloroacetate can be reduced by hydrogen in presence of nickel to ethyl acetate, some aldehyde and ethylene being formed by secondary reactions. Under similar conditions ethyl dichloroacetate can be reduced to the monochloroacetate, and ultimately to ethyl acetate. The reaction can also be applied to ethyl trichloroacetate and ethyl bromoacetate.—G. **Bouligand**: Limited and harmonic functions in an infinite domain, zero on the frontier.—S. **Stoïlow**: A classification of ensembles of zero measure.—E. **Kogbetliantz**: The unicity of ultra-spherical developments.—N. E. **Nörlund**: The calculus of finite differences.—T. **Carleman**: Integral equations.—C. **Frémont**: A new method for testing the fragility of metallic tubes. Two new methods of testing notched tubes by shock are detailed.—M. **Amans**: Thrust and power of rotating blades unequally bent.—G. **Fayet** and A. **Schaumasse**: Return of the periodic comet 1911 VII. (Schaumasse). This comet came under the influence of Jupiter, and its elements were, in consequence, considerably modified, and, although the perturbations have been calculated, the exact position of the comet was a matter of uncertainty. After some months' searching a feeble comet (magnitude 12·5) was discovered on October 29, which is very probably the 1911 VII. comet advanced eighteen days. The positions on October 29 and 30 are given, together with the positions of the comparison stars.—G. **Sagnac**: Comparison of experiment with the mechanical theory of the undulatory æther.—G. **Bruhat**: Separators of radiations: application to spectro-polarimetry.—MM. **Ledoux-Lebard** and **Dauvillier**: The fundamental constants of the spectrometry of the X-rays. Different values for the reticular distance d_p for calcite vary between 3·0279 and 3·04 (in 10^{-8} cm.). The results of Bragg, Webster, Compton, Uhler, and Cooksey and Siegbahn are reviewed and in part recalculated, and give $3{\cdot}0346{,}10^{-8}$ cm. as the most probable figure.—P. **Loisel**: The radio-activity of the water from the large spring at Bagnoles-de-l'Orne and its variations. The amount of radium present in this water varies between 22 and $109{,}10^{-12}$ g. per litre, with a mean of 68. The cause of the variation is unknown.—J. A. **Muller**: Remarks on chemical decompositions, simultaneous or successive, provoked by physical agents.—J. **Guyot** and J. J. **Simon**: The action of sulphuric anhydride and of oleum on methyl alcohol. The preparation of dimethyl sulphate. The action of 60 per cent. fuming sulphuric acid upon pure methyl alcohol in the proportions indicated in the paper gives a yield of more than 90 per cent. of methyl sulphate.—E. **Léger**: δ-cinchonine and its isomers: its relations with niquine.—M. **Stuart-Menteath**: Some points on the geology of the Pyrenees.—J. **de Lapparent**: Devonian rocks containing radiolaria in the valley of Bruche (Alsatian Vosges).—P. **Mazé**, M. **Vila**, and M. **Lemoigne**: The action of cyanamide and dicyanodiamide on the development of maize. Cyanamide (0·162 gram per litre), with or without nitrate, kills the seedling. Dicyanodiamide at the same concentration does not kill the plant, and in presence of nitrate is not toxic. Neither acts as a plant-food.—M. **Ringelmann**: Researches on the resistance to wear of parts of agricultural machines.—J. **Pellegrin**: The fresh-water fishes of Morocco.—J. **Legendre**: The food of *Eleotris Legendrei*. This fish is strictly carnivorous, and during the winter eats its own species.—V. **Galippe**: Micro-organisms living in paper: their resistance to the action of heat and of time. Living organisms were obtained from filter-paper which had been sterilised in an autoclave at 120° C. Living organisms were also obtained from paper of various ages, the oldest being a papyrus dating from about 200 B.C.—F. **d'Hérelle**: An epidemic of bird-typhus.

MELBOURNE.

Royal Society of Victoria, October 9.—Mr. J. A. Kershaw, president, in the chair.—F. **Chapman**: Notes on a collection of Tertiary fossils from the Ooldea Soak, South Australia. The author identifies two sets of fossils, the older series being Miocene (Janjukian), and the younger a raised beach deposit of older Pleistocene age. The most remarkable of the Miocene fossils is *Orbicella* (*Heliastraea*) *tasmaniensis*, which hitherto has been confined to the Miocene of Tasmania. This appears to indicate the former existence of land across the Great Bight connecting a lost remnant of the former southerly extension of the Australian continent. The later, Pleistocene, deposits at Ooldea contain the foraminifer Orbitolites, now extinct in these latitudes. The Miocene determinations in this area confirm Prof. J. W. Gregory's and Mr. J. T. Jutson's views of the age of similar limestones in Western Australia.—A. J. **Ewart** and J. R. **Tovey**: Contributions to the flora of Australia, No. 28. Two new species are described, *Casuarina Helmsi* and *Plagianthus monoica*, and the appearance of a number of new naturalised aliens, of which one, *Lolium subulatum*, has proved a useful grass in dry districts. An observation is recorded on a Moreton Bay fig, a large tree of which was ringed at the outbreak of the great war, but did not die until the declaration of peace. The death of the tree was due to the starvation of the roots, and as the young wood was removed the older wood retained the power of conducting water indefinitely. Data are also given in regard to the growth-expansion of an elm which appear to throw doubt upon Trowbridge and Weil's conclusion that frost cracks are formed, not by the expansion of frozen water, but by the contraction of the wood of the tree.

SYDNEY.

Royal Society of New South Wales, October 1.—Prof. C. E. Fawsitt, president, in the chair.—G. J. **Burrows**: The hydrolysis of urea hydrochloride.—Prof. O. U. **Vonwiller**: Notes on the elastic properties of selenium. Selenium in the vitreous form shows viscosity effects like those of pitch. When distorting forces are applied, in addition to the immediate elastic strain, disappearing with removal of the forces, there is a continuous yielding, the distortion increasing so long as the forces are applied. The rate of movement is much greater when the substance is illuminated than when it is in darkness. This effect of light has not hitherto been recorded. Selenium in the crystalline form shows the viscosity effect, but it is very much less than with the vitreous modification.

BOOKS RECEIVED.

Elementary Calculus. By C. H. P. Mayo. Pp. xx+345+(Answers) xxxix. (London: Rivingtons.) 10*s*.

School Mechanics. Part i. School Statics. By W. G. Borchardt. Pp. viii+266. (London: Rivingtons.) 6*s*.

Manganese Ores. By A. H. Curtis. Pp. x+118. (London: J. Murray.) 3*s*. 6*d*. net.

Tin Ores. By G. M. Davies. Pp. x+111. (London: J. Murray.) 3s. 6d. net.

Alcohol: Its Production, Properties, Chemistry, and Industrial Applications. With Chapters on Methyl Alcohol, Fusel Oil, and Spirituous Beverages. By C. Simmonds. Pp. xx+574. (London: Macmillan and Co., Ltd.) 21s. net.

Snapshots of the Wild. By F. St. Mars. Pp. vii+244. (London and Edinburgh: W. and R. Chambers, Ltd.) 5s. net.

Manual of Meteorology. By Sir Napier Shaw. Part iv.: The Relation of the Wind to the Distribution of Barometric Pressure. Pp. xvi+166+iii plates. (Cambridge: At the University Press.) 12s. 6d. net.

Examples in Heat and Heat Engines. By T. Peel. Pp. iii+104. (Cambridge: At the University Press.) 5s. net.

Justice and the Poor. By R. H. Smith. Pp. xiv+271. (New York City: The Carnegie Foundation for the Advancement of Teaching.)

A Naturalist's Sketch Book. By A. Thorburn. Pp. viii+72+60 plates. (London: Longmans and Co.) 6l. 6s. net.

Zinc and its Alloys. By Dr. T. E. Lones. Pp. ix+127. (London: Sir I. Pitman and Sons, Ltd.) 2s. 6d. net.

The Transmutation of Bacteria. By Dr. S. Gurney-Dixon. Pp. xviii+179. (Cambridge: At the University Press.) 10s. net.

Opere di Evangelista Torricelli. Edited by G. Loria and G. Vassura. Vol. i., Parte i. Pp xxxviii+407. Vol. i., Parte ii. Pp. 482. Vol. ii. Pp. 320. Vol. iii. Pp. 521. (Faenza: G. Montanari.) 60 franchi the 3 vols.

Animal Life under Water. By Dr. F. Ward. Pp. x+178. (London: Cassell and Co., Ltd.) 7s. 6d. net.

Enjoying Life: and Other Literary Remains of W. N. P. Barbellion. Pp. xvi+246. (London: Chatto and Windus.) 6s. net.

Twenty-four Nature Pictures. By E. I. Detmold. (London: J. M. Dent and Sons, Ltd.) 5l. 5s. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 27.

ROYAL COLLEGE OF SURGEONS, at 3.—Annual Meeting of Fellows and Members.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—C. C. Paterson, J. W. T. Walsh, A. K. Taylor, and W. Barnett: Carbon Arcs for Searchlights.

FRIDAY, NOVEMBER 28.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Dr. E. Pritchard: (1) Hypertrophy of Pylorus with other Associated Hypertrophies; (2) Hypertrophy of Lower End of Œsophagus with Papilloma of Cardia.

PHYSICAL SOCIETY, at 5.—Discussion on Lubrication. To be opened by Dr. T. E. Stanton. Speakers include Principal Skinner, W. B. Hardy, F. W. Lanchester, and H. M. Martin. Visitors are invited to this Meeting.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Col. W. Hunter: The Epidemiology of Typhus Fever in Serbia.

MONDAY, DECEMBER 1.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ROYAL INSTITUTION, at 5.—General Meeting of Members.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Capt. R. Twelvetrees: Mechanical Transport in the War.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street, W.1), at 8.—G. Cator: The Nature of Inference.

ROYAL INSTITUTE OF BRITISH ARCHITECTS (Members' Meeting), at 8.—Architects' Fees for Housing Schemes.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. T. Hewitt: Synthetic Drugs (Cantor Lecture).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—A. Henning: Ethyl Chloride.—C. E. Barrs: The Influence of Impurities in Lead when it is Heated with Concentrated Sulphuric Acid.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. Wilson Fox: Development of Transport on the Great Lakes of Africa.

TUESDAY, DECEMBER 2.

ROYAL HORTICULTURAL SOCIETY (at Vincent Square), at 3.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.

RÖNTGEN SOCIETY (at Medical Society of London), at 8.15.—Dr. E. Taylor Jones: The Action of Induction Coils.—Major Cooper: Description and Demonstration of New High-speed Interrupter for Induction Apparatus and Frimandeau Coils.

WEDNESDAY, DECEMBER 3.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Air Commodore H. R. Brooke-Popham: The Air Force.

ROYAL SOCIETY OF ARTS, at 4.30.—J. W. Pearson: The Oil Seed Crushing Industry.

ROYAL COLLEGE OF SURGEONS, at 5.—Sir John Tweedy: The Surgical Tradition (Thomas Vicary Lecture).

GEOLOGICAL SOCIETY, at 5.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—E. N. Duffield: Car Design and Car Usage from the Point of View of the Majority of Owner Drivers.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. van B. Gilmour: New Distillation Method for Detecting Adulteration in Butter and for Estimating Fats of the Coconut Group.—F. S. Sinnatt and L. Slater: An Investigation into the Composition of the Unsaturated Hydrocarbons Present in Coal Gas.—B. S. Evans: A New Process for the Determination of Arsenic; with Notes on the Chemistry of the Marsh-Berzelius Process.

THURSDAY, DECEMBER 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—A. M. Williams: (1) The Adsorption of Gases at Low and Moderate Concentrations: Part I. Deduction of the Theoretical Adsorption Isotere and Isotherm; Part II. Experimental Verification of the Form of the Theoretical Isoteres and Isotherms. (2) The Adsorption of Gases at Low and Moderate Concentrations: Part III. Experimental Verification of the Constant in the Theoretical Adsorption Isotere.—T. R. Merton: (1) The Secondary Spectrum of Hydrogen; (2) The Spectra of Isotopes.—E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces, Part II.—F. Horton and Ann C. Davies: An Experimental Determination of the Critical Electron Velocities for the Production of Radiation and Ionisation on Collision with Argon Atoms.

CHEMICAL SOCIETY, at 8.

FRIDAY, DECEMBER 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds Technical College, Leonard Street), at 7.—H. M. Barlow: Thermionic Magnifiers.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—R. D. Summerfield and H. J. Davey: Inspection and Testing of Materials.

CONTENTS.

	PAGE
The Royal Commission on the Universities of Oxford and Cambridge	329
Principles of Radio-communication. By A. R.	330
Round the Wrekin	331
Our Bookshelf	332
Letters to the Editor:—	
Holland and International Rivers.—Dr. P. Geyl and Prof. L. W. Lyde	333
The Colours of Racehorses.—Sir Wm. Ridgeway	334
Gravitation and Light.—Sir Oliver Lodge, F.R.S.	334
Variation of Refractive Indices.—Sir Henry A. Miers, F.R.S.	334
Neon.—F. W. Aston	334
Bird Migration.—Dr. Michael C. Grabbam	334
Luminous Worms.—Rev. Hilderic Friend	334
The Doubly Refracting Structure of Silica Glass.—Robert W. Lawson	335
The Antiquity of Man.—J. Reid Moir and Dr. A. Smith Woodward, F.R.S.	335
Western Turkestan. By S. Casson	335
The British Association and Scientific Research	337
Dr. John Aitken, F.R.S. By C. G. K.	337
Notes	338
Our Astronomical Column:—	
The Leonid Meteoric Shower	342
Two Stars with Large Parallaxes	342
Aphelia of Planets and Comets	343
The British Science Exhibition, Glasgow	343
A New Astronomical Model. By Rev. A. L. Cortie, S.J.	343
University and Educational Intelligence	344
Societies and Academies	345
Books Received	347
Diary of Societies	348

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THURSDAY, DECEMBER 4, 1919.

THE NURTURE OF KEY INDUSTRIES.

THE Bill "to constitute a Trade Regulation Committee, to regulate the importation of goods with a view to prevent dumping, safeguarding key industries and industries affected by the depreciation of a foreign currency," which Sir Auckland Geddes introduced in the House of Commons on November 19, will no doubt meet with strenuous opposition. It is, of course, anathema to the out-and-out Free Trader, and will be viewed with some doubt and suspicion even by those who, while not hide-bound by fiscal shibboleths, are yet distrustful of the bureaucratic control which the Bill would seem to entail. The terms of the amendment for its rejection on second reading, tabled by Mr. Wallace, one of the Coalition Liberals, are obviously drafted so as to secure the support, not only of the convinced Free Trader, but also, if possible, of those who object to all departmental control of our commercial relations.

As regards the Bourbons of the Manchester school, who learn nothing and forget nothing, Mr. Wallace is preaching to the converted; probably no argument will have the slightest effect upon them. They will find nothing in the changed conditions of the world, in the circumstances of the Empire, or in the influence of the war on our home industries to induce them to modify their convictions in the smallest degree. To them the basic principle of Free Trade has something of the sanctity of Holy Writ. It has all the force of a natural law as fixed and immutable as seemed to them the law of gravitation. But they may be reminded, as recent events have shown, that even the law of gravitation may possibly have a less stringent universality than we have hitherto been content to assume. How much more probable is it, therefore, that a so-called economic law depending upon fallible and transitory human conditions may be at least equally invalid and fundamentally more unsound.

The argument against bureaucratic control will no doubt appeal to a considerable body of public opinion. The Legislature, under the direction of the Government, has of late been steadily riveting the chains of this control in a variety of directions, and there is a growing impatience with the policy. It is a sort of aftermath of the war which the country will not tolerate to an indefinite extent. During the continuance of the war, when the free play of individualism might conceivably interfere with a united national effort, guidance and control by a Government which we had entrusted with the safeguarding and direction of our destiny were not only accepted, but also generally recognised as imperatively necessary. But under normal conditions the continuance and possible perpetuation of bureaucratic control is wholly opposed to the genius of the English people, as past experience has abundantly proved, and is certain to be fiercely resented sooner or later.

It may be argued, of course, that the times are not yet normal, and no doubt this consideration will appeal to many who would otherwise be disposed to reject the Bill *sans cérémonie.* The allegation that it is bound to impose an intolerable burden upon manufacturers, traders, and consumers, and that it is calculated to maintain high prices and arrest our rapid industrial recovery and development, of course, begs the question. It is at least arguable that the provisions in the Bill against dumping and for the safeguarding—we purposely omit the word "protecting," as a term of offence to some people—of key industries are really calculated to assist our industrial development, even although they may tend for a time to maintain high prices. Excessive cheapness has not hitherto proved the panacea for all human ills which some, in the past, would appear to have claimed for it.

Although the House of Commons is invited by the amendment to reject the Bill, it will be observed that in the Trade Regulation Committee which it is proposed to set up, and which is to be responsible for the working of the measure, the majority is to consist of members of that House nominated by the House itself. The measure, therefore, is not, strictly speaking, bureaucratic in the sense in which this term is usually understood. It is presumably intended that the representatives of the people, being in the majority, should exercise an effective control of its operations. It rests with the House of Commons to nominate persons of knowledge and experience in commercial and industrial matters, who would keep themselves in touch with the views of the trade organisations in the country, and who may be trusted to check any undue departmental interference or restriction, and to expedite, when necessary, departmental activity. Is the House so distrustful of its power, or of the ability of its members to cope with the permanent departmental officials, that it is to be asked to reject the measure on the ground that it is too "bureaucratic"?

There is much in the Bill of a highly technical character, and even experts are certain to differ as to the true meaning and effect of some of its provisions. Many of its terms are capable of various interpretations, and cases are certain to arise the equitable solution of which will tax the judgment and wisdom of the Committee. But the general sense of the House will, it is to be hoped, perceive that the measure is based upon the requirements and necessities of the times. This consideration ought surely to mitigate the factious opposition with which it is threatened.

No doubt the Bill will be modified in its passage through Parliament. It is certainly capable of amendment in some details. But it is to be hoped that the Government will stand firm in its effort to safeguard the key industries. The list of these named in the Second Schedule is considerably shorter than that drawn up by manufacturers' associations, and much of it is too technical to be within the comprehension of the average member of Parliament, who has little or no knowledge of science. It may be that the events of the last four or five years have made him acquainted with a certain amount of chemical terminology, but the list of articles enumerated in the first two sections of the Schedule dealing with synthetic colouring matters, drugs, "intermediates," and "fine chemicals," is sufficiently deterrent to the lay mind, and scarcely lends itself to effective party debate. It is to be regretted that at the present juncture no acknowledged representative of chemical science is a member of the House—no one of the authority and knowledge, perspicacity and breadth of view, for example, of the late Lord Playfair or of the late Sir Henry Roscoe. It is certain that, whatever might have been the views of these distinguished men concerning the fiscal policy of the Bill, they would be in hearty sympathy with the effort to resuscitate and strengthen an industry which had its rise in this country, and in all probability would never have sunk into partial insignificance had Parliament dealt earlier with the admitted deficiencies in our system of national education.

The Schedule may be said to have its origin in the war, and to embody some of its lessons. It is the direct result of the painful experience of our shortcomings as revealed to us on its outbreak. Some of the industries with which it is concerned are at present not much beyond their initiatory stage, but, as has been proved, they are all more or less necessary to our national welfare, and in the light of our recent experience it would be the height of unwisdom not to do everything in our power to place them on a permanent and independent basis. We are at the parting of the ways, and on the House of Commons rests the serious responsibility of choosing the right path. To neglect the present opportunity, or to be blind to its significance, would be an irreparable disaster.

THE DRAGON OF MYTHOLOGY.

The Evolution of the Dragon. By Prof. G. Elliot Smith. Pp. xx+234. (Manchester: At the University Press; London: Longmans, Green and Co., 1919.) Price 10s. 6d. net.

THE dragon may be regarded as the most venerable symbol employed in ornamental art, and it has been the inspiration of much of the world's great literature in every age and clime. The dragon-myth also represents the earliest doctrine or systematic theory of astronomy and meteorology. The study of dragon-lore thus leads us back to some of the most primitive workings of the human mind, and embraces many subjects which at first sight seem to have little connection with the end in view. Prof. Elliot Smith's work on the evolution of the dragon, indeed, alludes to almost every aspect of primitive thought and myth, and the author discusses questions which vary from the origin of embalming to the worship of the cow, the elixir of life, the swastika, and the reasons for wearing clothes. His volume consists of notes of three lectures delivered in the John Rylands Library, Manchester, illustrated by beautiful reproductions of an appropriate series of drawings. The chapters are entitled respectively Incense and Libations, Dragons and Rain Gods, and The Birth of Aphrodite.

Prof. Elliot Smith maintains that the dragon was originally a beneficent creature, the personification of water. The fundamental element in the dragon's powers was the control of water, whether rivers or seas, pools or wells, or clouds on the tops of mountains. The substratum of its anatomy usually consists of a serpent or a crocodile, with the scales of a fish for covering, the feet and wings (sometimes also the head) of an eagle or hawk, and the fore-limbs (sometimes also the head) of a lion. All the parts are symbols of the various attributes and uses of water in Nature. With various slight additions and modifications, this composite wonder-beast ranges from western Europe to the far east of Asia, and thence across the Pacific to America. It must, indeed, have had a common origin, and Prof. Elliot Smith particularly emphasises the interest of the American version, which he regards as having gradually evolved from several successive importations of ideas from the Old World. He remarks that "one and the same fundamental idea, such as the attributes of the serpent as a water-god, reached America in an infinite variety of guises, Egyptian, Babylonian, Indian, Indonesian, Chinese, and Japanese; and from this amazing jumble of confusion the local priesthood of Central America built up a system of beliefs which is distinctively American, though most of the ingredients and the principles of synthetic composition were borrowed from the Old World."

The lecture notes are unfortunately somewhat scrappy, and Prof. Elliot Smith apologises for the circumstances which led both to this defect and to the not infrequent repetitions. The book also lacks an index, which would add much to its usefulness. It is, however, a veritable mine of information on the subjects with which it deals, with numerous references to literature, and science is indebted to the John Rylands Library for undertaking the publication.

EUGENICS.

(1) *Lectures on Sex and Heredity delivered in Glasgow*, 1917–18. By F. O. Bower, J. Graham Kerr, and W. E. Agar. Pp. vi+119. (London: Macmillan and Co., Ltd., 1919.) Price 5*s*. net.

(2) *Eugenics and Environment.* By Prof. C. Lloyd Morgan. Pp. 82. (London: John Bale, Sons, and Danielsson, Ltd., 1919.) Price 2*s*. net.

(3) *La Sélection Humaine.* By Prof. Charles Richet. (Bibliothèque Scientifique Internationale.) Pp. iii+262. (Paris: Librairie Félix Alcan, 1919.) Price 6.60 francs.

THESE three books illustrate three somewhat different methods of setting the problem of eugenics before the general reader. The aim of the excellent little book by Prof. Bower, Prof. Graham Kerr, and Dr. Agar is to set forth the indispensable facts and principles, and leave the reader to draw the moral. It is not perhaps intended to deal with eugenics at all, but it is one which enthusiasts for eugenic propaganda will find very valuable. It consists of six lectures on the more elementary facts of sex, reproduction, and heredity in plants and animals. The first four lectures, two on plants and two on animals, deal with the subject in the two kingdoms in similar fashion, beginning with examples of reproduction and conjugation (syngamy) in the Protista, and passing through the simpler Metaphyta and Metazoa to the more complex phenomena of the highest plants and animals. No one who has a natural interest in living things, but has had no systematic training in biology, can fail to find these lectures interesting; those on plants are perhaps unnecessarily technical here and there, but with the assistance of the excellent illustrations any reasonably educated person should find them easy and interesting to read.

In the last two lectures Dr. Agar takes up the subject of heredity, begins with the phenomena of fertilisation, cleavage, and the early segregation of the germ-cells in Cyclops as an introduction to the conceptions of soma and germ-plasm and the material basis of inheritance, and then proceeds to give a short but lucid account of Mendel's law. In the last lecture he takes up heredity in Man. He points out that, since the characters in Man which are known to follow Mendel's law are comparatively few, and in general of small practical importance, human heredity must be studied in practice chiefly by the statistical methods of the biometric school. Of these he gives a lucid elementary description, illustrated by actual examples taken from the papers of Pearson, Heron, Schuster, and others, and shortly points out the bearing of the facts on eugenic proposals.

(2) Prof. Lloyd Morgan's little book is frankly an elementary text-book of eugenics. It deals with variation in human characters as illustrated by the normal curve of error, the principles of correlation, and the method of finding the correlation coefficient, very shortly with Mendelian heredity, and finally with acquired characters, selection, and the relation of biological characters to social tradition and civilisation. It is written in a pleasant and almost colloquial style, but suffers not infrequently from a certain obscurity of diction—*e.g.* in describing a correlation table (p. 33): "Along the left-hand vertical side the stature of the sons is given *in ascending order read downwards*" (our italics). Again, on p. 32 a misleading definition of perfect correlation is given, which is corrected at the bottom of the same page, a treatment which does not conduce to clearness. On p. 47 there is, doubtless by a slip, the misleading statement: "If blue eyes mate with brown eyes, one child in four may be blue-eyed." We feel also that the booklet suffers from being illustrated by purely imaginary examples the simplicity of which may give a false impression. Dr. Agar's account of biometric methods compares favourably with it in this respect. Nevertheless, it is in most respects an admirable elementary introduction to the subject, such as might well be used by those who wish to follow it up more fully by further reading.

(3) Prof. Richet's book has more of the character of an essay. It does not profess to set forth specific facts, but takes the facts for granted, and discusses the conclusions to be drawn from them. The main thesis of the author is that if selection can do such great things with domestic animals and plants, it could, if applied, do equally great things with man, and that the only hope for mankind in the future is in its application. The aim of life is happiness; progress is the increase of total happiness; this can be gained through science alone; it is limited only by the limits of the human mind, and these limits might be almost indefinitely extended by suitable selection. Selection must be of several kinds. In the first place, the white race is indisputably superior, and crossing with black or yellow gives bad results. All race-crosses must therefore be prohibited. Within the white race all defectives must be prevented from reproducing; seriously defective infants must not be allowed to live, and those found defective in later life must be segregated. Finally, positive encouragement must be given to marriage of the superior, especially between those superior in the same respect. The author's enthusiasm leads him at times to rather wild statements. He calls deaf-mutes (*sourds-muets*) "ces ébauches d'humanité, ces produits disgraciés . . . ces pauvres avortons," words which can only dis-

gust those who know the brilliant gifts of some who are thus afflicted. He states categorically that the mental improvement due to education is transmitted to offspring, and recommends late marriage of the highly educated in order that the effects of education may be more fully handed on. And neither Prof. Richet nor Prof. Lloyd Morgan seems to realise the extreme difficulty of eliminating an undesirable character if it is recessive in inheritance. In a stable population, if 1 per cent. show a recessive character, 18 per cent. will bear this character concealed by the corresponding dominant, and by preventing the reproduction of the 1 per cent. in which the recessive is homozygous, only very slow progress will be made in eliminating it. Prof. Richet is an enthusiast for eugenics, and has written an entertaining book, but one which is scarcely sufficiently abreast of modern work on heredity.

L. D.

OUR BOOKSHELF.

Essays in Common-sense Philosophy. By C. E. M. Joad. Pp. 252. (London: The Swarthmore Press, Ltd., 1919.) Price 8*s.* 6*d.* net.

If any man of science, perplexed at the disturbing challenge which philosophy throws down to the assumptions as to plain matter of fact on which science rests, wants comfort and support for his intellectual framework from within philosophy itself, he will find and certainly enjoy it in the delightfully clear essays of Mr. Joad. It is a somewhat unusual thing for a young writer to make his *début* in philosophy by rejecting every temptation to paradox and any attempt to startle the "plain man," and setting himself the apparently easy but really very difficult task of convincing the "plain man" that his views about the universe are not likely to be very far removed from truth. Yet this is what Mr. Joad sets out to do.

Mr. Joad is not a very trustworthy guide when he discusses famous philosophical theories. He adopts too easy a classification, with the consequence that we find ourselves in strange company. All philosophers, past and present, are in his view representationists, solipsists, or realists. But this does not in the least spoil our enjoyment of the concise and easy way in which the writer finds himself at home in philosophy, of the keenness of his wit, and of the dexterity of his cut and thrust. There is only one of us who comes in for unstinted praise—Prof. Dawes Hicks—and we believe he does not recognise his theory in Mr. Joad's exposition. The rest of us—Bergsonians, pragmatists, absolutists—are all alike well trounced.

There is one thing in Mr. Joad's own view, however, which is very puzzling, not to say disconcerting. He tells us that sensible objects exist "very much" as we know them. But why not altogether so? If there is any difference at all, why is he so confident it can only be a very little one?

H. W. C.

Modern Engineering Workshop Practice: A Text-book for the Use of Engineering Students, Apprentices, and Engineers engaged in Practical Work. By Herbert Thompson. (Griffin's Scientific Text-books.) Pp. xi+328. (London: Charles Griffin and Co., Ltd., 1919.) Price 9*s.* net.

This book is an attempt to give a fairly comprehensive view of modern engineering workshop practice, and includes sections dealing with general methods and machines, and others dealing with special processes and machines, such as turret lathes, spiral milling, grinding, hardening, tempering, annealing, autogenous and thermit welding, and soldering and brazing. The author is quite at home in these branches. The descriptions are clear, and whilst many of the illustrations are half-tone reproductions of photographs of machines and appliances, there is a sufficient number of line drawings to enable the reader to understand the construction. The author is not so happy in chap. i., which deals with materials. Thus, on p. 3 we read, under the paragraph heading "Malleable-iron Castings": "If an iron casting, made out of the right kind of pig iron, be heated to a red heat in an iron box surrounded by some carbonaceous material for from 12 to 24 hours, the surface of the material becomes converted into a form of steel. The casting then has lost its extreme brittleness, and becomes more or less malleable. The castings are generally embedded in red hæmatite." In view of this statement, it is of interest to note that later on (p. 229), in dealing with case-hardening, the author shows that his knowledge is sound, as regards both the process and the changes which take place during the progress of case-hardening. Despite blemishes of this kind, the young engineering student will find much that is instructive and of interest in the book.

Science and War: The Rede Lecture, 1919. By the Rt. Hon. Lord Moulton. Pp. 59. (Cambridge: At the University Press, 1919.) Price 2*s.* 6*d.* net.

Lord Moulton's lecture gives a striking picture of the manner in which the methods of warfare have been transformed by the application to military purposes of the results of the rapid growth of chemical and physical knowledge and the advances in engineering and medical science during the last half-century. Not unnaturally, a considerable part of the discourse is devoted to the subject of explosives, on which the lecturer can speak with special authority, and the warning which he gives as to the importance of establishing the manufacture of nitric acid from atmospheric nitrogen in this country is one that deserves serious attention. Lord Moulton's final conclusion is that man, "endowed with all the powers that science has given him, will be self-destructive unless his social instincts . . . become sufficiently strong to induce him voluntarily to submit to those powers being fettered." "It is easy to criticise the League of Nations, but let us never forget that some combined action of that type is necessary."

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Progress of the Natural History Museum.

THE admirable survey of scientific progress published in the jubilee number of NATURE on November 6 has received the most cordial appreciation of your numerous readers. May I be allowed to direct attention to one or two omissions, without being supposed to dissociate myself from the universal chorus of approval?

The removal of the natural history collections of the British Museum from Bloomsbury and the increase in their importance afterwards are events which deserve notice, even though the South Kensington branch of the museum was perhaps omitted from your survey on the ground that it was a new home for existing collections, and not an institution which originated during the period under review. The actual removal took place in 1882–83, and the years which have followed have been marked by an extraordinary growth in the collections, associated with a record of scientific research which is equally remarkable. It must not be forgotten that the accurate discrimination of the species of animals, plants, and minerals is a fundamental part of the respective sciences. Even though the philosophical biologist is sometimes inclined to underrate the work of the systematist, he is frequently obliged to turn to him for information with regard to the facts from which he derives his results. The far-reaching conclusions which are based on the study of geographical distribution lose their value if they depend on erroneous determinations of species, while the study of evolution is equally dependent on the labours of the systematist. In bringing together an unrivalled collection of specimens and in publishing a notable series of memoirs dealing with it, the naturalists of the British Museum have taken their full share in the scientific progress of the last fifty years.

The number of specimens in the department of zoology (including entomology), omitting those regarded as duplicates, has been estimated as having been about 1,400,000 at the time of the removal to South Kensington in 1882–83. Successive estimates have been 2,245,000 in 1895, 3,060,000 in 1904, 5,960,000 in 1917, and about 6,000,000 at the time of writing. The other departments of the museum have also increased at a rapid rate. Thousands of forms new to science have been described, and the type-specimens are preserved in the collection. In spite of the magnitude of the task, the specimens have been arranged so carefully that most of them can be found without difficulty when they are required for study.

In addition to this side of its activities, the museum has done much for scientific education by the way in which a part of its treasures have been exhibited in the public galleries. The requirements of visitors who are principally interested in the systematic arrangement of natural history objects are amply provided for; and, to take a single instance, the exhibited series of large mammals is not equalled in any other museum. Other exhibits of a more general nature are shown in the central hall, where may be seen illustrations of the principal types of structure found in the several classes of vertebrates, inaugurated by the late Sir W. H. Flower, a former Director; a series of cases containing objects bearing on the theory of evolution; models and specimens of insects and Arachnids instrumental in carrying diseases; and other exhibits of general interest. The evolution of animals, as illustrated by their geological history, can be studied in the palæontological galleries, and particular attention may be directed to the series of elephants and their presumed ancestors to be found among the treasures of the gallery of fossil mammals. The series of nesting-birds and eggs, arranged on a system which was itself a new departure, deserves special mention. Attention may also be directed to the great development of the collection of domesticated animals, and to the wonderful series of specimens in the mineral gallery.

In noting the progress of the Natural History Museum it is appropriate to refer to the fundamental alteration which has taken place during the last fifty years in the conception of the functions of museums in general. It is now admitted that the museum is a place which ought to exercise an educational influence, and there is an increasing desire to arrange the exhibits in such a way as to teach some definite lesson. It has, moreover, been recognised that the biological sciences are of great economic importance, as is shown, for instance, by the extraordinary advances which have been made in preventive medicine by the discovery that the parasitic organisms giving rise to certain diseases are transmitted by blood-sucking animals. In this field of research the work of the systematic zoologist is of special importance, since it is essential to be able to distinguish the species of insect or other carrier of the pathogenic organism from its near allies which are harmless in this respect. In dealing with economic questions of this kind, and of many others, the Natural History Museum has done its full share, and its function as a consultative body capable of giving valuable information on matters of practical moment has become an important side of its activities.

The action of the then Secretary of State for the Colonies in calling a meeting in 1909 for placing entomological research in our tropical Possessions in Africa on a proper basis is an event which ought not to pass unrecorded. The immediate result was the establishment of the Entomological Research Committee (Tropical Africa), now the Imperial Bureau of Entomology. Short as its life has been at present, the Bureau has fully justified its existence, and it has become an important centre of research, the utility of which is cordially recognised in all parts of the Empire. It already possesses a wide influence, and it may fairly be anticipated that it will become increasingly important in promoting researches tending to reduce the ravages of sleeping sickness, malaria, and many other diseases which have taken a heavy toll of the life of man and domesticated animals in the past. The Trustees of the British Museum associated themselves from the first with this new departure, and provided such accommodation at the Natural History Museum as they were able to spare for the Director of the Bureau and a part of his staff.

May I, in conclusion, direct attention to another side of biological activity which deserves notice? The foundation of the Marine Biological Association in 1884 led to the erection of the Plymouth Laboratory, which has had a most successful career, in spite of the difficulties due to insufficient funds, in promoting the study of marine biology, including practical questions of great importance connected with the fishing industry. Although not the first institution of this kind to be founded in this country, the Plymouth Laboratory, with those on the Clyde, in the Isle of Man, and at St. Andrews and Cullercoats, has become an indispensable part of the biological equipment of Great Britain. S. F. HARMER.

British Museum (Natural History),
November 17.

Gravitation and Light.

As I said last week (p. 334), and also in the December *Phil. Mag.* (p. 737), the refractivity $\mu-1$, necessary at every point of a gravitational field to produce the Einstein deflection, is the ratio of the energy of a constant-mass particle fallen there from infinity to the energy of the same particle moving with the speed of light; but it is not permissible to say that the solar gravitational field acts like a lens, for it has no focal length. If the sun were backed by a nebula or any luminous area, the light grazing the rim all round would be brought to a focus at a place seventeen times the distance of Neptune, while light from any larger circle would focus still further off in proportion to the area of the circle. So from a uniformly luminous area there would result a focal *line* of constant brightness. The moon is, unfortunately, impotent to make an annular eclipse interesting.

For an extended solar atmosphere to produce the deflection, its density would have to vary with the inverse distance, which seems unlikely; but this is just the way in which an æther tension ought to vary in order to cause gravitation—as Newton knew. The extra æther-tension factor, μ^2-1, would be twice the refractivity.

Possibly the concluding sentence in the *Phil. Mag.* article above referred to is not expressed with sufficient clearness. Permit me to explain my points thus:—

(1) The quasi-elasticity of æther—the property which enables it to transmit light and to effect electrical discharge—is probably due to exceedingly fine-grained constitutional vorticity with high-speed circulation, as argued in my book "The Ether of Space." Consequently it would have facility for gyrostatic action, yielding a perpendicular result to an acting force.

(2) That a gravitational force acting obliquely on light would probably be unable to alter speed, but, through the co-operation of its transverse and longitudinal components, it might be expected to produce an extra dose of deflection—assuming light to be subject to gravitation, as Newton surmised. So that by the time a beam of light coming from infinity had arrived at its nearest point to the sun, it would already have been deflected as much as an ordinary heavy particle would be deflected along its whole course.

I am aware that these are only suggestions for working out.

Einstein's equations, based on the impossibility of observing motion through æther, seem powerful instruments for extracting results; just as more familiar equations, based on the impossibility of "perpetual motion," have proved themselves effective; but neither set of equations explains, nor attempts to explain, the mechanism of the consequences they deduce. Dynamics have served us so well in the past that it must be still legitimate to try, wherever possible, to apply well-established principles to new phenomena. OLIVER J. LODGE.

Edgbaston, Birmingham, November 30.

The Displacement of Light Rays Passing near the Sun.

THE part of the earth's atmosphere within the conical shadow of the moon during a total solar eclipse may be regarded as approximately a right circular cylinder, the area of the base of which depends on the length of the shadow. Observations have shown that there are temperature and pressure gradients in this cylinder. The latter gradient at the surface of the earth is usually slight, but the temperature gradient may be considerable, so that, assuming that there is equilibrium, we have, roughly speaking, a cylinder of air the density of which decreases outwards in all directions perpendicular to its axis. When we remember that the light from stars at small angular distances from the sun's centre makes small angles with the axis of this cylinder, it is easy to see that a very small density gradient would be sufficient to account for the displacements that were observed in the total solar eclipse of the present year.

Suppose the cylinder to be made up of two parts, an inner and an outer, the common boundary being a coaxial cylinder, and let a ray of light in the outer portion inclined at a small angle α to the axis fall on the boundary, the deviation δ is given by

$$\cos\alpha=\mu\cos(\alpha+\delta),$$

where μ is the index of refraction for rays passing from the outer portion to the inner.

Since δ is very small in comparison with α, we have, approximately,

$$\delta=\frac{\mu-1}{\mu\tan\alpha}=\frac{\mu-1}{\tan\alpha}\ \text{very nearly},$$

since μ does not differ much from unity.

If $\alpha=30'$ and $\delta=1{\cdot}7''$, we get

$$\mu=1+\delta\tan\alpha,$$

δ being expressed in circular measure.

Thus $\mu=1{\cdot}00000007$, and for small values of α it is clear that δ is inversely proportional to the angular distance of the star from the centre of the sun's disc.

If we take μ_1, the absolute index of refraction of the outer portion, to be $1{\cdot}0003$, μ_2, the absolute index of refraction of the inner portion, will be $1{\cdot}00030007$, and consequently

$$\frac{\mu_2-1}{\mu_1-1}=1{\cdot}0002,$$

which will be the ratio of the density of the air in the inside portion to the density of the air in the outside portion. On the assumption that there is no gradient of pressure, this would imply a difference of temperature of about $1/18°$ C., a very small amount when it is remembered that the lowering of temperature at the surface of the earth during an eclipse may be as much as 5° C.

In the actual case the path of a ray will be a curve, but the above remarks will serve to show that the density gradient would probably be sufficient to produce the observed effect. It is clear, too, that the displacement in the actual case will be inversely proportional to the angular distance of the star from the sun's centre, and that it will depend on local conditions, so that the amount of displacement will be different for different places.

I think it is quite likely that if the refraction of the atmosphere of the earth due to density changes during an eclipse could be accurately obtained and allowed for, it would be found that there is no Einstein effect at all. ALEXR. ANDERSON.

University College, Galway.

EINSTEIN'S RELATIVITY THEORY OF GRAVITATION.

I.

THE results of the Solar Eclipse Expeditions announced at the joint meeting of the Royal Society and Royal Astronomical Society on November 6 brought for the first time to the notice of the general public the consummation of Einstein's new theory of gravitation. The theory was already in being before the war; it is one of the few pieces of pure scientific knowledge which have not been set aside in the emergency; preparations for this expedition were in progress before the war had ceased.

Before attempting to understand the theory which, if we are to believe the daily Press, has dimmed the fame of Newton, it may be worth while to recall what it was that he did. It was not so much that he, first among men, used the differential calculus. That claim was disputed by Leibniz. Nor did he first conceive the exact relations of inertia and force. Of these, Galileo certainly had an inkling. Kepler, long before, had a vague suspicion of a universal gravitation, and the law of the inverse square had, at any rate, been mooted by Hooke before the "Principia" saw the light. The outstanding feature of Newton's work was that it drew together so many loose threads. It unified phenomena so diverse as the planetary motions, exactly described by Kepler, the everyday facts of falling bodies, the rise and fall of the tides, the top-like motion of the earth's axis, besides many minor irregularities in lunar and planetary motions. With all these drawn into such a simple scheme as the three laws of motion combined with the compact law of the inverse square, it is no wonder that flights of speculation ceased for a time. The universe seemed simple and satisfying. For a century at least there was little to do but formal development of Newton's dynamics. In the mid-eighteenth century Maupertuis hinted at a new physical doctrine. He was not content to think of the universe as a great clock the wheels of which turned inevitably and irrevocably according to a fixed rule. Surely there must be some purpose, some divine economy in all its motions. So he propounded a principle of least action. But it soon appeared that this was only Newton's laws in a new guise; and so the eighteenth century closed.

The nineteenth saw great changes. When it closed, the age of electricity had come. Men were peering into the secrets of the atom. Space was no longer a mighty vacuum in the cold emptiness of which rolled the planets. It was filled in every part with restless energy. Æther, not matter, was the last reality. Mass and matter were electrical at bottom. A great problem was set for the present generation: to reconcile one with the other the new laws of electricity and the classical dynamics of Newton. At this point the principle of least action began to assume greater importance; for the old and the new schemes of the universe had this in common, that in each of them the time average of the difference between the kinetic and the potential energies appears to be a minimum.

One of the main difficulties encountered by the electrical theory of matter has been the obstinate refusal of gravitation to come within its scope. Quietly obeying the law of the inverse square, it heeded not the bustle and excitement of the new physics of the atom, but remained, independent and inevitable, a constant challenge to rash claimants to the key of the universe. The electrical theory seemed on the way to explain every property of matter yet known, except the one most universal of them all. It could trace to its origins the difference between copper and glass, but not the common fact of their weight; and now the æther began silently to steal away.

One matter that has seriously troubled men in Newton's picture of the universe is its failure to accord with the philosophic doctrine of the relativity of space and time. The vital quantity in dynamics is the acceleration, the change of motion of a body. This does not mean that Newton assumed the existence of some ultimate framework in space relative to which the actual velocity of a body can be uniquely specified, for no difference is made to his laws if any arbitrary constant velocity is added to the velocity of every particle of matter at all time. The serious matter is that the laws cannot possibly have the same simplicity of form relative to two frameworks of which one is in rotation or non-uniform motion relative to the other. It seems, for instance, that if Newton were right, the term "fixed direction" in space means something, but "fixed position" means nothing. It seems as if the two must stand or fall together. And yet the physical relations certainly make a distinction. Why this should be so has not yet been made known to us. Whatever new theory we adopt must take account of the fact.

It was with some feeling of relief that men hailed the advent of the æther as a substitute for empty space, though we may note in passing that some philosophers—Comte, for example—have held that the concept of an æther, infinite and intangible, is as illogical as that of an absolute space. But, jumping at the notion, physicists proposed to measure all velocities and rotations relative to it. Alas! the æther refused to disclose the measurements. Explanations were soon forthcoming to account for its reluctance; but these were so far-reaching that they explained away the æther itself in the sense in which it was commonly understood. At any rate, they proved that this creature of the scientific imagination was not one, but many. It quite failed to satisfy the cravings for a permanent standard against which motion might be measured. The problem was left exactly where it was before. This was pre-war relativity, summarised by Einstein in 1905. The physicists complained loudly that he was taking away their æther.

Let it not be thought, however, that the results of the hypothesis then advanced were purely negative. They showed quite clearly that many current ideas must be modified, and in what direction this must be done. Most notably it emphasised the fact that inertia is not a fundamental and invariable property of matter; rather it must be supposed that it is consequent upon the property of energy. And, again, energy is a relative term. One absolute quantity alone remained; one only stood independent of the taste or fancy of the observer, and that was "action." While the æther and the associated system of measurement could be selected as any one of a legion, the principle of least action was satisfied in each of them, and the magnitude of the action was the same in all.

But, still, gravitation had to be left out; and the question from which Einstein began the great advance now consummated in success was this. If energy and inertia are inseparable, may not gravitation, too, be rooted in energy? If the energy in a beam of light has momentum, may it not also have weight?

The mere thought was revolutionary, crude though it be. For if at all possible it means reconsidering the hypothesis of the constancy and universality of the velocity of light. This hypothesis was essential to the yet infant principle of relativity. But if called in question, if the velocity of light is only approximately constant because of our ordinary ways of measuring, the principle of relativity, general as it is, becomes itself an approximation. But to what? It can only be to something more general still. Is it possible to maintain anything at all of the principle with that essential limitation removed?

Here was exactly the point at which philosophers had criticised the original work of Einstein. For the physicist it did too much. For the philosopher it was not nearly drastic enough. He asked for an out-and-out relativity of space and time. He would have it that there is no ultimate criterion of the equality of space intervals or time intervals, save complete coincidence. All that is asked is that the order in which an observer perceives occurrences to happen and objects to be arranged shall not be disturbed. Subject to this, any way of measuring will do. The globe may be mapped on a Mercator projection, a gnomonic, a stereographic, or any other projection; but no one can say that one is a truer map than another. Each is a safe guide to the mariner or the aviator. So there are many ways of mapping out the sequences of events in space and time, all of which are equally true pictures and equally faithful servants.

This, then, was the mathematical problem presented to Einstein and solved. The pure mathematics required was already in existence. An absolute differential calculus, the theory of differential invariants, was already known. In pages of pure mathematics that the majority must always take as read, Riemann, Christoffel, Ricci, and Levi-Civita supplied him with the necessary machinery. It remained out of their equations and expressions to select some which had the nearest kinship to those of mathematical physics and to see what could be done with them. E. CUNNINGHAM.

DISCOVERY OF A MINOAN PALACE AT MALIA, IN CRETE.

DISCOVERIES of great importance have been made during the course of excavations carried out this year in Crete by M. Joseph Hatzidakis, at a site one kilometre from the shore, near the village of Malia, about twenty miles east of Candia.

The site of a palace of the Middle Minoan epoch has been uncovered, and numerous objects found. The containing walls of the palace, the lower courses of which consist of *poros* stone, can all be traced, the dimensions of the building being 110 metres in length and 80 metres in width. The interior walls, which are of bricks and rubble, are 2·30 metres in thickness, and the floor of the palace is composed of a layer of white earth upon which is a stratum of chalk and sand with a top surface of red chalk paste. The outside of the containing walls was covered with a white chalk wash.

The palace was destroyed by fire shortly after the end of the Middle Minoan epoch, and probably suffered from the depredations of looters for a considerable time after its destruction. In consequence, few objects of value, and nothing intact, have so far been discovered. A very large number of small fragments of gold leaf, however, have been found. For many years past similar fragments have been found by the peasants from time to time, and the site became known as "Chrysolakkos," "The ditch of gold." Capt. Spratt early last century noted the prevalence of such gold fragments on this site. The fragments are derived in all probability from some large bone or wooden objects which were decorated with gold leaf. Bronze was rare, only a dagger blade, a brooch, and a band having been found.

The fields between the shore and the palace show traces of walls, and in one case a complete house, all of the same date as the palace, and clearly belonging to the town in which the palace was situated. The site of a necropolis was found near the shore, where one grave containing pottery of the same date as the palace was opened.

Minoan pictographic or graphic signs were found cut on various stone blocks in the palace. The double-axe occurred on a large tetragonal pillar, which was of the type found at Knossos, but twice the size. A six-rayed star of a known type also occurred; a similar star with a spray at the end of one of the rays represents a sign not hitherto known.

The pottery so far discovered is disappointing, no complete or even well-preserved pieces having been found. The best fragments, mostly of cups of the Middle Minoan periods, were found in what appears to have been a shrine.

Three kilometres to the west of the palace a number of graves of the third Late Minoan or Mycenean period were found. One of these graves was opened, and was found to contain five rectangular "larnakes," in each of which was a skeleton.

The importance of the site lies in the fact that this is the only example hitherto found of a palace of the Middle Minoan epoch without an overlying building of later date. The Middle Minoan parts of the palaces of Phæstos and Knossos are overbuilt with walls of the Late Minoan periods, and the plans and details of the Middle Minoan palaces at these places cannot, in consequence, be definitely ascertained. The existence of a city and necropolis of the same date as the palace increases the importance of the site. The Late Minoan city is clearly to be found some distance away. The excavations will be continued, and promise important results.

NOTES.

THE desirability of fostering scientific research as a result of experience gained during the war was recently urged upon various Government Departments by the British Association. There is reason to believe that measures are being taken to this end in various directions; in particular, the association has received from the Admiralty a communication in the course of which it is stated that the authorities there "are keenly alive to the supreme importance of research in its bearing on naval requirements, and that the organisation of suitable arrangements for this purpose is now engaging, and will continue to engage, their earnest attention. Rapid progress is now being made in the elaboration of a complete scheme which will provide, on one hand, for systematic and continuous development in research and experimental establishments controlled by the Department, and, on the other, for an effective relation between these establishments and scientific institutions throughout the country."

THE collection of precious stones which was formed by the late Sir Arthur H. Church, and presented by his widow to the Trustees of the British Museum, has recently been placed in a special case under the archway leading from the main gallery of minerals to the meteorites pavilion at the Natural History Museum. Sir Arthur Church was for thirty-two years professor of chemistry at the Royal Academy of Arts, and his leaning towards art led him from his early days to take an interest in rare gem-stones. In consequence, the collection was at his death exceptionally rich in specimens of mineral species seldom seen in ordinary jewelry, as well as in unusual specimens of familiar species. The pride of the collection is the brilliant orange-coloured spessartite, which is all but unique, since only one other such stone (cut, in fact, from the same original crystal) is known to exist. The collection is very rich in zircons. Together with the four stones which Sir Arthur Church presented in his lifetime, the collection numbers 207 specimens, without counting the eight diamond points and the twenty-one diamond brilliants used in the setting of a zircon and a peridot ring respectively; of them, 170 are set in 162 gold rings and 37 are unset.

DR. O. HOLTEDAHL is organising a Norwegian exploring expedition to Novaya Zemlya, and hopes to sail in June next year. Dr. Holtedahl, who has had previous polar experience in geological exploration in Spitsbergen, has laid his plans before the Norwegian Academy of Sciences, where they obtained the support of Dr. F. Nansen, who advocated a State grant. According to the *Morning Post*, Dr. Holtedahl will make the base of his expedition on Matochkin Shar, the strait between the two large islands, where there is a small Samoyede settlement. A botanist, a zoologist, and a meteorologist will accompany the expedition, while the leader will devote his time to geology and geophysical problems. Novaya Zemlya is by no means a *terra incognita*; Russian explorers have frequently visited it, particularly in search of minerals. But the results of their work have only partly been published, and the collections and observations have probably been destroyed. In 1916 the Russian Government proposed to erect two permanent meteorological stations in Novaya Zemlya, one at the north end and the other at Matochkin Shar; but nothing has yet been done. Dr. Holtedahl rightly insists on the usefulness of a permanent station. He would also like to see one on the island of Jan Mayen, between Iceland and Spitsbergen.

A LETTER has been received by us from Dr. Th. Mortensen, the distinguished curator of the zoological collections in the Royal Museum, Copenhagen, protesting against the use of the German word "Anlage" in zoological papers written in English. It is rather curious that it should have been left to a friendly neutral to protest against this disfigurement of the English language. Dr. Mortensen suggests that the English word "rudiment" conveys exactly the meaning of "Anlage," and he hazards the supposition that the reason why "rudiment" is not more largely used in this sense is that it has been customary in the past to employ the phrase "rudimentary organ" to signify the disappearing remnant of a once functional structure. In both his views we heartily concur with Dr. Mortensen. Unfortunately, the phrase "rudimentary organ" is found embedded in our great classic of biology, the "Origin of Species," and it is probably for this reason that some years ago leading American zoologists, who disliked the word "Anlage," attempted to replace it by the English word "fundament," an attempt which excited only amusement in the zoological world in general. To us it seems that only a little perseverance is required in order to establish the word "rudiment" as the English equivalent of "Anlage," whilst the equally good English word "vestige" can be used to signify the remnant of a disappearing organ. This usage has already been adopted by some of our most recent writers on embryology, and it is to be hoped that it will spread until it becomes universally recognised.

THE appeal which is being made by the Research Institute in Dairying, attached to University College, Reading, for funds to purchase a suitable farm and to provide research laboratories and a dairy is deserving of support, not only by those connected with the dairying industry, but also by the public at large. A good supply of pure milk at a moderate price is most important for the nation, and it is only by a systematic inquiry conducted with proper equipment by skilled workers that the problem will be solved. The formation of a research institute on dairying dates only from 1912, and, naturally, the work which has been undertaken up to the present has been seriously handicapped by war conditions. Now, however, the staff of the institute is in a position to press forward the various inquiries which have in many cases already been commenced. An excellent start was made with an investigation of the causes which lead annually to heavy losses when milk sours prematurely. As would be expected, cleanliness and a low temperature have been proved to be the chief agents in the prevention of these avoidable losses. The reports already issued from the institute give some very striking illustrations of the high "keeping" properties of clean milk. In cheese-making the Research Institute has also a most promising field of investigation, for although many of the best varieties of cheese in the world have had their origin in this country, very little is known of the details of the processes. The higher price of milk makes it imperative that there should be no avoidable losses either in the milk supply or in the articles made from milk, the high food value (to say nothing of the physiological value) of which is now so generally recognised.

THE death has occurred, at the age of sixty-nine, of Dr. John Vose Hazen, who had recently resigned the chair of civil engineering and graphics at Dartmouth College, New Hampshire, after a long tenure.

DR. W. G. BISSELL, whose death is reported in his fiftieth year, had been chief of the Bureau of Bacteriology in the city of Buffalo since 1894. He was president of the New York State Sanitary Officers' Association.

AT the ordinary scientific meeting of the Chemical Society to be held on Thursday, December 18, Prof. J. Walker will deliver a lecture entitled "War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes."

DR. PAUL SABATIER (Toulouse), Dr. Pierre Paul Emile Roux (Paris), Dr. Jacques Loeb (New York), Dr. Robert Andrews Millikan (Chicago), Dr. Arthur Gordon Webster (Harvard), and Dr. William Wallace Campbell (California) have been elected honorary members of the Royal Institution.

THE death is announced, in his eighty-fourth year, of Dr. Charles Henry Hitchcock, professor of geology at Dartmouth College, U.S.A., from 1868 to 1908. Dr. Hitchcock was widely known as the compiler of several geological maps of the United States, and for his researches in ichnology, geology of the crystalline schists, and glacial geology. During the winter of 1870–71 he established, on the top of Mount Washington, the first high mountain observatory in the United States. Among his many publications were memoirs upon the fossil tracks of the Connecticut Valley. On his retirement he went to live in Hawaii (where he died), and in 1909 he published a book on the volcanoes of that territory.

THE following are among the lecture arrangements at the Royal Institution before Easter, 1920:—Prof. W. H. Bragg, six lectures adapted to a juvenile auditory on The World of Sound; Sir John Cadman, two lectures on (1) Modern Development of the Miner's Safety Lamp and (2) Petroleum and the War; Prof. G. Elliot Smith, three lectures on The Evolution of Man and the Early History of Civilisation; Prof. Ernest Wilson, two lectures on Magnetic Susceptibility; Prof. Arthur Keith, four lectures on British Ethnology: The Invaders of England; Prof. A. E. Conrady, two lectures on Recent Progress in Photography; Prof. A. H. Smith, two lectures on Illustrations of Ancient Greek and Roman Life in the British Museum; Lt.-Col. E. Gold, two lectures on The Upper Air; Sir F. W. Dyson, Astronomer Royal, three lectures on The Astronomical Evidence bearing on Einstein's Theory of Gravitation; and Sir J. J. Thomson, six lectures on Positive Rays. The Friday evening discourses will begin on Friday, January 16, 1920, at 9 o'clock, when Sir James Dewar will deliver a discourse on Low-temperature Studies. Succeeding discourses will probably be given by Sir C. A. Parsons, Mr. S. G. Brown, Prof. W. M. Bayliss, Dr. E. J. Russell, Mr. W. B. Hardy, the Hon. J. W. Fortescue, Prof. J. A. Fleming, Mr. E. McCurdy, Sir J. J. Thomson, and others.

WE learn with regret of the death on November 25 of Mr. Frederick Webb Headley, at the age of sixty-three years. Educated at Harrow and Caius College, Cambridge, where he obtained a First Class in the Classical Tripos, Mr. Headley spent nearly forty years of his life as an assistant master at Haileybury College, where, so recently as June 30 last, he delivered his last lecture to the College Natural History Society on his favourite subject, "The Pedigree and Life of Birds." Through the instrumentality of this society and of the museum he succeeded in maintaining, generation after generation, a body of active boy-naturalists in the college, and few men were better able to fan into enthusiasm the spark of what so often proves but the passing hobby of a young boy. Of Headley's published works two, namely, "The Structure and Life of Birds" and "Life and Evolution," are very largely the finished product of lectures delivered to the boys. The variety of subjects handled is eloquent testimony to the wide sympathy and biological knowledge of the man—a classic by early training. The doctrine of evolution made a powerful appeal to his mind, as is evidenced by his "Problems of Evolution" and by "Darwinism and Modern Socialism." But it was "birds" and "flight" that more than all else attracted him. The war prevented the execution of a projected tour abroad with "birds" as a main object, and kept him at Haileybury longer than he had intended. Another such tour was planned after his final retirement last July. *Dis aliter visum.*

AT the meeting of the Illuminating Engineering Society on November 25, a short address on "Lambert and Photometry" was given by the president, Mr. A. P. Trotter, who raised the question whether Lambert ever devised a photometer, inclining, however, to the view that Bouguer was the first to contrive an apparatus for measuring light. Later in the evening Mr. Haydn T. Harrison exhibited a new form of photometer which had several interesting features, notably the use of an illuminated scale. The greater part of the evening was given up to exhibits, including a new form of "daylight" or colour-matching lamp, shown by Mr. L. C. Martin. This device, which is due to Mr. Sheringham, the well-known artist, involves the projection upwards of light from an electric lamp to a surface carrying a chessboard pattern in various colours. The reflected light closely resembles daylight in colour, and is stated to be well adapted to colour-matching processes. The indirect method thus utilised is considered very suitable for use in picture galleries, etc. Other exhibits included a series of tungsten arc ("pointolite") lamps exhibited by Mr. P. Freedman, of the Ediswan laboratory. This form of lamp utilises an arc between tungsten electrodes within a hermetically sealed bulb, and has proved very suitable for optical projection. By improved methods of manufacture larger tungsten globules, facilitating much higher candle-powers, have been prepared. Lamps giving up to 1000 c.p. have already been used, and a special 4000-c.p. unit, which it is hoped will prove specially suitable for kinema work, was shown at the meeting.

THE retirement of Dr. Cecil Lyster from the position of head of the electro-therapeutic department of the Middlesex Hospital was announced at a meeting of the governors of the hospital. The chairman, Lord Athlone, said that Dr. Lyster was now lying in a critical condition directly due to his self-sacrificing devotion to duty. Dr. Lyster was one of the pioneers of scientific research, and applied himself to the study of X-rays and radium and their use in the treatment of disease, especially cancer. By exposure to the rays in the early days he fell a victim to the disease he sought to conquer. Though suffering, he declined to be set aside from his purpose, and continued his good work until now, when work for a time was no longer possible. Mr. Sampson Handley spoke of the high esteem in which Dr. Lyster was held by his colleagues on the staff of the hospital. Dr. Lyster was president of the section of electro-therapeutics of the Royal Society of Medicine for the year which ended in October last. His colleagues in the domain of X-rays and electro-therapeutics had occasion to appreciate his invariable tact and sympathy at the meetings over which he presided. At the joint meeting of his section with the Institution of Electrical Engineers on March 21 last he remarked, in introducing the president of the institution and asking him to take the chair: "We are amateurs in electricity, and we are at last asking the professional electrician to tell us what we want. I hope meetings of this sort will be continued in years to come, and that we shall be able to interest the Institution of Electrical Engineers in our work as electro-therapeutists and radiologists. It is a fascinating subject, and a far-reaching one for humanity—that is, the future of the electrical and radiological treatment of disease Perhaps my optimism is enormous." It is this spirit of optimism that has buoyed up Dr. Lyster through his times of suffering, and caused him to remain at his post to the last.

DR. J. WALTER FEWKES, Chief of the Bureau of American Ethnology, has recently returned from two months' field-work on the Mesa Verde National Park, Colorado. This park is the only one reserved by the U.S. Government for the protection of aboriginal buildings, and for the last decade the Department of the Interior and the Smithsonian Institution have co-operated in the excavation and repair of ruins in order that they may be preserved for posterity, after having been put in a condition to show their structural features. The field-work of last summer was devoted to a cliff-dwelling called Square Tower House from a high tower situated midway in its length. This tower is 40 ft. high, and is the highest building constructed of masonry by Indians north of Mexico before the coming of the whites. It adds to this unique feature the best-known example of prehistoric masonry, shown in the construction of the roofs of two circular rooms. The original rafters are still in place, showing the marks of stone implements used by the builders. The whole ruin, which measures 136 ft. in length, is most picturesquely situated, and has already become one of the greatest attractions of the park. An unexpected result of the field-work was the discovery of many inconspicuous buildings among the cedars on top of the plateau. The evidences of these buildings before excavating were very obscure, but they are so numerous in certain areas that there is scarcely a square quarter-mile in which one of them does not occur. One of these small buildings when excavated was found to belong to a very ancient type, probably the oldest on the mesa.

WE have received the second number of *Medical Science*, a monthly periodical of abstracts and reviews of medical science published by the Medical Research Committee. The present issue contains, among others, reviews on diphtheria, tuberculosis, gastric ulceration, influenza, and cerebro-spinal fever. In the last-named, Dr. Rolleston surveys the epidemiology, symptoms, and treatment of the disease, particularly with serum. This, in the hands of numerous observers, has proved to be of benefit, reducing the mortality provided it is administered early enough.

A SHORT, but very welcome, account of the courtship of the dabchick, by Mr. Julian Huxley, appears in *British Birds* for November. The author was too late to witness the earlier phases of the courtship, but he contrived to glean much information as to their behaviour after pairing-up had taken place. These birds, lacking the frills and crests characteristic of other species of grebes, display none of the posturing which takes place in the more resplendent species, but content themselves with the performance of duets recalling the neighing of a horse. They also spend much time in long excursions on the water, swimming side by side. It is to be hoped that next year it will be possible to start observations earlier in order that the initial stages of the courtship may be studied. Mr. Huxley's studies on the courtship of the great crested grebe are known to all ornithologists, and his able handling of this theme makes us the more anxious to have the complementary picture.

IN an important memoir on a new type of nephridium found in Indian earthworms of the genus Pheretima (*Quarterly Journal of Microscopical Science*, vol. lxiv., part 1) Mr. Karm Narayan Bahl gives a very interesting description of the excretory system of *Pheretima posthuma*. He finds three distinct kinds of nephridia in this worm: septal, pharyngeal, and integumentary. Although the nephridia are very numerous and all small (micronephridia), the system is not plectonephric, each nephridium being a separate organ. The chief novelty of the author's work lies in the discovery that the septal nephridia open into the intestine, instead of on to the surface of the body, by segmentally arranged apertures, not directly, but through a system of ducts, of which the most important are a pair of longitudinal excretory canals lying above the intestine, one on each side of the mid-dorsal line. The author applies the term "enteronephric" to this remarkable type of nephridial system, and puts forward the suggestion —due to Prof. W. N. F. Woodland—that the discharge of the excretory products into the intestine may be a special adaptation for the conservation of moisture in a dry climate.

THE *Journal of the Board of Agriculture* for October contains a preliminary report on the recent Lincoln tractor trials. The excellent work done by the machines and the large attendance of farmers show that the industry has now passed the pioneer stage. The tendency of the manufacturers is less to novelty of design than to development in accordance with the experience obtained in this country, chiefly as the result of the operation of the Government tractor scheme. Close attention is being paid to the reduction of weight, to the increased accessibility of the vital parts of the machinery, and to the provision of protection from the effect of weather and dirt. Interesting comparisons were made of the ploughing done by tractors fitted respectively with high-speed vertical and low-speed horizontal engines, with wheels and caterpillar-tracks, and between self-contained machines and independent tractors. The use of the tractor is not restricted to ploughing, and there were important haulage tests and threshing demonstrations. Great as is the value of the present trials from the commercial and educational points of view, further trials extending over a considerable interval, and giving greater uniformity of task and conditions, will be necessary before the capacity of the various machines can be defined.

THE *Kew Bulletin* (Nos. 6 and 7, 1919) contains an account of recent investigations by J. Bintner on the symptoms and distribution of silver-leaf disease. There has been much controversy as to the cause of the disease, which is now established as mainly due to the growth in the tissues of the mycelium of the fungus *Stereum purpureum*. Mr Bintner demonstrates the presence of the fungus in the wood of diseased branches, which show the brown coloration beneath the bark characteristic of the disease. No trace of the fungus has been found in the leaves, and it is suggested that the separation of the cells, which gives the silver effect, is caused by the production of some diffusible toxin by the fungus, which is conveyed to the leaves in the water-conducting channels. Infection takes place through open wounds above ground and immediately below ground-level, and inoculation experiments confirm the view that injured superficial roots can be infected. Localised silvering of a branch results from local infection which has not yet spread to the main stem, and excision of the diseased branch may save the tree. On the other hand, silvered suckers springing from a healthy tree indicate root-infection, and where root or stem is infected there is no hope of saving the tree. The disease has been proved to occur on a number of plants besides plum, apple, and other members of the family Rosaceæ, including species of laburnum, horse-chestnut, and cultivated varieties of gooseberries and currants. As a preventive measure good cultivation is recommended; careless pruning, unsatisfactory drainage, and deficiency of lime are especially to be avoided. The author also indicates an apparently distinct disease which he calls "false silver-leaf," which may be mistaken for the disease caused by Stereum, but no trace of this fungus has been found in the plants affected. It is suggested that false silver-leaf, from which plants recover under careful treatment, is due to physiological weakness. It has been observed in cultivated varieties of apple, cherry, peach, and plum.

A NOTEWORTHY addition to our knowledge of Eocene foraminifera is made by the publication of the late Mr. E. Halkyard's "Fossil Foraminifera of the Blue Marl of the Côte des Basques, Biarritz," under the care of Messrs. E. Heron-Allen and A. Earland (Mem. Manchester Lit. and Phil. Soc., vol. lxii., part ii.). Megalospheric and microspheric forms are discussed among the nummulites.

MESSRS. F. F. GROUT and T. M. Broderick (*Amer. Journ. Sci.*, vol. xlviii., p. 199, 1919) describe structures in the Huronian iron-bearing strata of the Mesabie range in Minnesota as due to algæ. In this they have the support of Dr. C. Walcott, who writes that the iron-ore was evidently separated out of marine waters through the metabolism of the algal growths, which he compares with Cryptozoön.

IN the *American Journal of Science* (vol. xlviii., p. 136, 1919) Prof. R. A. Daly replies to recent criticisms of his "glacial-control" theory of the growth of coral-reefs. He urges that the general absence of cliffs on the island spurs may be due to the protection afforded by rapidly growing fringing reefs in late Cainozoic time; these would have to be scoured away before the Pleistocene sea could attack the volcanic masses. Variations in the depths of lagoons, again, may be expected even on a general platform of erosion, owing to the presence of drowned valleys, fault-troughs, and volcanically formed depressions not yet filled with detritus. Lagoon depths greater than 50 or 60 fathoms are, however, rare.

THE *Times* of November 28 contains an article from Prof. Einstein on his generalised principle of relativity. Prof. Einstein remarks at the beginning of the article: "After the lamentable breach in the former international relations existing among men of science, it is with joy and gratefulness that I accept this opportunity of communication with English astronomers and physicists. It was in accordance with the high and proud tradition of English science that English scientific men should have given their time and labour, and that English institutions should have provided the material means, to test a theory that had been completed and published in the country of their enemies in the midst of the war." After a brief account of the general nature of the theory, which does not add anything to what has been summarised by Prof. Eddington in his report to the Physical Society, Prof. Einstein concludes: "The great attraction of the theory is its logical consistency. If any deduction from it should prove untenable, it must be given up. A modification of it seems impossible without destruction of the whole. No one must think that Newton's great creation can be overthrown in any real sense by this or any other theory. His clear and wide ideas will for ever retain their significance as the foundation on which our modern conceptions of physics have been built. . . . By an application of the theory of relativity to the taste of readers, to-day in Germany I am called a German man of science, and in England I am represented as a Swiss Jew. If I come to be regarded as a *bête noire*, the descriptions will be reversed." Prof. Eddington, in the *Contemporary Review*, quotes from Newton's "Opticks":—"Query 1. Do not bodies act upon light at a distance, and by their action bend its rays?"

ON Engler's theory of the origin of petroleum, the oil has been formed out of animal and vegetable fatty matters derived from marine animals and plants. The fats have been hydrolysed by water, and the resulting fatty acids, under the influence of heat and pressure, have then been decomposed into carbon dioxide and hydrocarbons, these latter constituting the petroleum. Whilst this theory would account for the liquid hydrocarbons of the aliphatic series found in petroleum, it does not explain the presence either of solid paraffins or of the aromatic (naphthenic) hydrocarbons which are found in most petroleums, and, indeed, form the whole of some varieties. Engler's distillation experiments in confirmation of the theory were made chiefly on free oleic and stearic acids. It is probable, however, that salts of these acids, rather than the free acids themselves, would be the bodies acted upon during the natural production of petroleum. Following up this idea, MM. Pictet and Potok have carried out a series of experiments on the distillation of sodium stearate and sodium oleate, with the view of ascertaining whether, in operations thus approximating more closely to the natural conditions, aromatic hydrocarbons or paraffins of high boiling points are produced (*Helvetica Chimica Acta*, 2, v., 501). In the result it was found that the chief products were acyclic and unsaturated hydrocarbons closely agreeing with those found in American petroleum, but no trace of naphthenic (aromatic) hydrocarbons was produced. Hence the origin of Baku petroleum, and of the numerous other kinds which contain these naphthenic bodies, is not accounted for by Engler's theory. Further, since many of these bodies show optical rotation, they have probably been produced at relatively low temperatures, and not by the closing up of acyclic compounds, which would demand high temperatures and yield inactive products. No likely source of such optically active bodies suggests itself except the resinous or terpenic constituents of the higher plants. Similar compounds have, in fact, been extracted from coal. For the numerous petroleums containing both acyclic and naphthenic hydrocarbons a twofold origin appears to be indicated.

THE announcements of *Messrs. A. and C. Black, Ltd.*, include "X-rays in General Practice," Alice Vance Knox, with chapters on Instrumentation, Dr. R. Knox; "Cerebro-Spinal Fever: The Etiology, Symptomatology, Diagnosis, and Treatment of Epidemic Cerebro-Spinal Meningitis," Drs. C. Worster-Drought and A. M. Kennedy; "Medieval Medicine," J. J. Walsh; and "The Making of Europe: A Geographic Treatment of the Historic Development of Europe," W. H. Barker and W. Rees. In addition to the books announced for publication by the *Cambridge University Press* (see NATURE, November 20, p. 321) may be mentioned "Physics," Dr. Norman R. Campbell, 3 vols.; "The Theory of the Imaginary in Geometry," J. L. S. Hatton; "Practical Chemistry for Agricultural Students," H. A. D. Neville, vol. i.; "What Became of the Bones of St. Thomas," Rev. Canon A. J. Maron; "From Ritual to Romance" (A Study of Comparative Religion and

Folk-lore), Miss J. L. Weston. *Messrs. Constable and Co., Ltd.*, announce "Physiology and the Nation's Needs," edited by Prof. W. D. Halliburton, containing essays by Dr. M. S. Pembrey, Prof. D. Noël Paton, and the editor on, respectively, "Physical Training and the Open-air Life," "Physiology in the Study of Disease," and "Physiology and the Food Problem." They also promise "Elementary Plane Trigonometry," H. E. Piggott.

MESSRS. DULAU AND CO., LTD., 34 Margaret Street, W.1, have issued a Catalogue (No. 80) of nearly six hundred works on Diatomaceæ, Botany, Horticulture, Agriculture, Natural History, Geology, Palæontology, Voyages and Travels, Astronomy, Physics and Mechanics which will doubtless appeal to many readers of NATURE. It can be obtained upon application.

OUR ASTRONOMICAL COLUMN.

HELIOCENTRIC GROUPING OF PLANETS IN DECEMBER.—The astrologers have been amusing themselves and alarming the timid by predicting violent cosmic convulsions as the result of the planetary grouping on December 17. The actual position is sufficiently interesting to warrant a note. During the five days December 13 to 17, six of the eight major planets will be within a range of 26° in heliocentric longitude, while Uranus will be in the same line on the other side of the sun, the earth alone standing out. In the following list the two longitudes given refer to noon on December 13 and 17 respectively:—Mercury, 130° to 154°; Venus, 135° to 143°; Earth, 79° to 84°; Mars, 152° to 154°; Jupiter, 129°; Saturn, 155½°; Uranus, 331°; and Neptune, 130°. There were similar scares when the four giant planets were all near perihelion together. We may safely predict that they will be as baseless now as they were then.

COMETS.—Finlay's periodic comet passed perihelion about October 15·38. It was a fairly conspicuous object in November, and observations are numerous. It will be much fainter in December, but an ephemeris (for Greenwich midnight) may still be of use:—

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Dec. 5	1 33 59	13 14	Dec. 13	2 7 12	16 52
7	1 43 7	14 20	15	2 14 13	17 28
9	1 51 41	15 18	17	2 20 47	17 56
11	1 59 42	16 9	19	2 26 56	18 17

Schaumasse's periodic comet is also fading, but more slowly. Ephemeris for Greenwich midnight:—

	R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Dec. 5	14 9 36	2 2	Dec. 13	14 33 13	3 52
7	14 15 38	2 30	15	14 38 54	4 17
9	14 21 35	2 58	17	14 44 31	4 42
11	14 27 27	3 25	19	14 50 3	5 6

Messrs. Braae and Fischer Petersen announce that their supposition that comet 1919*b* (Brorsen-Metcalf) has made two revolutions since 1847 is not correct; its true period is 72·1 years.

FALL OF A METEORITE IN AMERICA.—The daily papers report that on the night of November 27 last a large meteorite descended into Lake Michigan, and that the object was seen before its fall by many persons over a wide extent of country. If this event is fully corroborated, it seems quite possible that the meteorite may have been a fragment of Biela's lost comet, like the Mazapil meteorite of November 27, 1885, on which date there occurred a great shower of ordinary meteors.

The earth passed through the orbit of Biela's comet on that occasion, and must have been very near, if not involved in, the denser portion of the material forming the remains of the comet. The latter had a periodic time of revolution amounting to about 6¾ years, and if we add five periods to the last return near the end of 1885 we arrive at the present time, so that a display of meteors was rendered quite probable. However, no very conspicuous shower occurred, though from reports sent in by various observers for the period November 19–25 a few meteors, including several of special brilliancy, were recorded from the right direction in Andromeda. In all, seventeen paths appear to be conformable to this shower, and the radiant is indicated at 29°+44° near the star γ Andromedæ.

On the same night, at 9h. 50m., that the meteorite is said to have fallen in America, a fireball was seen at Bristol descending slowly in the north-eastern sky, but the atmosphere was very hazy and few stars were visible. Observations of this object from other places would be valuable.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Monday, when the report of the council was presented and the president, Sir J. J. Thomson, delivered an address. In the evening fellows and their guests dined together at the Royal Palace Hotel, Kensington, this being the first anniversary dinner since 1913. The assembly received with much satisfaction the announcement of the president that the Prince of Wales is to be admitted a fellow of the society early next year.

The report of the council is largely occupied with an account of the origin and constitution of the International Research Council and the related National Research Council. It is hoped that the British Government will consent to make the annual contribution required from countries forming part of the international organisation, in order to place the Council on a sound financial basis. The report refers also to the increased need of financial assistance for the promotion of research in pure sciences and to developments of the National Physical Laboratory under Sir Richard Glazebrook's directorship. The names of the new officers and council were announced in NATURE of November 13 (p. 295)

In his presidential address Sir Joseph Thomson referred to the retirement of Sir Alfred Kempe (treasurer) and Dr. Schuster (secretary) and to the invaluable services which these officers have rendered to the society. He also announced with regret that the assistant secretary, Mr. R. Harrison, has been obliged to resign his office owing to ill-health. The subjoined extracts are from the president's address.

Einstein's Theory.

I cannot pass over without notice the remarkable result that was announced at our first meeting this session: that the observations made at the eclipse of May 29 showed that light was deflected, when passing close to the sun, by an amount which, within the somewhat wide limits of the experimental error, agreed with that predicted by Einstein.

The deflection of light by matter, suggested by Newton in the first of his Queries, would in itself be a result of first-rate scientific importance; it is of still greater importance when its magnitude supports the law of gravity put forward by Einstein, a law which has explained the long-standing difficulty of the motion of the perihelion of Mercury.

On Einstein's law the velocity of light passing through a field of gravitational attraction depends upon the gravitational potential, and diminishes as the potential diminishes. Thus the gravitational field round the sun acts like a refracting atmosphere, the refraction diminishing as the distance from the sun increases.

Though there are some hundreds of theories of gravitation, Einstein's is the only one which has predicted a result which has been verified by experience. On Einstein's, as on several other theories, changes in gravitational attraction travel with the velocity of light, and also the mass of a body varies with the proximity of other bodies.

In view of the statements in the Press about the overthrow of the Newtonian law, it may be well to point out that it is only in most exceptional cases—cases which are very difficult to realise—that the difference between the effects of the two laws is appreciable.

The modified theory of relativity by which Einstein arrived at this result is of remarkable interest and subtlety. The space around matter is on this theory distorted by an amount which diminishes as the distance from the matter increases, so that an observer in an aeroplane, if he were provided with infinitely delicate instruments, would, as he rose in the air, find the shapes of objects on the ground continually changing; and again the ratio of the circumference to the diameter of a circle would be changed to a minute amount by placing a weight at the centre of the circle. The laws of morality have been said to be a question of latitude; on Einstein's view those of geometry are a question of altitude.

On Einstein's view, gravitation is due to a particle trying to find the easiest way through space distorted and disturbed in this way. We may put it as follows:—The dynamical principle of least action, when applied to a particle moving through a space of this kind, would lead to a different path from that which would be pursued if the space were Euclidean, and this difference in path is that which would be produced if we supposed the space to remain Euclidean and the particle to be acted upon by an appropriate force. This force is what we call gravitational attraction. Thus we can represent the effect of this distorted space by the effects of suitable forces, and I expect it will be found that even the most enthusiastic relativitists will be tempted to think in terms of forces rather than in those of the geometry of non-Euclidean space.

If the distortion of space were very great, the customary methods of dynamics might lose their significance; and the question arises: Will, on Einstein's theory, the space inside an atom be so far from Euclidean that ordinary dynamical methods are unjustifiable? The answer to this question is, "No." There are two lengths which have special significance in connection with the atom; one of these is what we call the radius of the atom, and is of the order 10^{-8} cm.; the other we call the radius of the electron, and is about 10^{-13} cm. Even at the smaller of these distances the gravitational potential due to the mass of the atom, and therefore the distortion from Euclidean space, would be exceedingly small compared with the corresponding quantities due to earth at its surface, so that there is no special distortion inside the atom, except at distances from the centre which are infinitesimal even when compared with the radius of an electron.

One point of interest in connection with any view we take about mass is that, on the electrical theory of matter, the massive part of the atom is invariably positively charged, so that any state of space which we associate with mass ought to involve something corresponding to a positive charge of electricity.

The determination of the consequences of Einstein's theory on the principles of relativity, where the ideas of space and time are so intimately correlated that time has to be treated as a fourth-space dimension, introduces us into a space of four dimensions which we cannot visualise, and the properties of which are very remote from our experience. It is this which makes any general explanation of Einstein methods so difficult. To the analyst the difficulties presented by space of four dimensions are mainly those of an increase in the number of his symbols and equations; his difficulties begin when he has to explain his results to someone who is not an analyst. It is a remarkable and most interesting fact, from the point of view of either physics or metaphysics, that from such transcendental considerations as those I have indicated should have emerged a result so closely connected with such a prosaic thing as that it is more tiring to go upstairs than down.

According to Einstein's theory, the Fraunhofer lines in the sun must be displaced towards the red. This effect, though looked for by several observers, has not been confirmed; but even should it turn out that the theory has greatly to be modified, or even abandoned, its conception and development will, I think, always be regarded as one of the great triumphs of human thought.

Another interesting consequence of Einstein's theory is the exceeding minuteness of structure which it demands from matter. The electron, with a radius of 10^{-13} cm., carried our notions of the minuteness of some constituents of the universe far beyond those associated with the older atomic theory, but the size of the centres of disturbance, which in Einstein's theory are associated with matter, bears to the size of the electrons about the same proportion as the size of the smallest particle visible under the most powerful microscope to that of the earth itself.

I am afraid that the termination of the war has not brought to an end the difficulties in the way of scientific research in this country. Not the least of these is the difficulty and expense of procuring apparatus; it is perhaps surprising that in these circumstances the Government should have put obstacles in the way of the importation of philosophical instruments. Another very real difficulty is that the large increase in the number of students in our universities has greatly increased the educational duties of many of our most active workers, and so diminished the time they can devote to research.

The demands of war required large quantities of substances which previously were obtainable only in small quantities and at great expense. Prominent among these is helium, which can now be procured on a scale which, measured by laboratory standards, is unlimited. Such supplies of helium put cryogenic research on a new footing, and render possible investigations which promise to be of the greatest importance to many different branches of science. It is greatly to be regretted that in this country, the birthplace of cryogenic research, we have no adequately equipped cryogenic laboratory.

The Medallists.

The COPLEY MEDAL is awarded to WILLIAM MADDOCK BAYLISS.

Prof. W. M. Bayliss has been engaged in the investigation of physiological problems for the last thirty-five years. His work has ranged over a wide field. His paper with Starling on the electrical phenomena of the mammalian heart was the first to give the correct form of the normal variation, as confirmed by later investigations with the spring galvanometer. Again, he and Starling showed that the pancreatic secretion was effected by the production of a specific chemical messenger, which travelled by the blood, and not by the stimulation of nerve-endings and the passage of impulses through nerves and the central nervous system. They showed that this secretin was but a type of a whole group of substances which they designated hormones. The discovery of these hormones, and the precise definition of their nature and of the conditions of their activity, mark an important epoch in the development of our knowledge of the organs of the animal body. Prof. Bayliss's researches on the mode of action of enzymes and on the closely related questions with regard to the nature of colloidal solutions have obtained universal recognition. The war led to Prof. Bayliss making a great advance in practical medicine. He studied the condition known as shock, which follows great loss of blood. The condition had previously been treated by the injection of saline solution, but the effect produced was characteristically transitory, and sometimes no benefit accrued at all. Prof. Bayliss, amongst other things, proved that perfused fluid to be effective must contain colloidal matter sufficient to give the osmotic pressure of the normal colloidals of the blood.

A ROYAL MEDAL is awarded to PROF. JOHN BRETLAND FARMER for his researches in botany, especially in the cytology and anatomy of plants.

Prof. Farmer's work is characterised by the fundamental importance of the problems worked upon; thus his memoirs on the meiotic phase (reduction division) in animals and plants are of as great value to zoologists as to botanists, and his conclusions and interpretations of the complex nuclear changes which precede the differentiation of the sexual cells have stood the test of criticism, and remain the clearest and most logical account of these very important phenomena. His papers, in collaboration with his pupil, Miss Digby, on the cytology of those ferns in which the normal alternation of generations is departed from has thrown new light on problems of the greatest biological interest, and especially on the nature of sexuality. In his cytological work on cancerous growths Prof. Farmer has established the close similarity between the cells of malignant growths and those of normal reproductive tissue.

A ROYAL MEDAL is awarded to MR. JAMES HAYWOOD JEANS.

Mr. Jeans has successfully attacked some of the most difficult problems in mathematical physics and astronomy. In the kinetic theory of gases he has improved the theory of viscosity, and, using generalised co-ordinates, has given the best proof yet devised of the equipartition of energy and of Maxwell's law of the distribution of molecular velocities, assuming the validity of the laws of Newtonian dynamics. In dynamical astronomy he took up the difficult problem of the stability of the pear-shaped form of rotating, incompressible, gravitating fluid at a point where Darwin, Poincaré, and Liapounoff had left it, and obtained discordant results. By proceeding to a third order of approximation, for which very great mathematical skill was required, he showed that this form was unstable. He followed this up by the discussion of the similar problem when the fluid is compressible, and concluded that for a density greater than a critical value of about one-quarter that of water the behaviour is generally similar to that of an incompressible fluid. For lower densities the behaviour resembles that of a perfectly compressible fluid, and with increasing rotation matter will take a lenticular shape and later be ejected from the edge.

The DAVY MEDAL is awarded to PROF. PERCY FARADAY FRANKLAND for his investigations in three sections of chemical science.

Prof. Frankland's early work on the illuminating power of burning hydrocarbons was considerable in amount, and had the further merit of inspiring others in the study of combustion. He was one of the first after Pasteur to study seriously the chemical reactions which occur during the vital processes of numerous lower organisms, and to apply such reactions to the preparation of pure products. During the last twenty years he has devoted himself to the elucidation of the relationship existing between the chemical constitution and the rotatory power of optically active substances.

The SYLVESTER MEDAL is awarded to MAJOR PERCY ALEXANDER MACMAHON.

Major MacMahon's researches on the combinatory analysis and on subjects allied to the partition of numbers are of the highest value, and display great originality and invention. He has shown equal power in the discovery and treatment of the wonderful ranges of partition theorems which are derivable from the theory of elliptic functions, and of the similar theorems to be obtained by the application of analysis to purely arithmetical principles.

The HUGHES MEDAL is awarded to DR. CHARLES CHREE.

Dr. Chree has for many years devoted himself to the intimate study of the phenomena of terrestrial magnetism, notably those which are recorded by self-registering instruments. He has investigated the differences which occur in the diurnal variation on quiet or moderately disturbed days, studied the initial stages of magnetic storms, and investigated various problems connected with the relation of solar phenomena and manifestations of terrestrial magnetism. Perhaps the most notable result obtained is that called by Dr. Chree the "acyclic change." This manifests itself on taking the averages of quiet days, when it appears that the mean value of the magnetic force is not the same at the end as it was at the beginning of the 24-hourly period, but shows a difference which is always in the same direction.

THE HYDRO-ELECTRIC SURVEY OF INDIA.[1]

AT a time when so much enterprise and energy are being displayed in collecting facts and data concerning the world's water-power resources, the issue of a preliminary report on the water-power resources of India is an incident of considerable interest and importance. The investigation was commenced in 1918 under instructions from the Indian Government by the late Mr. G. T. Barlow, C.I.E., who was placed in charge of the survey, with Mr. J. W. Meares as his assistant. The untimely and deplorably sudden death of Mr. Barlow in April, 1919, towards the close of the tour of inspection, left the compilation of the report in the hands of Mr. Meares, who was appointed as his successor in the post of Chief Engineer. Mr. Meares has discharged his exacting task in a very able manner. The removal of Mr. Barlow's collaboration was, of course, a serious deprivation, as a number of places were visited by him unaccompanied; and, although he compiled his notes with every care, his unrecorded impressions would have been of great value. Notwithstanding this the report is excellently put together, and full of useful information.

The earliest water-power installation in India was the electric lighting plant of the town of Darjeeling, carried out by Mr. Meares himself in 1897. Five years later considerable power for industrial purposes was developed in Mysore from the River Cauvery. Then nothing of importance happened until the initia-

[1] "Hydro-electric Survey of India." Preliminary Report on the Water-power Resources of India. Ascertained during the Season 1918–19 by the late G. T. Barlow, assisted by J. W. Meares. Compiled by J. W. Meares. Pp. vii+108+iii plates. (Calcutta: Superintendent Government Printing, India.) Price Rs. 3.2 or 4s. 9d.

tion of the great Tata hydro-electric power project at Bombay, which has recently been completed. The country is known to abound in hydraulic possibilities, but, owing to the paucity of important manufacturing industries, no serious attempt has been made to exploit these possibilities, except in a few rare instances.

The difficulty in regard to the promotion of power-development schemes is the erratic incidence of the rainfall. India differs very greatly in this respect from other countries. The rainfall is seasonal, often tremendously heavy, followed by protracted spells of drought. In amount it ranges from 500 to a few inches.

Apart from canals, the mountainous regions, where the rainfall is a maximum, are the natural sources of water-power, but here there is a certain disability in that they lie largely in unsettled districts in the north inhabited by uncivilised tribes. "Except in localities where storage on a large scale is possible, such as the Western Ghats and possibly the uplands of the Central Provinces, the greater part of the monsoon rainfall of India must necessarily pass to the great rivers and canals undeveloped for power purposes." The Jaldaka River in the Bengal Duars is instanced as a case in point. The catchment area is 250 square miles, and the annual rainfall not less than 150 in.—probably 200 in. as an average. In the seven months from April to October the total fall amounts to some 75,000,000,000 cubic ft., giving an average flow of nearly 4000 cubic ft. per second, yet the flow gauged in April this year was only 170 cubic ft. per second. Add to this that a single day's rainfall may reach, and even exceed, 10 in., and the difficulty of controlling such extremes becomes at once apparent.

In consequence of the prevalence of conditions such as these, many Indian rivers during the dry season sink to insignificant streamlets. Storage, therefore, during the monsoon period is the only possible means of obtaining continuous supplies of water. But in most localities this is not economically possible. Certain seasonal industries, such as tea-drying and kindred processes, might be served by intermittent supplies, but the cost would be relatively higher than by a continuous supply.

As indicating the backward state of electrical development in India, the following figures are interesting. The number of watts installed per head of population in Canada is 148, in Australasia 62, in South Africa 57, in the British Isles 33, and in India less than 1.

The total brake-horse-power of all kinds is set down approximately as follows:—

Assam	22,550	
Bengal...	201,518	
Bihar	2,325	(apart from collieries)
Bombay	782,872	
Burma	17,750	(exclusive of rice mills, etc.)
Central Provinces	32,773	
Madras	39,568	
Punjab...	15,734	(steam only)
United Provinces	38,548	
Grand Total ...	1,153,638	

No estimate of the total water-power available for development is given or attempted. Mr. Meares states that it would take several years to ascertain it, even approximately. A statement is set out of existing hydro-electric plants and a number of possible sites for developing water-power are discussed. The report concludes with a series of practical notes and suggestions on methods of collecting and tabulating the necessary data, with a view to the future work of the survey.

BRYSSON CUNNINGHAM.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A further benefaction of 1000*l.* has been received by Prof. Nuttall on behalf of the institute for parasitology from the executors of the late Lord Strathcona and Mount Royal, in fulfilment of a promise made in 1910 to contribute that sum when the sum of 6000*l.* had been collected from other sources.

Dr. F. H. A. Marshall, fellow of Christ's College, has been appointed reader in agricultural physiology.

Mr. P. Lake, of St. John's College, has been appointed reader in geography.

Mr. W. B. R. King, of Jesus College, has been appointed assistant to the professor of geology, and Mr. T. C. Nicholas, fellow of Trinity College, to be demonstrator in geology.

OXFORD.—On November 2 an amendment to the Responsions statute was moved in Congregation by Prof. Gilbert Murray. This, if carried, would have had the effect of restricting the exemption from compulsory Greek to candidates in the pass schools and in the honour schools of natural science and mathematics. The amendment was lost on a division by 104 votes to 123. This decision will, no doubt, lead to a reopening of the question of exemption before Congregation, with a possible appeal to Convocation before a final settlement can be reached.

ON Friday, December 5, the Marquess of Northampton will distribute prizes and certificates at the Northampton Polytechnic Institute, Clerkenwell, E.C.1.

OWING to the lack of fuel for heating purposes, the University of Budapest has been unable to resume its activities this session. It is not anticipated that the resumption of work will be possible until next spring.

THE RIGHT HON. VISCOUNT HALDANE OF CLOAN, president of Birkbeck College, will receive the college graduates and deliver an address on "What is Truth?" at the celebration of the ninety-sixth anniversary of founder's day of the college on Friday, December 12. The chair will be taken at 8 p.m.

THE Dean of the faculty of medicine of the University of Paris has directed our attention to the reorganisation of the courses of instruction and the reopening of the laboratories and clinics in this faculty. A booklet has been published by Messrs. Masson (price 1 franc) giving a valuable and interesting historical account of the school, together with complete information with respect to the various courses. The booklet is admirably produced, and illustrated with twenty-one well-executed photographic plates. It should be in the hands of all those who wish to make use of the great resources now open to them. There should be many of these. Some of the clinical courses are given in vacation time—a fact which makes them available to those who might otherwise find it impossible to make a visit to Paris.

THE Prime Minister has appointed a Committee "to inquire into the position to be assigned to the classics (*i.e.* to the language, literature, and history of ancient Greece and Rome) in the educational system of the United Kingdom, and to advise as to the means by which the proper study of these subjects may be maintained and improved." The constitution of the Committee is as follows:—The Marquess of Crewe (chairman), Sir George Adam Smith, the Rev. C. A. Alington, Mr. S. O. Andrew, Miss M. D. Brock, Prof. H. J. Browne, Prof. J. Burnet, Mr. T. R. Glover, Sir Henry Hadow, Miss K. Jex-Blake, Prof. W. P. Ker, Mr. J. G. Legge, Mr. R. W. Livingstone, Mr. G. A. Macmillan, Prof. Gilbert Murray, Mr. Cyril Norwood, Prof. W. Rhys Roberts, Mr. C. E. Robinson, Prof. A. N. Whitehead, and Mr. C. Cookson (secretary). Communications intended for the Committee should be addressed to Mr. C. Cookson at the offices of the Board of Education, Victoria and Albert Museum, Exhibition Road, South Kensington, S.W.7.

THE eighth annual Conference of Educational Associations will be held in University College, Gower Street, London, W.C.1, from Wednesday, December 31, 1919, to Saturday, January 10, 1920. Mr. H. A. L. Fisher, President of the Board of Education, will give an address at the inaugural meeting, and the following are among the subjects to be discussed at meetings of some of the associations:—National Association of Manual Training Teachers and Educational Handwork Association: (a) The Measurement of Practical Ability and (b) Handwork and Science. British Psychological Society—Education Section: The Development of Mental Tests. Association of Science Teachers: Anti-gas Fans—with Experiments. Geographical Association: The Present Position of Geography in the Upper Forms—Some Causes and Possible Remedies; Spitsbergen; Islands, Peninsulas, and Empires; and Rainfall Considered as a Geographical Function. The Association of Science Teachers has arranged for a demonstration of Dr. Wilson's astronomical model at intervals throughout Monday, January 5.

THE inauguration of the University of Strasbourg under the new *régime*, which took place on November 22, was naturally an event of importance. The position of Strasbourg as the eastern outpost of French culture gives to its University a position of outstanding prestige. The authorities responsible for its "reconstruction" under the tricolour intend to maintain a very high standard of studies, and are especially anxious to attract students from this country. There are six faculties (law, sciences, letters, medicine, and Protestant and Catholic theology) and a *personnel enseignant* of 170 professors and *maîtres de conférence*. A well-endowed Société des Amis de l'Université (2 rue Geiler, Strasbourg) has just been founded, and one of its chief objects will be that of welcoming students (of either sex) from abroad and of making life attractive to them. Inquiries should be addressed to the society. The cost of living is much to the advantage of British residents on account of the very favourable rate of exchange. The imposing university buildings (opened in 1884 at a cost of 2,000,000*l.*) stand in the centre of the city, and close at hand is the magnificent library of 1,200,000 volumes, so rich in German literature. Strasbourg itself is, without doubt, one of the most attractive and well-governed cities in Western Europe, and its close proximity to the beautiful forests of the Vosges gives it a further advantage as a place of residence for British students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 20.—Sir J. J. Thomson, president, in the chair.—W. J. **Johnston**: A linear associative algebra suitable for electro-magnetic relations and the theory of relativity. The algebra is based on four fundamental units i, j, k, o. The square of each unit is -1, while the other binary products are polar ($ij=-ji$, $io=-oi$, etc.). This algebra is associative. i, j, k are interpreted as mutually rectangular unit vectors in Euclidean space, while o is a unit vector in the fourth dimension perpendicular to the other three. Let ω be the pure imaginary scalar $ct\sqrt{-1}$ and $W=c^{-1}\phi\sqrt{-1}$, where ϕ is the scalar potential, then if (F, G, H) is the ordinary vector potential the vector

$$U=iF+jG+kH+oW$$

is the fourfold vector potential. If ∇_1 is the operator

$$i\frac{\partial}{\partial x}+j\frac{\partial}{\partial y}+k\frac{\partial}{\partial z}+o\frac{\partial}{\partial \omega},$$

then the electric and magnetic forces are the six components of $c\nabla_1 U$, the scalar part of which vanishes; and the eight scalar equations of the electrodynamic field which connect these forces are expressed by the single equation $\nabla_1(\nabla_1 U)=0$. This equation in the equivalent form $\nabla_1{}^2U=0$, when interpreted in terms of ordinary space, expresses that all the disturbances are propagated from their point-sources with uniform velocity c.—Sir Joseph **Larmor**: Generalised relativity, in connection with Mr. W. J. Johnston's symbolic calculus. If ijk are polar units, so that $i^2=-1$, $ij=-ji$, then $ik+jy+kz$ is a binary form involving the position of a point xyz and that of a trihedron ijk. So far as regards relative position, a displacement of the one is the same thing as a displacement of the other. A vector $iF+jG+kH$ represents an entity independent of the trihedron of reference, so is invariant for changes of the latter. Operations of addition and multiplication of vectors give results which are also invariant. Similar statements apply in geometric algebras of higher dimensions, and the scalars involved may be ordinary imaginaries. With the four dimensions $x, y, z, ct\sqrt{-1}$ of Minkowski, Mr. Johnston has shown that the vector forces of the electro-dynamic field are specified by $\nabla_1 U$, where U is the fourfold vector potential, and the eight equations of the field are summed up in $\nabla_1{}^2U=0$. But a source, naturally conceived as a singular point in ordinary space, complicates now into a Minkowski line. Again, all the geometric quantities natural to any Euclidean hyperspace are those which are evolved immediately from the addition and multiplication of vectors in it. It is proved that the possible types of disturbance propagated through an æther, which conform to the principle of relativity, are restricted to the single one specified by Maxwell's electro-dynamic scheme. In an appendix the Einstein idea of gravitation is developed as a theory of correspondence of modes of action of a physical system; it appears, at any rate on this view, that it does not involve displacement of the solar spectral lines.—G. E. **Bairsto**: The variation with frequency of the conductivity and dielectric constant of dielectrics for high-frequency oscillations.—F. J. W. **Whipple**: Equal parallel cylindrical conductors in electrical problems. Dr. Alexander Russell has recently directed attention to the practical importance of determining the mutual induction between currents of high frequency carried by parallel cylindrical conductors, and pointed out that the problem is mathematically equivalent to that of finding the distribution of static charge on two electrified conductors. The first part of the present paper is devoted to the solution of this problem. The coefficients of mutual and self-induction and the force between the cylinders, regarded as carriers of high-frequency currents, concentrated on the surfaces, are also investigated.—G. A. **Schott**: The scattering of X- and γ-rays by rings of electrons. A crucial test of the electron-ring theory of atoms. This paper investigates the effect of the regular spacing of the electrons of a ring on the scattering of X- and γ-rays, treated as undamped simple harmonic wave-trains of high frequency. The ring, whether at rest or revolving uniformly about its axis, diffracts the waves incident on it in all directions, but not equally. For a single electron the law of distribution is that of Sir J. J. Thomson's simple-pulse theory, but it deviates from it as the number of electrons increases, more energy going forward in the direction of the incident rays than backward. This asymmetry is retained, though to a less extent, by an irregular assemblage of similar electron rings with their axes distributed uniformly in space. An expression is obtained for the scattering coefficient, or mean total energy scattered per ring per unit intensity of the incident radiation, in a finite form, depending upon the number of electrons in the ring and on the ratio which its radius bears to the wave-length of the incident radiation.

Physical Society, November 14.—Prof. C. H. Lees, president, in the chair.—S. **Butterworth**: The self-inductance of single-layer flat coils. Two formulæ are established for the computation of the self-inductance of single-layer flat coils, one for the case when the inner and outer radii are not very different, and the other for the case of small inner radius. The two formulæ are shown to be consistent and capable of including all possible cases.—Dr. N. W. **McLachlan**: An experimental method of determining the primary current at break in a magneto. A method of obtaining experimentally the current at break in a magneto is described. A condenser is connected across the secondary winding to reduce the voltage below that required to cause sparking at the safety gap. The peak voltage due solely to interruption of the current at any speed is found. The interrupted direct current necessary to give the same peak voltage is also found by using a calibrating circuit. The magnitude of this current is equal to that broken in the magneto. The influence of the secondary condenser on the primary current at high speeds is discussed.—F. W. **Newman**: A new form of Wehnelt interrupter.

Royal Meteorological Society, November 19.—Sir Napier Shaw, president, in the chair.—Lieut. C. W. B. **Normand**: Effect of high temperature, humidity, and wind on the human body. The climatic conditions under which a wet bulb, restricted to a certain maximum rate of evaporation and having an initial temperature of 36·5° C., will neither gain nor lose heat are derived from kata-thermometer and wet-bulb formulæ. The application of these results to the human body is then considered, and, on the assumption that conditions resulting in a rise of body temperature above 36·5° C. must be fatal, the upper limits to liveable climatic conditions are deduced. The scorching, and sometimes deadly, simoom of tropical deserts is considered to be a case of the onset of a high wind without necessarily a change of temperature or humidity, converting liveable into unliveable conditions. The suggestion is also made that an essential feature of heat-strokes may be that a portion of the body has been exposed for a time to air conditions which are above the limit for existence. The wet kata-thermometer and wet-bulb formulæ were found to furnish quite discordant results regarding the behaviour of a wet surface under varying wind velocities, and it is suggested that this discrepancy is due to a less efficient wetting of the kata-thermometer bulb and to a consequently restricted rate of evaporation from it.—Capt. A. J. **Bamford**: Some observations of the upper air over Palestine. This paper gives a brief summary of some upper-air observations made in Palestine during the last two years. Tables and graphs are given showing the monthly averages of the horizontal movements at different altitudes over three stations, at one of which (near Ramleh) observations were kept up continuously for a year. The second part of the paper deals with vertical velocities, and includes frequency curves, showing for each of the layers 0–2000 ft., 2000–4000 ft., and 4000–6000 ft. the number of times in each month that the observed velocities differed from the theoretical ones by not more than 10, 20, 30, or 40 per cent., etc. The lowest layer is appreciably the most varied, and in it differences of 50 per cent. are not unusual, although the average velocity differs very slightly from theory. In the other layers there is a distinct increase in the compactness of the frequency curves, while the average velocity changes from slightly above to slightly below the theoretical value.—E. G. **Bilham**: Barometric pressure and underground water-level. The results recently obtained from a study of an experimental well with autographic registration at Kew Observatory, Richmond, Surrey, are compared with some earlier records obtained by Dr. Isaac Roberts at Maghull, near Liverpool, and by Prof. K. Honda in the neighbourhood of Tokyo, in Japan. As at Kew, the sensitiveness of the water surface at Maghull to pressure changes varies considerably, high sensitiveness being associated with saturation of the soil by previous heavy rainfall. In Japan it was found that in surface wells the water-level was not affected by pressure changes, sensitiveness being exhibited by deep artesian wells only. Prof. Honda has pointed out that by determining the sensitiveness of a well to barometric pressure the extent to which pressure changes affect strata at a given depth below the surface can be deduced. Data for Japan and the British Isles obtained in this way show marked points of difference.

CAMBRIDGE.

Philosophical Society, November 10.—Mr. C. T. R. Wilson, president, in the chair.—Dr. **Hartridge**: Colorimeter design.—J. T. **Saunders**: A note on hydrogen-ion concentration and photosynthesis. Spirogyra and elodea during photosynthesis cause the surrounding water to become markedly alkaline. Acids are very rapidly absorbed.—J. **Gray**: (1) The effects of some ions on spermatozoa. A suspension of Echinus spermatozoa in sea-water behaves in an electric field or in the presence of hydrogen ions or trivalent ions in the same way as an emulsion of albumen in alkaline solution. (2) The effects of ions on ciliary movement (gills of *Mytilus edulis*). By far the most potent ions in sea-water which affect ciliary movement are hydrogen ions and hydroxyl ions.—C. **Warburton**: Note on the solitary wasp, *Crabro cephalotes*. A small colony of *C. cephalotes* took possession in August, 1919, of a log in the author's garden, and afforded an opportunity of studying their habits with some accuracy. Observations were made on the time occupied in capturing and bringing home their prey and in packing them in the burrows.—Miss M. D. **Haviland**: Preliminary note on the life-history of a Proctotrypid (Lygocerus sp.) hyperparasite of Aphidius. *Lygocerus Cameroni*, Kieff (Proctotrypidæ), is a hyperparasite of certain Braconid parasites of plant-lice, and not a parasite of the aphides themselves, as has hitherto been assumed.—H. J. **Snell** and W. H. **Tams**: The natural history of Rodrigues, with exhibits. The paper gives a brief account of the island of Rodrigues as it at present exists. Since it was first discovered it appears to have been completely swept by fire, save only for peculiar deep pits in the elevated coral rock which in places overlies the volcanic. Here a certain number of the indigenous plants still survive, but probably the species in the flora are only half as numerous as when the island was first discovered; great damage has also been done by pigs and goats. The fauna previously described was almost in its size that of a coral island, but the present collections reveal much larger numbers of species and more variety, indicating probably a greater age for the island; the fauna also shows a close parallel to that of Mauritius and other volcanic islands in its adaptability to island conditions.

MANCHESTER.

Literary and Philosophical Society, November 4.—Prof. F. E. Weiss in the chair.—Prof. W. H. **Lang**: One of the simplest land-plants, *Hornea Lignieri*. The further results obtained by Dr. R. Kidston and Prof. W. H. Lang in the study of the silicified Old Red Sandstone plants at Rhynie were described. Two species of Rhynia are now distinguished, *R. Gwynne-Vaughani* and *R. major*. The latter is the larger in all its parts, and differs in some details of anatomy. These plants are rootless and leafless, and consist of a subterranean rhizome with rhizoids, dichotomously branched cylindrical aerial stems, and large terminal sporangia. Another equally simple plant, associated with these in the family Rhyniaceæ, has been discovered and investigated. This, *Hornea Lignieri*, consisted of rhizomes, branched stems, and terminal sporangia, without roots or leaves. The rhizomes were lobed parenchymatous structures, suggesting comparison with the protocorm of certain species of Lycopodium. The stems branched dichotomously, and had a simple central cylinder, cortex, and epidermis. No stomata have yet been discovered in this plant, as they have in Rhynia, but its organisation suggests a similar land-habit. The sporangia are remarkable in the presence of a columella-like central region, making the spore cavity dome-shaped. These simple vascular Cryptogams suggest comparisons with Bryophyta and Algæ.

PARIS.

Academy of Sciences, November 10.—M. Léon Guignard in the chair.—M. **Hamy**: A case of diffraction of images of circular stars.—H. **Douvillé**: The geology of Mont Blanc.—A. **Blondel**: A solution of heterochromatic photometry permitting of a physical measurement of the luminous intensity. The instrument proposed is based on the inversion of a spectrograph, the slit being replaced by a thermocouple.—L. **Cuénot**: The coaptation of the anterior femurs and of the head in the Phasmidæ.—E. **Bompiani**: Surfaces of translation and minimum surfaces in curved space.—B. **Baillaud**: Return of the Finlay comet; re-found by M. Schaumasse; compared by M. Fayet with the recent Sasaki comet. The comet discovered on October 25 by Sasaki is considered by M. Fayet, director of the Nice Observatory, as identical with the periodic Finlay comet recently found by Schaumasse.—A. **Véronnet**: Time and temperature of formation of a star. The author concludes that the sun originally could not have had a temperature more than three times its present temperature, or a radius more than double the present one. Even in this case the time of formation would have to be less than a million years. The physical conditions have never been greatly different from the existing ones.—M. **Girousse**: The calculation of the current thrown into the ground by the rails of electric tramways.—H. **Colin** and Mlle. A. **Chaudin**: The diastatic inversion of saccharose: influence of the products of the reaction on the velocity of hydrolysis. In all the cases studied the velocity of hydrolysis is a linear function of the fluidity of the solutions. The reduced velocity of hydrolysis of sugar by sucrase caused by the presence of lævulose or glucose must be attributed to the purely physical effect of increased viscosity.—L. **Chelle**: The detection of hydrocyanic acid in a case of poisoning. Its *post-mortem* transformation into thiocyanic acid. It is well recognised that hydrocyanic acid apparently disappears from the body at a certain period after death. It is now shown that this acid is not destroyed or transformed in an irreversible manner, but takes up sulphur and is converted into thiocyanic acid. The latter resists the action of putrefaction, and can be extracted from the tissues and reconverted by oxidation into hydrocyanic acid.—R. **Levaillant** and L. J. **Simon**: The action of methyl alcohol on sulphuryl chloride and on methyl chlorosulphonate.—J. **Barthoux**: Relation of volcanic eruptions and marine transgressions in Egypt.—A. **Briquet**. The age of the old littoral lines of the Bas-Champs of Picardy.—G. **Mouret**: The prolongation to the north-west of the zone of crushed rocks recognised between Asprières (Aveyron) and Fromental (Haute-Vienne).—Ph. **Glangeaud**: The plateau of Millevaches, its cycles of erosion, its ancient glaciers and peat-bogs.—J. **de Lapparent**: The conglomerates of the valley of la Bruche and the character of the breccias of sedimentary origin.—P. **Garrigou-Lagrange**: The kinematography of atmospheric movements and weather prediction.—C. E. **Brazier**: Relations of wind with gradient in the lower layers of the atmosphere.—A. **Goris** and Ch. **Vischniac**: Characters and composition of primeverose. The new sugar was isolated from two glucosides extracted from *Primula officinalis*. Its physical and chemical properties are given. Glucose and xylose are the products of hydrolysis, and primeverose is the first known biose of this composition.—G. **Tanret**: The *miellée* of the poplar. Melezitose has been isolated from the sugary deposit (*miellée*) found in warm seasons on the upper faces of the leaves of certain species.—J. **Amar**: Mechanism of the cough in respiratory diseases.—J. **Nageotte**: The formation of conjunctive fibres in a non-living medium at the expense of dead protoplasm.—MM. G. **Bertrand**, **Brocq-Rousseu**, and **Dassonville**: Destruction of *Sitotroga ceralella* by chloropicrin.

BOOKS RECEIVED.

Human Personality and its Survival of Bodily Death. By Frederic W. H. Myers. Edited and abridged by S. B. and L. H. M. Pp. xiii+307. (London: Longmans, Green, and Co.) 6*s*. 6*d*. net.

South: The Story of Shackleton's Last Expedition, 1914–17. By Sir Ernest Shackleton. Pp. xxi+376. (London: William Heinemann.) 25*s*. net.

Identification of the Economic Woods of the United States: Including a Discussion of the Structural and Physical Properties of Wood. By Prof. Samuel J. Record. Second edition, revised and enlarged. Pp. ix+157+vi plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

The Theory and Practice of Working Plans (Forest Organization). By Prof. A. B. Recknagel. Second edition, thoroughly revised. Pp. xiv+265+vi plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 9*s*. net.

Spiritual Pluralism and Recent Philosophy. By C. A. Richardson. Pp. xxi+335. (Cambridge: At the University Press.) 14*s*. net.

The Principles of Electrical Engineering and their Application. By Prof. Gisbert Kapp. Vol. ii.: Application. Pp. viii+388. (London: Edward Arnold.) 18*s*. net.

Asbestos and the Asbestos Industry: The World's Most Wonderful Mineral and Other Fireproof Materials. By A. Leonard Summers. (Pitman's Common Commodities and Industries.) Pp. ix+107. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Meteorology for All: Being Some Weather Problems Explained. By Donald W. Horner. With an introduction by C. S. Salter. Pp. xvi+184+vii plates. (London: Witherby and Co.) 6*s*. net.

Ions, Electrons, and Ionizing Radiations. By Dr. James Arnold Crowther. Pp. xii+276. (London: Edward Arnold.) 12*s*. 6*d*. net.

Psychology and the Day's Work: A Study in the

Application of Psychology to Daily Life. By Prof. Edgar James Swift. Pp. ix+388. (London: George Allen and Unwin, Ltd.) 10s. 6d. net.

Notions Fondamentales de Chimie Organique. By Prof. Charles Moureu. Sixième édition. Pp. vii+552. (Paris: Gauthier-Villars et Cie.) 16 francs.

Agriculture and the Farming Business. By O. H. Benson and George Herbert Betts. Pp. xvii+778. (London: Kegan Paul, Trench, Trübner, and Co., Ltd.) 10s. 6d. net.

Introduction to Physical Chemistry. By Prof. James Walker. Eighth edition. Pp. xiii+433. (London: Macmillan and Co., Ltd.) 16s. net.

The Outline of History. By H. G. Wells. Part i. Pp. 32+plates. (London: George Newnes, Ltd.) 1s. 2d. net

Examples in Electrical Engineering. By J. F. Gill and F. J. Teago. Pp. 173. (London: Edward Arnold.) 7s. 6d. net.

Memoirs of the Geological Survey: England and Wales. Explanation of Sheet 154. The Geology of the Country around Lichfield, including the Northern Parts of the South Staffordshire and Warwickshire Coalfields. By G. Barrow and others. With contributions by J. B. Hill and others. Pp. viii+302. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 9s. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 4.

ROYAL SOCIETY, at 4.30.—A. M. Williams: (1) The Adsorption of Gases at Low and Moderate Concentrations. Part I: Deduction of the Theoretical Adsorption Isotere and Isotherm. Part II: Experimental Verification of the Form of the Theoretical Isoteres and Isotherms. (2) The Adsorption of Gases at Low and Moderate Concentrations. Part III: Experimental Verification of the Constant in the Theoretical Adsorption Isotere.—T. R. Merton: (1) The Secondary Spectrum of Hydrogen. (2) The Spectra of Isotopes.—E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces, Part II.—F. Horton and Ann C. Davies: An Experimental Determination of the Critical Electron Velocities for the Production of Radiation and Ionisation on Collision with Argon Atoms.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. C. F. Sonntag: The History of Baths and Bathing in Britain before the Norman Conquest.

CHEMICAL SOCIETY, at 8.—H. Henstock: Di-phenanthryl.—B. D. Steele and H. G. Denham: A New Sulphuretted Hydrogen Generator.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—*Discussion:* On the Recently Published Report on the Teaching of Obstetrics and Gynæcology to Medical Students and Graduates in London. Dr. T. W. Eden will introduce the discussion, and a Criticism of the Report will be read by Dr. H. Spencer.

FRIDAY, DECEMBER 5.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds Technical College, Leonard Street, E.C. 2), at 7.—H. M. Barlow: Thermionic Magnifiers.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—W. B. R. King: Geological Work on the Western Front.

TECHNICAL INSPECTION ASSOCIATION (at the Royal Society of Arts), at 7.30.—R. D. Summerfield and H. J. Davey: Inspection and Testing of Materials.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. C. H. Mott: Intratracheal Insufflation of Chloroform; a Report on 357 Cases.

MONDAY, DECEMBER 8.

VICTORIA INSTITUTE (at the Central Hall, Westminster), at 4.30.—A. W. Sutton: The Ruined Cities of Palestine, East and West of the Jordan.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore, S.W. 7), at 5.—Lt.-Col. W. J. Johnston: The New Inch and Quarter-inch Maps of the Ordnance Survey.

BIOCHEMICAL SOCIETY (at the Lister Institute), at 5.30.—B. Moore, E. B. R. Prideaux, E. Whitley, and A. Webster: (1) Season Variations in Reaction of Sea Water Due to Photosynthesis; (2) Fixation of Atmospheric Nitrogen by Marine Algæ.—B. Moore and E. Whitley: Velocity of Photosynthesis by Green, Brown, and Red Seaweeds Respectively in Light of Varying Intensity.—A. Slator: The Rate of Inactivation of Yeast-cells.—I. S. MacLean: Composition of Yeast Fat.—C. J. Martin: (1) Method of Preparation of Sörensen's Phosphate Solutions in Absence of Pure Salts. (2) Adjustment of Reaction of Media by the Use of α-Naphtholphthalein.—A. Harden and S. S. Zilva: Production of Water-soluble B by *S. ellipsoideus.*

SURVEYORS' INSTITUTION (Junior Meeting), at 7.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. T. Hewitt: Synthetic Drugs (Cantor Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association), at 8.—R. J. Glinn: Large Boiler Units.

TUESDAY, DECEMBER 9.

ROYAL SOCIETY OF ARTS (Colonial Section), at 4.30.—Sir Edward Davson: Problems of the West Indies.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. F. Farmer: Demonstration of the "Carbro" Process.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. H. Hutton: The Leopard Men of the Naga Hills.

WEDNESDAY, DECEMBER 10.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at the College of Preceptors).

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Botanical Department, Imperial College of Science and Technology), at 11.30.—Annual General Meeting. Exhibitions and Communications.

CONJOINT BOARD OF SCIENTIFIC SOCIETIES (at the Royal Society), at 3.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Rear-Admiral Sir W. E. Goodenough: Light Cruisers.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Oliver Lodge: Some Possible Sources of Energy (Trueman Wood Lecture).

ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts), at 8.—J. D. North: Aircraft Undercarriages.

THURSDAY, DECEMBER 11.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Botanical Department, Imperial College of Science and Technology), at 10.30.—Discussion on the Integration of Mycological Research with Practice in Agriculture, Horticulture, and Forestry.—Sir A. D. Hall: The Administrative Problem.—Prof. V. H. Blackman: The Teaching Problem.—Dr. E. J. Russell: The Agricultural Problem.—F. J. Chittenden: The Horticultural Problem.—Prof. W. Somerville: The Forestry Problem.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Col. C. F. U. Meek: A Further Study of Chromosome Dimensions.—J. M. H. Campbell, C. G. Douglas, and F. G. Hobson: The Respiratory Exchange of Man During and After Muscular Exercise.—Dr. A. D. Waller: The Energy Output of Dock Labourers during Heavy Work.—C. H. Usher: Histological Examination of an Adult Human Albino's Eyeball, with a Note on Mesoblastic Pigmentation in Fœtal Eyes.—J. Gray: The Relation of Spermatozoa to Certain Electrolytes, II.

LINNEAN SOCIETY, at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles A. Ballance: The Surgery of the Heart (Bradshaw Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Civil Engineers), at 6.—Capt. J. M. Scott Maxwell: Scientific Management—A Solution of the "Capital and Labour" Problem.

OPTICAL SOCIETY, at 7.30.—Experimental and Conversational Evening.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (28 Victoria Street), at 8.—Debate: Worm *v.* Bevel Drive.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Discussion: The Late Effects of Injuries to the Nervous System.

FRIDAY, DECEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Consideration of the Theory of Relativity. Discussion to be opened by Prof. Eddington.

PHYSICAL SOCIETY OF LONDON, at 5.—Prof. W. M. Coleman: First Steps in the Experimental Analysis of a Galvanic Cell.—J. W. T. Walsh: Radiation from a Perfectly Diffusing Circular Disc.—Dr. N. W. McLachlan: A Comparative Method of Testing Thermionic Valves for Passing no Reverse Current at High Voltages.—Dr. A. O. Rankine: Recording and Reproducing Sounds by Means of Light.

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.

CONTENTS.

	PAGE
The Nurture of Key Industries	349
The Dragon of Mythology	350
Eugenics. By L. D.	351
Our Bookshelf	352
Letters to the Editor:—	
Progress of the Natural History Museum.—Dr. S. F. Harmer, F.R.S.	353
Gravitation and Light.—Sir Oliver J. Lodge, F.R.S.	354
The Displacement of Light Rays Passing near the Sun.—Prof. Alexr. Anderson	354
Einstein's Relativity Theory of Gravitation. I. By E. Cunningham	354
Discovery of a Minoan Palace at Malia, in Crete	356
Notes	357
Our Astronomical Column:—	
Heliocentric Grouping of Planets in December	361
Comets	361
Fall of a Meteorite in America	361
Anniversary Meeting of the Royal Society	361
The Hydro-electric Survey of India. By Dr. Brysson Cunningham	363
University and Educational Intelligence	364
Societies and Academies	365
Books Received	367
Diary of Societies	368

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THURSDAY, DECEMBER 11, 1919.

PARASITIC AMŒBÆ AND DISEASE.

The Amoebae Living in Man: A Zoological Monograph. By Prof. Clifford Dobell. Pp. vii+155+v plates. (London: John Bale, Sons, and Danielsson, Ltd., 1919.) Price 7*s.* 6*d.* net.

THIS is a very valuable piece of work, bringing order and critical intelligence to bear in a field of study which, already touched by many observers, has immensely increased in activity and importance during the war. The common freshwater Amœba, living freely in natural pools, has many relatives, some of which have been distinguished by definite characters of the nucleus, form of pseudopodia, cysts, and other characteristics as "good" species and even assigned to distinct genera. But there has been no careful cytological study of the various species, though here and there important observations have been made. When to these forms are added those living in the soil, in sea-water, and, lastly, those parasitic in other animals, we find that there is quite a large group of these "amœboid" organisms which have been recorded from this or that habitat by observers who were hurried by other work or insufficiently trained in cytological methods. As a consequence, without sound method or criticism, specific and even generic names have been given to "Amœbæ," parasitic or free-living, and misleading sketches of them have been published. A perplexing confusion of inaccurate statements obscures the whole subject.

A great source of inaccuracy and vague statement has been the interest excited among medical men by the parasitic species of Amœba-like organisms and their association with dysentery and possibly with other diseases. As a rule the medical observers have not been trained "protozoologists," or attentive to the laws of zoological nomenclature. It is creditable to them that in the midst of other important work they have done so much in directing attention to these parasites. But to give any serious value to a knowledge of the Amœbæ as a guide to the diagnosis and control of disease, it was absolutely necessary that a high standard of accuracy in observation and statement, correct nomenclature, and a severe criticism of the accumulated mass of loose statements published by incompetent though well-meaning writers, should be applied to this subject by a competent authority having not only special experience and understanding of systematic zoology, but also time and opportunity to ensure full examination by him of the organisms in question.

The Government was fortunate in being able to secure the services of Mr. Clifford Dobell, assistant professor of Protistology and Cytology in the Imperial College of Science, for this purpose. Prof. Dobell had before the war made for himself a distinguished name as an investigator of the structure and reproduction of such minute parasites as the Coccidia, the Bacteria, and, amongst others, of the Amœbæ parasitic in frogs. He had carried the discrimination of details in the structure and reproductive changes of the threads and granules of the cell-nucleus of such minute organisms beyond that attained by other microscopists. His careful and precise work was recognised by his scientific *confrères* as certain to lead to sound conclusions when applied with ample time and material to the problem of the relation of Amœbæ to disease in man, and especially to the question of the causation of dysentery (and other diseases) by one, or more than one, species of Amœba.

In 1915 the return to this country of large bodies of troops from the Eastern war area—many afflicted with dysentery—rendered it necessary to examine the stools of a very large number of patients in order to decide whether those returning from Gallipoli and Egypt were suffering, as was supposed (but shown to be erroneously so), from "amœbic dysentery." A large number of trained workers were required for this purpose. Their training was undertaken, at first, by Dr. C. M. Wenyon, but when his services were required elsewhere at the end of 1915, Prof. Dobell took charge of the work and for four years has devoted himself uninterruptedly to the practical study of the intestinal protozoa of man. A large part of his time has been occupied with the routine work of diagnosis, with teaching that routine to others, and with the investigation of methods of treating amœbic dysentery. But, as he says, he has had great opportunities for studying the human intestinal protozoa from the zoological point of view, and probably no zoologist has ever before had such an immense amount of this special material at his disposal.

As a result, in spite of the really formidable difficulties in interpreting the results of many other workers, Prof. Dobell is able to say that almost all his own doubts have disappeared, and he presents to other workers in this field in the present volume a very full and detailed account of the work of his predecessors and of his own work and conclusions—together with the story of his methods of microscopic observation—illustrated by five remarkably well-executed plates.

This book is not for the general reader, and not even for every zoologist. It is addressed to the protozoologist who has some familiarity with the later developments of cytology, and is either already engaged in such studies or qualifying for them. At the same time we may briefly direct attention to some of Prof. Dobell's conclusions which have general interest. For reasons fully set forth, he reduces the number of species of "Amœbæ" ascertained to be living in man to six, which he arranges in four genera, as follows:—

Genus I.—ENTAMŒBA, Cassagrandi and Barbagallo, 1895 (*nec* Endamœba, Leidy, 1879).

Species 1. *E. coli*, Grassi; 2. *E. histolytica*, Schaudinn; 3. *E. gingivalis*, Gros.

Genus II.—ENDOLIMAX, Kuenen and Swellengrebel, 1917.

Species 4. *E. nana*, Wenyon and O'Connor.

Genus III.—IODAMŒBA, *nov. gen.*

Species 5. *I. Bütschlii*, Prowazek.

Genus IV.—DIENTAMŒBA, Jepps and Dobell, 1918.

Species 6. *D. fragilis*, Jepps and Dobell.

Of these only *Entamoeba histolytica* is proved experimentally to be pathogenic; it causes dysentery and liver abscess. None of the other five are pathogenic. *E. coli* is proved experimentally to be harmless. It is held by Prof. Dobell, in agreement with recent investigators, such as Goodrich and Moseley, that *E. gingivalis*, common on the human gums, is innocuous and not a cause of pyorrhœa. He cites their observation of the occurrence of *E. gingivalis* in pus from the mouths of dogs and cats. *Endolimax nana* is a small but well-marked innocuous species common in the human bowel. *Iodamoeba Bütschlii* is a small and uncommon species which produces in its cysts a mass of glycogen, which gives the mahogany stain when treated with iodine. *Dientamoeba fragilis* is a very small form studied only in seven cases. It is typically "bi-nucleate."

Entamoeba coli is as large as *E. histolytica*, and the two have been persistently mistaken for one another and confused in name. Even when occurring together they have not been distinguished. Hence endless misapprehension and trouble have arisen as to which "Amœba" it is that is harmless and which that causes dysentery. Lösch, in 1875, gave the name *Amoeba coli* to what is now by common consent called *Entamoeba histolytica*. Grassi, in 1879, described as the *Amoeba coli* of Lösch, not what Lösch had so called, but the harmless form which to-day passes under that name. Schaudinn (1903) described what Lösch had named *Amoeba coli* under the name *Amoeba histolytica*. Schaudinn *ought* to have recognised what he described as being Lösch's *A. coli*, but he *failed* to do so. Hence *E. histolytica* is to-day the name in use for the dysentery-causing species, and *E. coli* is that applied (contrary to the original use of the name) to the harmless species. Prof. Dobell declines (and we think rightly) to reverse or interchange the two names again, as such a course would cause "endless confusion." The mere citation of this one example of the misunderstandings of former authorities will serve to suggest to the reader how great are the difficulties in regard to nomenclature and identification with which Prof. Dobell has successfully contended. All future workers in this line must be grateful to him for his laborious and judicious treatment of these questions, as well as for his new and accurate observations.

E. RAY LANKESTER.

ASTRONOMICAL LECTURES AND ESSAYS.

(1) *The Adolfo Stahl Lectures in Astronomy. Delivered in San Francisco, California, in 1916–17 and 1917–18, under the Auspices of the Astronomical Society of the Pacific.* Pp. xiv + 257 + liv plates. (San Francisco: D. S. Richardson, 128 Lick Building, 35 Montgomery Street, 1919.) Price 2.75 dollars.

(2) *Planetary Rotation Periods and Group Ratios.* By F. A. Black. Pp. xii + 115. (Edinburgh and London: Gall and Inglis, n.d.) Price 3*s.* 6*d.*

(1) THE Astronomical Society of the Pacific is in several respects an interesting and fortunate body. As Dr. Aitken recalls in one of these lectures, it had its origin in the co-operation of amateur and professional observers of the eclipse of 1889, which crossed California and was the object of an expedition, the first of a splendidly organised series, from the Lick Observatory, then only recently established. The society is essentially an amateur association enjoying the cordial support of professional astronomers, and this means much, for in its province—a thousand miles long—is to be found the most notable part of the instrumental equipment of astronomy in the world, including the three largest reflectors, with an average aperture of nearly 80 in. It bestows the Bruce medal on conditions which make the award the seal of the highest professional approval on the work of the recipient. It grants the Donohoe medal to the discoverer of every unexpected comet. Its "Publications," without having the severity of a conventional learned journal, contain notes on results of the most recent work, and often give an intimate account of observatory life in circumstances of peculiar interest, especially welcome to those who have had personal experience of it.

It was quite in accordance with the aims and spirit of the society that an organised course of six popular lectures should be given in San Francisco by members of the Lick Observatory staff in the winter of 1916–17, and equally fitting, but no less welcome, that a generous benefactor should be found in Mr. Adolfo Stahl to defray the expenses; for the readiness of Californian citizens to help worthy astronomical projects of all kinds with financial support is unequalled elsewhere. And Mr. Stahl's liberality did not stop there; for when the success of the first course suggested a second series in the following winter, this time with the help of the Mount Wilson and the Berkeley staffs, Mr. Stahl again lent the same aid, and when it was very properly felt that the lectures, which had been printed in the "Publications," deserved to be published in collected book form, he undertook once more to guarantee the cost. The result is this handsome volume, beautifully illustrated and containing a dozen lectures, popular in the sense of being simply stated and dealing for the most part with modern aspects of astronomy, by competent authors.

The first two lectures, on the solar system and on comets, are by the director of the Lick Observatory. Surely the time is at hand for an advance in our knowledge of the physics of comets. Dr. Aitken, who has acted as editor of the volume, is responsible for three lectures—on solar eclipses, on the moon, and on recent results from stars and nebulæ. Dr. H. D. Curtis discourses on nebulæ and on some aspects of astronomical discovery. Four single lectures are by Dr. Crawford on epochs in astronomical history, by Dr. St. John on the sun, by Dr. Leuschner on motions in the solar system, dealing mainly with recent computing work at Berkeley, and by Mr. Seares on the brightness, colours, distribution, and motions of the stars. These last three are very useful summaries of current work. The final lecture, on the Mount Wilson 100-in. reflector, was delivered by Dr. Ritchey, but not reduced to writing, and, owing to the lecturer's preoccupation with war work, it has been necessary to substitute an account compiled from other sources.

The book deserved an index. The photograph of the Pleiades (plate xliv.) was not by *Sir* Isaac Roberts. Did space not forbid, one would be tempted to dispute some of Dr. Crawford's views of history. Both he and Dr. Leuschner disparage Kepler's achievements by calling them guesswork. If to be fertile in hypotheses and to submit them instantly to the test of comparison with good observations be guesswork, then a good part of the truest scientific method is guesswork. Of this part Kepler is the supreme and unrivalled example.

(2) A reviewer would be quite justified in declining to take Mr. Black's little book seriously. It is a dreary collection of petty calculations, made with 7-figure logarithms when 4-figure would have been ample and printed *in extenso*. As there is no clear and intelligible summary, it takes no little trouble to find out what is the precise object aimed at, or how successfully that object is attained. But the effect is to set up an empirical relation between the rotation periods of the planets and their masses and radii, which may be expressed by the formula (p. 56)

$$\frac{T_1}{T_2}=\left(\frac{R_2}{R_1}\right)^{\frac{1}{2}}\left(\frac{g_1}{g_2}\right)^{\frac{1}{3}}=\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}},$$

$g=M/R^2$ being the surface gravity; the corresponding suffix notation is not Mr. Black's. Now among the eight planets the rotation periods of four are practically unknown. Obviously, three assumed periods can be satisfied rigorously by a proper choice of the two exponents. Hence a consistent result for the Earth, Mars, and Jupiter, with a 20 per cent. error for Saturn, has nothing impressive about it. The author then goes on to complicate his formula further by introducing imaginary satellites skimming over the surface of imaginary planets, and the effect (p. 59) can be expressed in the form

$$\frac{T_1}{T_2}=\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}}\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{M_2R_1^3}{M_1R_2^3}\right)^{\frac{1}{18}}\left(\frac{M_1R_1^3}{M_2R_2^3}\right)^{\frac{1}{18}}=\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}}.$$

So the results are naturally the same. In fact, Mr. Black plays on himself a variant of the old game beginning "Think of a number" with a portentous elaboration which may amuse some readers. On p. 59 the Sun should be substituted for the first planet mentioned in the definitions of both M and *m*.

The foundation of a second essay rests on the approximate equality of the mass ratios

$$\frac{\text{Jupiter}}{\text{Mars}}=\frac{\text{Saturn}}{\text{Mercury}},\quad\frac{\text{Uranus}}{\text{Venus}}=\frac{\text{Neptune}}{\text{Earth}}.$$

Of course, the mass of Mercury is really unknown, but it is rather remarkable that Newcomb's masses for Uranus and Neptune only require an adjustment each within 2 per cent. to make the second relation exact. With this slender material the author again builds up elaborate arithmetical combinations and finds an evident delight in results which are nothing more than simple numerical verifications of the laws of proportion.

H. C. P.

THE DOMINION OF MAN.

The Outline of History: Being a Plain History of Life and Mankind. By H. G. Wells. With the editorial help of Mr. Ernest Barker, Sir H. H. Johnston, Sir E. Ray Lankester, and Prof. Gilbert Murray. To be completed in about twenty fortnightly parts. Part i. Pp. 32. (London: George Newnes, Ltd.) Price 1*s.* 2*d.* net.

IN this first part of his "Outline of History" Mr. H. G. Wells has surpassed the old author who carried the Trojan war back to Leda's eggs, for he begins with our solar system as a nebula condensing into sun and planets, and our earth as a mass of glowing matter. He tells how, in the course of cooling, an ocean gathered on its surface, on the margin of which the first structureless organic matter at last appeared, from which, in the course of ages, the earth's living tenants were developed. He describes in graphic terms not a few characteristic members in their succession, some of which are well depicted by Mr. J. F. Horrabin. Once or twice a phrase occurs to which we may demur: for instance, the nautilus is not a genus of ammonite; volcanic eruptions are more often a consequence than a cause of mountain upheaval; and we doubt whether the changes between the Mesozoic and the Kainozoic were so "catastrophic" as he implies. But these are trifles, and we find, after a discussion of the estimates of geological time, a good sketch of natural selection and the changes of species. As these changes in life depend not only on alterations in the world's physical geography, but also on its climate, the causes of the latter are briefly explained.

Next, Mr. Wells, after sketching the strange living tenants of the earth in ages when no creature with a backbone existed in sea or on land, brings before his readers the strange aspects of the earlier vertebrates, such as Pareiosaurus, which, low down as it is among the reptiles, seems as if striving to be a mammal. This leads to the "Age of Reptiles," which is illustrated by such huge forms as Brontosaurus and Diplodocus, Stegosaurus and Triceratops, which might be a first attempt at a Pachyderm, together with Megalosaurus, Tyrannosaurus, and Iguanodon, besides Plesiosaurus and Ichthyosaurus in the sea, with flying creatures like Pterodactyles and Archæopteryx, half bird, half lizard; and then dentigerous birds, which pass on to the Kainozoic, and end the present part of the work, which when completed will be a broad survey of the world throughout time.

Mr. Wells has undertaken a difficult task, and it is not too much to say that no other writer of the present day is so well equipped as he is to bring it to a successful completion. He possesses the rare combination of brilliant literary power with comprehensive and precise knowledge, and this distinctive quality makes his work one in which all intelligent readers will find profit and delight.

OUR BOOKSHELF.

Principles of Electric Spark Ignition in Internal-combustion Engines. By J. D. Morgan. Pp. vii+88. (London: Crosby Lockwood and Son, 1920.) Price 8*s*. 6*d*. net.

In the eighty or so pages of this little book Mr. Morgan gives the result of certain experiments by others and himself to determine the nature of electric spark ignition in internal-combustion engines. A wide circle of readers will feel grateful to the author for providing in this convenient form an account of the more important work along these lines, and for the reference which he provides to the sources from which information in fuller detail may be obtained. Mr. Morgan puts them still further in his debt by the lucidity with which he writes, and his manifest endeavour—almost always successful—to ensure that, even in the more intricate parts of the subject, his phraseology shall be free from the ambiguity which is so often the despair of readers of technical books.

Mr. Morgan explains most ingeniously and simply his view of the double nature of the spark, its important "capacity" component and the less valuable "inductance" oscillation. Experiment so far has failed to show any effect on the resultant gaseous explosion, or on the upper and lower limits of richness at which explosion will occur, of change in the size, temperature, energy, or other feature of the spark. Any one individual spark seems to be as good as any other, provided that explosion is caused; but the apparatus must be unfailing in the succession of sparks which it is designed to provide.

The book is one which should be in the hands of all who are interested in the scientific side of the design of internal-combustion engines in their many forms. That further work along these lines will cause spark gaps to be less sensitive than they now are to short circuiting caused by the inevitable gradual loss of insulation is greatly to be hoped.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Gravitation and Light.

Jupiter ought just to show the Einstein deflection, for if it pass between two stars a couple of diameters of the planet apart, their temporary relative displacement will be a "third" of arc, the sixtieth of a second; and this could be measured with a heliometer.

Oliver J. Lodge.

Mariemont, Edgbaston, December 6.

The Deflection of Light during a Solar Eclipse.

Prof. Anderson suggested in Nature of December 4 (p. 354) a possible source of systematic error in the determination of the deflection of light at an eclipse, owing to lateral refraction caused by a temperature-gradient in the shadow-cone in our atmosphere. Having carefully considered this suggestion, I feel convinced that the effects of any possible temperature-gradient would be small.

Taking the height of the atmosphere as 10 miles, the ray from a star 30′ from the sun's centre would traverse a distance of 150 yards in the direction perpendicular to the shadow-axis whilst passing through our atmosphere. Prof. Anderson estimates a temperature-drop of 1/18 of a degree as required to produce the observed deflection. Thus the lateral temperature-gradient must be 1° C. per $1\frac{1}{2}$ miles. The shadow moves over the earth at about 30 miles a minute, so that for a stationary observer the fall of temperature would have to be at the rate of 20° a minute to produce the observed effect.

In the case of a single surface of discontinuity, considered for simplicity by Prof. Anderson, the displacement by lateral refraction is inversely proportional to the distance from the sun's centre; but this law does not apply in the actual case of a continuous temperature-gradient.

It seems possible that the effect might amount to as much as 1/20 of the Einstein deflection in some cases, and possibly the rather high value found at Sobral has been increased by this cause. At Principe there was no perceptible change of temperature during the eclipse, but the climatic conditions there are exceptional.

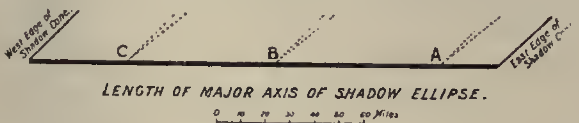
A. S. Eddington.

Observatory, Cambridge.

Prof. Anderson's letter in Nature of December 4 raises a point well worthy of consideration—that is, the possibility of abnormal refraction due to the lowering of temperature in the air by the passage of the shadow cone. I do not, however, think that more than a very small portion of the effect noted at Sobral could be explained in this way. The shadow ellipse was 194 miles long (direction of motion) and 137 miles broad. I have drawn a section in the former direction to scale, taking the height as 20 miles. It is certainly unnecessary to take it higher, as the temperature of the upper air is unaffected by the passage of the shadow.

Photographs were taken at Sobral at uniform intervals throughout totality, and all give tolerably accordant values of the shift.

But at the point A, near the beginning of totality, the left-hand ray, coming from a star about 1° west of the sun, would be travelling from a denser to a rarer medium; the right-hand ray, coming from a star 1° east of the sun, from a rarer to a denser medium. Hence both rays would be deflected towards the east, and the distance between the stars would be unaffected. The same thing would happen at C, the deflection of both being now to the west. It is only at the middle point B that the apparent distance could be altered, and here the temperature-gradient vanishes.



Moreover, at A and C there would be no temperature gradient (and therefore no optical shift) in the plane perpendicular to the plane of the diagram. But the measures showed equal shifts in all directions. In actual fact, the presence of much cloud must have made the temperature gradients irregular; the fall of temperature at Sobral during totality was very small, doubtless owing to the cloudiness before totality.

A. C. D. CROMMELIN.

Sex-Phenomena in the Common Limpet (*Patella vulgata*).

IN the course of investigations on the rate of growth and the age at which breeding begins the common limpet was examined, and the following interesting phenomena were observed:—A preliminary examination of batches of limpets of about 2 cm. long, and later still of smaller specimens, revealed the occurrence of a large proportion of males. The proportion of males was so high indeed as to give strong suspicions of a change of sex from male to female (*i.e.* protandric hermaphroditism), and a sample of about 1000 small ones less than 1 in. was therefore collected from cement piles between 3 ft. and 9 ft. above low-water springs at the Great Western Docks, Plymouth, and the sex examined and recorded. As the common limpet has no penis or uterus, it is necessary to examine the internal sex-organ (the gonad) to determine the sex. Of the 1102 limpets collected, 167 were rejected as being found by experience to be too small to show development of the internal sex-organ; these were mainly about 13 mm. long. Of the remainder, 169 (mostly about 14 mm.) showed no development of gonad on examination, 64 were females mostly about 2 cm. long, and the remaining 702 were males mostly about 15 mm. to 20 mm. long. These males probably comprise the bulk of the limpets in this sample in their first spawning year.

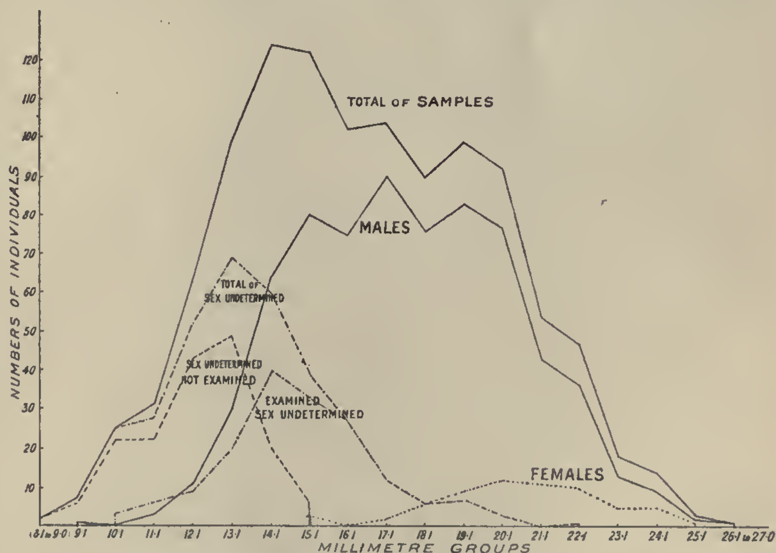


FIG. 1.—Length and sex analysis of a sample of 1102 young limpets under 1 in. in length collected at random at Plymouth, October 31, 1919.

This result confirmed the suspicion that all limpets might be born as males, and to determine whether they all change into females a sample of about 600 larger but medium-sized specimens from 3 cm. to 4·5 cm. was examined from the same locality. Of these 255 were males, 3 of indeterminate sex, and 334 females. These figures indicated sex-change, but were not sufficiently definite; hence a further sample of about 1000 very large limpets, from 5 cm. to 7·5 cm. in length, was obtained from Looe Island and examined, with the result that 693 were found to be females, 18 were of indeterminate sex, and 301 were males. Some of these latter males were very big, ranging up to 6·5 cm. in length; some males, therefore, may live several years before changing into females, if, indeed, these larger males ever change into females. At the same time as these very large limpets were collected a batch of tiny limpets was taken from the same locality and the sex examined. Of this sample of 1233 tiny limpets, 138 were rejected as being too small (*i.e. circa* 13 mm. and less), and of the remainder, all of which were examined, 944 were males (mainly from 16 mm. to 20 mm.); 113 showed no gonad developed, and were mostly small, about 15 mm. in length; and the remainder, only 38, were females, and mostly about 2 cm. long.

Amongst the 102 females recorded in the 2030 young examined, however, 4 were found of a size about 15 mm. long. The writer thinks that this small proportion of small females will be found to be dwarf females analogous to those described by Conklin[1] and by Orton[2] in the slipper limpets (*Crepidula fornicata* and other species). In this investigation so far length of shell has been taken as an indicator of age, and doubtless *on the average* length is a good indicator for a given locality. But the rate of growth is known to be variable from as yet unpublished work, and it is surmised that the smallest female limpets are two-year-old forms in which growth has been stunted, and that such specimens are therefore older than their size indicates. In this case it would appear that sex-change may occur any time after the first spawning season. One ready method of testing this view would be to obtain a large number of young limpets of known age, and this letter is written mainly with the view of obtaining information of any dock-walls, slips,

[1] "The Embryology of Crepidula." By E. G. Conklin. *Journal of Morphology*, vol. xiii., p. 12, 1897.

[2] "On the Occurrence of Protandric Hermaphroditism in *Crepidula fornicata*." By J. H. Orton. Proc. Roy. Soc., B, vol. lxxxi., p. 480 1909.

or other constructions in tidal waters built during the years 1918, 1919, or even 1917. As the examination for sex can be conducted with speed only during the breeding season, which may shortly end in some localities, it is hoped that anyone knowing of suitable constructions will inform the writer at the address given below.

Evidence of sex-change is apparently already available from Gemmill's observations,[3] made so long ago as 1896. Gemmill found that 3 specimens out of 250 examined by him were hermaphrodite. In the samples quoted above no definite hermaphrodite forms were found, but several were suspected and preserved for microscopic examination. These forms were, however, mainly male or female, and are recorded above tentatively as males and females respectively. Sex-change may be seasonal, as is indeed indicated by Russell's observations on the sex of the common limpet.[4]

The sex-phenomena in the common limpet closely resemble in most respects those found in the slipper limpet, where the small females and large males are accounted for, but in which all the tiny ones—some thousands of which have now been examined—have a penis. It is, however, not impossible, on the evidence available at the moment, that sexual dimorphism without sex-change may explain the phenomena in the common limpet, but this explanation does not seem probable. The observations on the sex of the common limpet cannot all be described here; they will be continued and completed and the results published in the Journal of the Marine Biological Association, Plymouth. Fig. 1 shows a length-sex analysis of the sample of small limpets under 1 in. in length collected at Plymouth. J. H. ORTON.

The Marine Biological Laboratory,
The Hoe, Plymouth.

A Tribute from Prague.

PERMIT me to congratulate you upon the jubilee issue of November 6, which has just reached me and has been received with great pleasure, for the last number of NATURE which reached me before this was that of July 30, 1914!

It may interest readers of NATURE to learn that from that date the Austrian Government prohibited for more than four years the circulation of anything printed in England as a punishment for the regard which, especially during the war, we have always had for your country, to which, with the other Allies, we owe our liberty. To the bodily sufferings of the war was added isolation from nearly the whole civilised world.

In a year's time I shall celebrate the fortieth anniversary of my introduction to NATURE, for while a student of Owens College, Manchester, I purchased in October, 1880, my first copy of the journal, and since that time I have been an ardent reader, contributor, and even Bohemian correspondent. The reading of NATURE's all-round scientific contents has been one of the greatest pleasures of my life in my leisure hours, and the richness of information which I have gathered from it cannot be expressed in better words than those of Dr. Deslandres in the jubilee number. I do not wonder that all attempts at founding a similar scientific and yet popular (in its best sense) journal in other European countries have invariably failed, for there a man of science is usually identical with a professor (a professional worker); and though I am one myself, yet I am of the opinion that the scientific character of NATURE is in no small measure due to the high type of British scientific amateur or student of science for its own sake, which I do not find equalled in any other country in the world.

Even we scientific workers in this remote part of Europe owe sincere thanks to Sir Norman Lockyer, who is a brilliant representative of the "non-professional" English man of science, for providing us with NATURE and conducting it so admirably for so many years. BOHUSLAV BRAUNER.

Chemical Laboratory, Bohemian University,
Prague, November 17.

[3] "On Some Cases of Hermaphroditism in the Limpet (Patella), with Observations regarding the Influence of Nutrition on Sex in the Limpet." By G. F. Gemmill. *Anat. Anzeiger*, xii., pp. 392–94, 1896.

[4] "On the Shell-growth of the Limpet (*Patella vulgata*)." By E. S. Russell. Proc. Zool. Soc., 1909 (1), p. 236.

EINSTEIN'S RELATIVITY THEORY OF GRAVITATION.[1]

II.—THE NATURE OF THE THEORY.

IN the first article an attempt was made to show the roads which led to Einstein's adventure of thought. On the physical side briefly it was this. Newton associated gravitation definitely with mass. Electromagnetic theory showed that the mass of a body is not a definite and invariable quantity inherent in matter alone. The energy of light and heat certainly has inertia. Is it, then, also susceptible to gravitation, and, if so, exactly in what manner? The very precise experiments of Eötvös rather indicated that the mass of a body, as indicated by its inertia, is the same as that which is affected by gravitation.

Also, how must the expression of Newton's law of gravitation be modified to meet the new view of mass? How, also, must the electromagnetic theory and the related pre-war relativity be adapted to allow of the effect of gravitation? With the relaxation of the stipulation that the velocity of light shall be constant, will the principle of relativity become more general and acceptable to the philosophic doctrine of relativity, or will it, on the other hand, become completely impossible?

One point arises immediately. The out-and-out relativist will not admit an absolute measure of acceleration any more than of velocity. The effect, however, of an accelerated motion is to produce an apparent change in gravitation; the measure of gravitation at any place must therefore be a relative quantity depending upon the choice which the observer makes as to the way in which he will measure velocities and accelerations. This is one of Einstein's fundamental points. It has been customary in expositions of mechanics to distinguish between so-called "centrifugal force" and "gravitational force." The former is said to be fictitious, being simply a manifestation of the desire of a body to travel uniformly in a straight line. On the other hand, gravitation has been called a real force because associated with a cause external to the body on which it acts.

Einstein asks us to consider the result of supposing that the distinction is not essential. This was his so-called "principle of equivalence." It led at once to the idea of a ray of light being deviated as it passes through a field of gravitational force. An observer near the surface of the

[1] The first article appeared in NATURE of December 4

earth notes objects falling away from him towards the earth. Ordinarily, he attributes this to the earth's attraction. If he falls with them, his sense of gravitation is lost. His watch ceases to press on the bottom of his pocket; his feet no longer press on his boots. To this falling observer there is no gravitation. If he had time to think or make observations of the propagation of light, according to the principle of equivalence he would now find nothing gravitational to disturb the rectilinear motion of light. In other words, a ray of light propagated horizontally would share in his vertical motion. To an observer not falling, and, therefore, cognisant of a gravitational field, the path of the ray would therefore be bending downward towards the earth.

The systematic working out of this idea requires, as has been remarked, considerable mathematics. All that can be attempted here is to give a faint indication of the line of attack, mainly by way of analogy.

It is no new discovery to speak of time as a fourth dimension. Every human mind has the power in some degree of looking upon a period of the history of the world as a whole. In doing this, little difference is made between intervals of time and intervals of space. The whole is laid out before him to comprehend in one glance. He can at the same time contemplate a succession of events in time, and the spatial relations of those events. He can, for instance, think simultaneously of the growth of the British Empire chronologically and territorially. He can, so to speak, draw a map, a four-dimensional map, incapable of being drawn on paper, but none the less a picture of a domain of events.

Let us pursue the map analogy in the familiar two-dimensional sense. Imagine that a map of some region of the globe is drawn on some material capable of extension and distortion without physical restriction save that of the preservation of its continuity. No matter what distortion takes place, a continuous line marking a sequence of places remains continuous, and the places remain in the same order along that line. The map ceases to be any good as a record of distance travelled, but it invariably records certain facts, as, for example, that a place called London is in a region called England, and that another place called Paris cannot be reached from London without crossing a region of water. But the common characteristic of maps of correctly recording the shape of any small area is lost.

The shortest path from any place on the earth's surface to any other place is along a great circle; on all the common maps, one series of great circles, the meridians, is mapped as a series of straight lines. It might seem at first sight that our extensible map might be so strained that all great circles on the earth's surface might be represented by straight lines. But, as a matter of fact, this is not so. We might represent the meridians and the great circles through a second diameter of the earth as two sets of straight lines, but then every other great circle would be represented as a curve.

The extension of this to four dimensions gives a fair idea of Einstein's basic conception. In a world free from gravitation we ordinarily conceive of free particles as being permanently at rest or moving uniformly in straight lines. We may imagine a four-dimensional map in which the history of such a particle is recorded as a straight line. If the particle is at rest, the straight line is parallel to the time axis; otherwise it is inclined to it. Now if this map be strained in any manner, the paths of particles are no longer represented as straight lines. Any person who accepts the strained map as a picture of the facts may interpret the bent paths as evidence of a "gravitational field," but this field can be explained right away as due to his particular representation, for the paths can all be made straight.

But our two-dimensional analogy shows that we may conceive of cases where no amount of straining will make all the lines that record the history of free particles simultaneously straight; pure mathematics can show the precise geometrical significance of this, and can write down expressions which may serve as a measure of the deviations that cannot be removed. The necessary calculus we owe to the genius of Riemann and Christoffel.

Einstein now identifies the presence of curvatures that cannot be smoothed out with the presence of matter. This means that the vanishing of certain mathematical expressions indicates the absence of matter. Thus he writes down the laws of the gravitational field in free space. On the other hand, if the expressions do not vanish, they must be equal to quantities characteristic of matter and its motion. These equalities form the expression of his law of gravitation at points where matter exists.

The reader will ask: What are the quantities which enter into these equations? To this only a very insufficient answer can here be given. If, in the four-dimensional map, two neighbouring points be taken, representing what may be called two neighbouring occurrences, the actual distance between them measured in the ordinary geometrical sense has no physical meaning. If the map be strained, it will be altered, and therefore to the relativist it represents something which is not in the external world of events apart from the observer's caprice of measurement. But Einstein assumes that there is a quantity depending on the relation of the points one to the other which is invariant—that is, independent of the particular map of events. Comparing one map with another, thinking of one being strained into the other, the relative positions of the two events are altered as the strain is altered. It is assumed that the strain at any point may be specified by a number of quantities (commonly denoted g_{rs}), and the invariable quantity is a function of these and of the relative positions of the points.

It is these quantities g which characterise the gravitational field and enter into the differential equations which constitute the new law of gravitation.

It is, of course, impossible to convey a precise impression of the mathematical basis of this theory in non-mathematical terms. But the main purpose of this article is to indicate its very general nature. It differs from many theories in that it is not devised to meet newly observed phenomena. It is put together to satisfy a mental craving and an obstinate philosophic questioning. It is essentially pure mathematics. The first impression on the problem being stated is that it is incapable of solution; the second of amazement that it has been carried through; and the third of surprise that it should suggest phenomena capable of experimental investigation. This last aspect and the confirmation of its anticipations will form the subject of the next article.

E. CUNNINGHAM.

LORD WALSINGHAM, F.R.S.

LORD WALSINGHAM, whose death from pleurisy took place on December 3, in his seventy-seventh year, was a man very highly esteemed in many circles, and in none more than in those devoted to the study of natural history. As an entomologist he was greatly distinguished, and the work and influence which he brought to bear in promoting the study of insects were widely known, and have borne much good fruit. His work was not of the type associated with the name of Fabre, the famous French observer, but he by no means neglected the study of the living insect, and was keenly interested in every problem on which entomology could help to throw light. He saw also its economic importance, and he had the wisdom to know how greatly its value in every direction depended upon the accurate identification of species, and how this in its turn depended upon good methods of classification and arrangement, and upon an exact and stable system of nomenclature. His own studies, and such influence as he could exert, were, in consequence, largely directed towards the fundamental work of naming and describing species, and improving the means that would lead to their more easy identification.

From an early age Lord Walsingham gave his time freely to a study of the Microlepidoptera, or small moths, and he lost no opportunity to add to his collection of these obscure but very important insects. He maintained his interest in them up to the last, and, a month or so before his death, he was to be seen still working at them in the Natural History Museum, to which his own very large collection, together with a valuable library of entomological works, had been transferred as a gift in the year 1910. He was elected a trustee of the British Museum in 1876, and a fellow of the Royal Society in 1887. As a trustee of the museum, more especially during the time when he was a member of the Standing Committee, he was always actively interested in its affairs, and it was doubtless due to his initiative that the entomological staff was increased, and entomology afterwards made into a separate department. He would like to have seen the staff still further increased, for he was greatly impressed with the necessity of having a large and competent staff to deal with the rapidly accumulating accessions of specimens.

Lord Walsingham was president of the Entomological Society in 1889–90, and in one of his addresses he pointed out that of the more than two million species of insects estimated to be living on the globe, less than a tithe had been named and described, and the vast majority were still altogether unknown. His entomological publications, beginning in the year 1867, were numerous, and always showed careful and accurate work. They appeared in the "Biologia Centrali-Americana," the "Fauna Hawaiensis," in catalogues of the British Museum, and in the transactions and proceedings of the Entomological, Zoological, and Linnean Societies, to each of which he belonged as a fellow; and also in the *Entomologists' Monthly Magazine*, of which he had been one of the co-editors, as well as in other scientific journals. Entomology, however, was not his only interest; ornithology and other branches of natural history shared in his attentions. He was a traveller and a keen sportsman, and in his time was noted as a great shot. He was a graceful and gifted speaker, and as a man of wide knowledge and good judgment was always listened to attentively at the scientific or other meetings in which he used so frequently to take a part. Although he might have made his mark in almost any sphere of life, Science has reason to be gratified that so great a part of his time and work had been devoted to her service.

NOTES.

THE Electricity (Supply) Bill was read a second time in the House of Lords on December 8.

THE council of the Royal Institute of Public Health has appointed Prof. Maurice Nicoll, of the Pasteur Institute, Paris, Harben lecturer for 1920.

WE regret to learn that Prof. A. Werner, professor of chemistry in Zurich University, Nobel prizeman for chemistry in 1913, and foreign member of the Chemical Society, died on November 15 at fifty-two years of age.

SIR RICHARD REDMAYNE, who has been Chief Inspector of Mines since 1908, will shortly resign his post. He proposes to devote himself in the future to the work of the Imperial Mineral Resources Bureau, of which he is the chairman, and to the practice of his profession as a consulting mining engineer.

THE late Dr. John Aitken bequeathed the sum of 1500*l*. to the Royal Society of Edinburgh for the purpose of publishing in book form a collection of his papers read before various societies. He also left to the Universities of Edinburgh and Glasgow any of his dust, colour, or other apparatus which they may wish to possess.

THE Elliot medal for 1918 of the U.S. National Academy of Sciences has been awarded to Mr. C. W. Beebe, of the New York Zoological Society, on the com pletion of the first volume of his work on "The Pheasants." The medal is awarded annually to the author of the leading publication of the year in zoology or palæontology. The first award was made for the year 1917 to Mr. F. M. Chapman for his volume, "The Distribution of Bird-life in Columbia," published by the American Museum of Natural History.

A conference of representatives of research organisations connected with the Scientific and Industrial Research Department will be held at the Institution of Civil Engineers, Westminster, to-morrow, December 12, at 2.30. Mr. A. J. Balfour, president of the Committee of the Privy Council for Scientific and Industrial Research, will preside, and will deliver an introductory address. A paper on "Research Associations and Consulting Work and the Collection and Indexing of Information" will be read by Mr. H. J. W. Bliss, and one on "The Equipment of Research Laboratories" by Dr. W. Lawrence Balls.

Before the war the Royal Institute of Public Health was accustomed to hold an annual congress, which was attended by well-known leaders engaged in the conduct of measures for the prevention and arrest of disease. In 1912 Berlin was the meeting-place; in the following year Paris welcomed the institute; and the last congress was held in Edinburgh in 1914. These annual meetings of the institute are now to be resumed. The president and council have received a renewed invitation from the Burgomaster of Brussels, M. Adolphe Max, on behalf of the city, and from the rectors of the University of Belgium, for the next congress to be held in Brussels. The dates have been fixed for Thursday, May 20, to Monday, May 24, 1920, inclusive. Delegates will, as usual, be invited from all the universities, municipalities, and other public bodies in due course, and full particulars will be issued at an early date. Meanwhile, all desirous of participating in the congress in the spring of next year should communicate with the Hon. Secretaries, the Royal Institute of Public Health, 37 Russell Square, London, W.C.1.

By the death of the Rev. E. S. Marshall at Offa's Dyke, near Chepstow, on November 25, the study of British plants has sustained a serious loss. For at least thirty-five years Mr. Marshall spent nearly all his leisure in excursions to almost every part of the British Isles, studying the flora *in situ* and collecting herbarium specimens. He was fortunate in meeting in early days such distinguished botanists as the late Rev. R. P. Murray, and his diligence and accuracy, aided by a retentive memory, eventually placed him in the front rank of field botanists. Mr. Marshall was an authority on Hieracia, and wrote the article on Betula in the second volume of "The Cambridge Flora." For very many years he spent his summer holidays in remote districts in Scotland, his work in this field winning him his recent election as honorary fellow of the Botanical Society of Edinburgh. Owing to the accident of residence Mr. Marshall was particularly conversant with the flora of the south-east of England and of Somerset. In 1899 he collaborated with Mr. F. C. Hanbury in publishing "The Flora of Kent," and in 1914 he wrote a copious Supplement to Murray's "Flora of Somerset," published in the Proceedings of the Somerset Archæological and Natural History Society. He will, however, be chiefly remembered for his almost unique general knowledge of the whole flora of the British Isles, which gave his identifications exceptional authority. Mr. Marshall contributed largely to the *Journal of Botany* and to other botanical works, and revised the tenth edition of the "London Catalogue" in 1908. He was a member of two exchange clubs, and carried on a voluminous correspondence. He bequeathed his fine herbarium to the University of Cambridge.

After serving as secretary of the Royal Horticultural Society for thirty-two years, the Rev. W. Wilks has felt himself compelled by advancing years to resign his office. It is in large measure due to Mr. Wilks's devotion, energy, and ability that the society has been brought to its present flourishing state. When he became secretary the society's finances were at a low ebb and its membership poor; now, thanks to his prudence and enthusiasm—a rare combination of gifts—the society is in a strong financial position, and its membership large and ever increasing. The development of the gardens at Wisley into a research station had his strong support, and, indeed, not the least of Mr. Wilks's titles to enduring memory is the strenuous help which he has given in effecting that *rapprochement* between scientific and practical horticulture which is undoubtedly destined to bring advantage to both. Mr. W. R. Dykes, who has been nominated by the council as Mr. Wilks's successor, is a keen and accomplished gardener, and the author of an admirable monograph on the genus Iris. It is pleasant to know that Mr. Wilks's long official association with the Royal Horticultural Society will continue, and that he will act with Mr. Chittenden, the director of Wisley, as joint author of the society's publications.

Under the auspices of the Staff Association, a highly successful scientific reunion—the last of the series for the current year—was held in the board room of the Natural History Museum on November 26, and was attended by nearly eighty members and visitors. The Director, Dr. S. F. Harmer, gave a short address, illustrated by lantern-slides, on "Antarctic Whaling," in which he described the enormous development of the industry in recent years and the methods employed, and discussed the danger of extinction that seems to threaten several of the species of whales, adding that the Government was alive to this danger, and was about to dispatch an expedition to investigate the question. A large number of exhibits were placed round the room. In the Haldane Report on the Machinery of Government it is stated that museums may be considered either as centres for diffusing information or as centres providing facilities for research. That the Natural History Museum fulfils the first of these two functions is familiar knowledge, but probably few even among scientific experts are aware what a great centre of research the museum has become. Visitors to these scientific reunions cannot fail to be impressed with the extreme importance and varied nature of the research carried on by the staff of the museum.

The *Contemporary Review* for December contains an article by Prof. Eddington on Einstein's theory of space and time, and the *Nineteenth Century* has secured an exposition of the matter from Sir Oliver Lodge. Clearly the former is interested in the theory, and the latter in the result predicted and confirmed by the Eclipse Expedition. Sir Oliver holds it dangerous to base such far-reaching conceptions as that of a "warped" space on a predicted effect which may be accounted for in simpler fashion, new and striking though that effect may be. Prof. Eddington, on the other hand, attacks directly our current confusions in regard to the meaning of space and time. Both writers are forced to confess the difficulty of translating Einstein's theory into simple language, Prof. Eddington affirming that the whole theory is a revolt against the simple language which here, as in so many regions, implies confused ideas. Apparently we are only at the beginning of a long controversy on the merits and demerits of Einstein's theory. The *Times Educational Supplement* seeks to give some material for its readers to form a judgment upon it; its correspondent, however, devotes the major portion of his exposition to Einstein's earlier theory, and touches only lightly upon the new work.

The Faraday Society, the Royal Microscopical Society, the Optical Society, and the Photomicrographic Society, in co-operation with the Optical Committee of the British Science Guild, meeting in joint session, will hold a symposium and general discussion on "The Microscope: Its Design, Construction, and Applications," on Wednesday, January 14 next. The meeting will be held in the rooms of the Royal Society, Burlington House, Piccadilly, W.1 (by kind permission of the president and council), and it will extend over two sessions—from 4.30 to 6.30 and from 8 to 10 p.m. During the afternoon preceding the meeting, from 2.30 to 4.30, an exhibition will be held in the library of the Royal Society, which will illustrate recent developments in the science of microscopy and the latest applications of the microscope in all branches of industry. The meeting will be presided over by Sir Robert Hadfield, president of the Faraday Society, who will deliver the opening address. Mr. J. E. Barnard, president of the Royal Microscopical Society, will then give a general survey of the subject, and he will be followed by Sir Herbert Jackson. Prof. F. C. Cheshire will speak on the mechanical design of microscopes, and a paper by Prof. A. E. Conrady on microscopical optics will be presented. Further particulars relating to the discussion may be obtained from Mr. F. S. Spiers, secretary, the Faraday Society, 10 Essex Street, London, W.C.2, or Mr. C. J. Lock, secretary, the Royal Microscopical Society, 20 Hanover Square, London, W.1.

Prof. Annibale Riccò, whose death in September last at the age of seventy-five we much regret to see announced, was born at Modena on September 15, 1844. In his early days Prof. Riccò took up engineering. He was present at the Meteorological Congress at Vienna in 1873, when he paid visits to several Austrian and German observatories. In 1877 he was appointed professor of physics at Modena, and shortly afterwards professor of physical technology at the Engineering School at Naples. Prof. Riccò took up astronomical work in 1879, becoming an assistant at Palermo Observatory. His work included observations of sun-spots and prominences, comets, and the planet Jupiter. In 1890 he was appointed director of the Observatory of Catania and Etna, which post he retained until his death. His special subject was solar physics. He undertook regular observations of sun-spots and prominences, and took part in several eclipse expeditions: to Russia in 1887, to Algeria in 1900, to Spain in 1905, and to the Crimea in 1914. On the last occasion he detected a new red band in the coronal spectrum, the principal line of which appeared to conform to a series discovered by Nicholson, having the cube roots of their wave-lengths in arithmetical progression. Work on sidereal astronomy, meteorology, seismology, and geodesy was also carried on under his direction. Prof. Riccò further undertook the laborious task of photographing one of the zones of the Astrographic Catalogue (north declination 54° to 44°). In spite of great financial difficulties, he published the catalogue of the first three hours of right ascension. His published papers are very numerous; a recent one directs attention to the advisability of correlating solar variations with meteorological phenomena, on the lines initiated by Prof. Abbot. Prof. Riccò was elected an associate of the Royal Astronomical Society in 1911, and last July he was chosen as one of the four vice-presidents of the new Union Astronomique Internationale.

In the October issue of *Man* Dr. J. W. Fewkes describes a remarkable carved wooden object from Santo Domingo, now in the collection of the Missouri Historical Society, St. Louis. It is a rude figure of a man found in a cave in that island. The ancient Antilleans are said to have lived in caves, where they performed their religious ceremonies, and the fact that this relic was discovered in a cave accounts for its good state of preservation. It so closely resembles a specimen in the British Museum, described in the Journal of the Royal Anthropological Institute (vol. xxxvii., 1907), that there is little doubt that it represents a Duko or seat used in some religious rite by the prehistoric people of the island.

The report of the Superintendent of the Archæological Survey of Burma for 1918–19 contains a discussion on the origin of the Shan alphabet. From this it appears that it is derived from the Tibetan rather than from the Burman or the Talaiqu alphabet, and its transmission is due to the close connection between Tibet and the ancient Shan kingdom of Nanchao. Mr. Duroiselle is now engaged on the systematic collection of materials for the early history of Burma. The epigraphical records cover a wide period, and these are now being interpreted. This is supplemented by evidence, not only from Burman chronicles, but also from Chinese works and accounts of the voyages of Arab, Persian, and Indian travellers. The pioneer in this work was Father Sangermano, but the fresh material now available will form a useful supplement to the information collected by him.

The Danish *Kommissionen for Havundersögelser* (Copenhagen: C. A. Reitzel, 1918) has published an exhaustive geographical and biological study of Randersfjord, a long inlet on the east coast of Denmark. The volume, which is entitled "Randers Fjords Naturhistorie," is edited by Dr. A. C. Johansen. It contains more than five hundred pages, and has numerous excellent maps and photographs. Among the eleven authors who have contributed to this fine work we note that the editor is responsible for the geology, archæology, and vertebrate zoology, Dr. J. P. Jacobsen for the hydrography, and Dr. C. H. Ostenfeld for a long section on the plants and general features of the vegetation. This section is particularly valuable, as the author has entered into the detailed relationship of the plant-life to its environment, and gives many fine photographic illustrations of different vegetation formations. Among the maps in the volume there is a layer-coloured orographical map of the whole district on a scale of 1 : 200,000.

The habits and economic relations of the guano birds of Peru form the subject of an able Report (No. 2298) by Mr. Robert E. Coker, issued by the United States National Museum. The hordes of penguins, cormorants, gannets, and pelicans which resort to the islands fringing the coast of Peru for breeding purposes are protected by the Peruvian Government for the sake of the vast quantities of guano they deposit. This, owing to the fact that rain never falls, retains its nitrogen, which would otherwise be converted into ammonia and lost by evaporation. The pages of the report are crowded with interesting observations on the habits of these birds, and it is to be hoped that immediate steps will be taken to protect certain species, which the author shows are in grave danger of speedy extermination. A diving petrel is one of these, the penguin another. The first-named is killed remorselessly for food, the other for the sake of its oil and feathers. As an example of what may be done by judicious protection, Mr. Coker quotes the case of the south island of the Chinchas, where the birds were left undisturbed for three years. At the end of that time 22,337 tons of guano were collected.

With the October issue the *Scottish Journal of Agriculture* completes its second volume. The contents are varied and interesting. The first article, "Problems of Animal-breeding," points out the essential factors and principles involved, and pleads for commercial utility as the real end in view. The second article, on "Aberdeen-Angus Cattle," is presumably the first of a series on "Scottish Pure-bred Livestock." Both serve as reminders that home-grown beef, as well as home-grown wheat, should find a place in any sound agricultural policy. The articles on "Rhizoctonia Disease, or Stem-rot, on Potatoes" and "*Nosema apis* in Hive-bees" are of the kind that bring home to the farmer the realisation of the way in which science can minister to his needs and solve many of the problems that puzzle and perplex him and cause him financial loss. "Agriculture in the Outer Hebrides" affords an interesting glimpse of the state of the industry in this remote and little-known "corner" of the British Isles. It is not altogether without significance to read that although the spraying of potatoes is a firmly established custom in parts of Lewis, yet the next advance recommended is the enclosing of the arable land, thereby bringing about a substantial increase in all crops and rendering proper rotations practicable. Other articles are "Oat-growing Experiments in Scotland," "Composition of Linseed Recovered from Home-grown Flax," "Scottish Farm Labour," "Woodlands and Woodland Industries in Relation to Small Holdings," and short notes on various subjects such as "Leaf-stripe of Barley," "Village Industries," "Agricultural Labour in Other Countries," and that ever-important and intricate problem "Farm Bookkeeping and Cost Accounting."

The difficulties appertaining to work done in order to ascertain the changes in chemical composition undergone by fruits during ripening and storage are enhanced by the fact that the fruit-juice may, and generally does, vary in composition with the method of extraction. In the *Biochemical Journal* for November Misses D. Haynes and H. M. Judd describe experiments made to ascertain whether the first runnings obtained from pressed apples after freezing are similar in composition to those obtained later. A uniform sample of apple-pulp was divided into two portions, one of which was immediately frozen in liquid air and pressed so soon as it had re-attained the laboratory temperature, whilst the other was left overnight in a freezing mixture and then treated in the same way. The chemical and physical properties of the two juices were almost identical, thus showing that no more chemical action takes place in the prolonged freezing of an ordinary freezing mixture than in liquid air. In another series of experiments the juice was expressed from apple-pulp in several fractions to ascertain whether the tissues after freezing are freely permeable to all those constituents of the cell-sap present in the expressed juice. It was found that the concentration of acids and sugars is the same in the first fraction as in the last, but the viscosity of the latter is greater than that of the former, indicating that the colloidal constituents of the sap are held back by the tissues. The authors find that the large fluctuations in the samples investigated cause the probable error to be very large, and they point out that neglect of sampling errors by previous estimations made by other workers detracts very seriously from the value of the results obtained.

Some notes on the use of the aeroplane in African exploration by Lieut. L. Walmsley in the *Geographical Journal* for November (vol. liv., No. 5) are valuable in giving the results of experience. Mr. Walmsley points out that "air-pockets" are normally encountered during the daytime in tropical Africa up to a height of about 6000 ft. As a result he had to do his aerial photography in East Africa in the morning and evening, when the light was not very favourable. Above 7000 ft., however, he thinks that operations could be carried out all day long. As regards the location of air-photographs on the map, Mr. Walmsley points out that two adjoining photographs should overlap, showing at least two objects in common. Owing to the absence of definite objects in hundreds of square miles of African landscape, the only satisfactory method is to operate along clearly marked geographical features, such as rivers, mountain ranges, and roads, so that each picture contains part of an easily recognisable feature. Mr. Walmsley made most successful photographic surveys in north-western Portuguese East Africa. He suggests the application of photographic survey to navigable estuaries, such as those of the Rufiji, Rovuma, or Zambezi. The shifting mud-banks can be seen distinctly at a height of 2000 ft.

Mr. P. R. Burchall gives an "Elementary Survey of the Present Position of Aerial Photogrammetry" in the *British Journal of Photography* for November 28. After giving many details, he concludes by stating that many thoughtless people imagine that aerial photographs are all that is required for map-making, while many surveyors rather disdain them. "Meanwhile, inventors are busy improving aircraft and photogrammetric apparatus, and mathematicians are busy working out and simplifying systems of correction." He prophesies that as soon as the cheapness and accuracy of the aerial photographic method have been demonstrated, it will be speedily recognised and appreciated.

The principal results obtained by Mr. H. J. Hodsman and Prof. Cobb in their tests of the expansions of refractory materials were described at the meeting of the Society of Glass Technology held at the University of Sheffield on November 10. On first firing, silica refractories are permanently expanded, while fireclay refractories are permanently contracted. On subsequent reheating both expand, and on cooling contract to their dimensions after firing. It is this type of reversible expansion which has been investigated for a number of materials between 15° C. and 1000° C. Kaolin, carborundum, alumina, alundum, and ball-clay expand at rates which are nearly constant throughout this range. Silica expands up to 500° C. at a rate slightly greater than that of kaolin, between 500° C. and 600° C. at a much greater rate, while between 600° C. and 1000° C. there is practically no expansion. At 1000° C. its total expansion is nearly equal to that of kaolin. A mixture of ganister and clay containing 80 per cent. of ganister expands like silica, while fireclay and pot-clay have expansion curves which lie between those of silica and kaolin, nearer to the former than to the latter.

The *Times Engineering Supplement* for November directs attention to the announcement that advantage is to be taken of the refitting of the White Star liner *Olympia* for mercantile service to equip her for the use of oil-fuel, and gives this fact in evidence of the growing favour with which oil-fuel is regarded by shipping interests. In view of the great advantages of oil-fuel, it is probable that only the cheapness of coal and the comparatively high price, and at times the uncertainty, of oil-fuel supplies have prevented the more rapid substitution of liquid for solid fuel on shipboard. The diminished output of coal, hampering bunkering regulations, and fears of labour troubles have caused shipping interests to give closer attention to the question of using oil-fuel under the boilers of steamships. One unsatisfactory feature of the situation is that the British shipowner is likely for a considerable time to come to be compelled to rely on foreign sources of supply. Many of the leading dock authorities, such as at Avonmouth, Belfast, Liverpool, etc., are taking steps to augment the facilities available for oil-fuel storage, and shipowners ought soon to be able to obtain supplies at all important home ports.

The following works are in preparation for appearance in the Drapers' Company Research Memoirs of the Biometric Laboratory Publications (*Cambridge University Press*):—In the Biometric Series: "Mathematical Contributions to the Theory of Evolution," xvii. "On Homotyposis in the Animal Kingdom": A Co-operative Study, and in "Studies in National Deterioration," "The Health of the School-Child in Relation to its Mental Characters," Prof. Karl Pearson. In the Memoir Series of the Eugenics Laboratory Publications, "The Influence of Parental Occupation and Home Conditions on the Physique of the Offspring," Ethel M. Elderton, is also in preparation for publication by the same firm. *Messrs. Longmans and Co.* have in the press "Diagnosing and Curing of Troubles in Electric Machinery," Prof. Miles Walker.

OUR ASTRONOMICAL COLUMN.

COMETS.—Prof. Crawford and Misses Fairfield and Cummings have deduced the following orbit of Finlay's comet (1919*d*) from observations on November 9, 12, and 15:—

T = 1919 Oct. 15·52 G.M.T.	log q = 0·0056
ω = 318° 15′	e = 0·7146
☊ = 46° 55′	Period = 6·688 years
i = 3° 23′	

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Dec. 9 ...	1 46 27	14 41	0·1046	9·5768
13 ...	2 2 24	16 26	0·1155	9·6198
17 ...	2 16 27	17 53	0·1267	9·6621
21 ...	2 29 42	19 6	0·1377	9·7025
25 ...	2 41 16	20 7	0·1486	9·7419
29 ...	2 52 45	21 0	0·1594	9·7796

It is of interest that three perihelion passages occurred within five days, viz. Finlay on October 15, Brorsen-Metcalf on October 16, and Schaumasse on October 20.

Another long-period comet, de Vico's of 1846, is expected within the next year or two.

WIRELESS TIME SIGNALS.—The *London Gazette* of November 21 gives an interesting list of the stations that now send out these signals. There are three in Europe, thirteen in North and Central America, four in South America, four in Asia and Japan, three in Africa and Mauritius, four in Australia and New Zealand, and three in the Pacific Ocean (Philippines and Honolulu). A ship with an equipment suited to the different systems used should be able to pick up her time in almost any part of the ocean; a comparatively small increase in the number of signal stations would make this absolutely the case. This is a development in navigational facilities that would have seemed incredible a few years ago.

LEEDS ASTRONOMICAL SOCIETY.—Vol. xxvi. of this society's Journal has lately been published under the editorship of Mr. C. T. Whitmell, and contains, as usual, much interesting matter. A paper on Nova Aquilæ by Mr. C. L. Brook may be specially noted. There are also descriptive papers on stellar subjects by the Rev. I. Carr-Gregg and Miss A. Grace Cook, and a very useful note on the limits of vision (1) in detecting an object, and (2) in defining its shape, by Dr. A. S. Percival. The occultation of 7 Aquarii by Venus, 1918 March 2, observed at Lick Observatory, and that of Cape (1900) No. 1524, 1918 April 11, well observed in Australia, were both predicted by Mr. A. Burnet, an energetic member of the society, now at the University Observatory, Oxford. It is noteworthy that he made these predictions while on military service in France.

THE JUBILEE OF "NATURE."

FURTHER OFFICIAL MESSAGES.

WE desire to express grateful acknowledgment of the many friendly references made to our jubilee issue by our contemporaries, and of messages of congratulation received from readers and contributors since those published in NATURE of November 13. It is a pleasant duty to print the following messages which have reached us from official representatives of several important scientific societies:—

November 1. ROYAL SOCIETY OF CANADA: *President, Prof. R. F. Ruttan.*—"It affords me great pleasure to offer you the sincere congratulations of the Royal Society of Canada on the completion of NATURE's half-century of service to the English-speaking world. During this period the journal has not only done much to create and maintain popular interest in natural science, it has also been a driving-power in the recent movement in favour of educational reform. We recognise in Canada that its widely quoted articles have been a strong factor in creating that background of public opinion so essential to ensure official support for scientific education and research. Permit me to add my best wishes for its continued success."

November 3. AMERICAN ACADEMY OF ARTS AND SCIENCES.—"The president and secretaries congratulate the Editor of NATURE on the jubilee of this admirable publication. During fifty years NATURE has upheld a high standard and effectively fostered scientific attainment. To-day the study of the mechanism of the universe is recognised by all thinking men as of exceedingly great importance both in peace and in war. The need was never greater that science—a bringer of increased power to humanity—should be guided by high-minded pilots in order that its great possibilities may be directed in beneficent channels. May the helpful and civilising mission of NATURE long continue!"

November 4. CALIFORNIA ACADEMY OF SCIENCES. *Director of Museum, Dr. B. W. Evermann.* "NATURE is a publication which has long held a large place in the reading and thought of the California Academy of Sciences. We depend upon it more than perhaps upon any other single publication for the scientific news and achievements of the world. The American publication *Science* is, of course, of great interest to us for American scientific news, but its field is rather limited, and in its presentation of valuable contributions to science it scarcely ranks with NATURE. Their fields, however, are in a sense quite different, and it is perhaps, therefore, not fair to compare them. It is a matter of very great satisfaction to be able to extend sincere congratulations to NATURE on the completion of its fiftieth year of extraordinarily useful service."

November 8. SOCIETÀ REALE DI NAPOLI: Accademia delle Scienze Fisiche e Matematiche: *Secretary, Senator G. De Lorenzo.*—"Although it is somewhat late, I am glad to express, on behalf of the academy, my sincere congratulations on the important scientific work which your esteemed journal has accomplished during its fifty years of existence, and trust it may have a prosperous future before it."

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION K.

BOTANY.

OPENING ADDRESS (ABRIDGED) BY SIR DANIEL MORRIS, K.C.M.G., M.A., D.Sc., D.C.L., LL.D., F.L.S., PRESIDENT OF THE SECTION.

IT has been made abundantly clear that in botany, as in other applied sciences, we must rely in future less on chance individual effort and initiative. We must co-operate our efforts and organise them at every stage, bearing in mind that we shall always require the services of the worker in pure science to solve those larger problems of national importance which confront us. We must be armed by science, or we shall be placed at a disadvantage in the great struggle now before us. We are told that it is absolutely necessary for the prosperity and safety of the country that the development of the resources of the Empire and the production of our industries must be on a scale greatly in excess of anything we have hitherto achieved. As an Imperial people it is our duty to develop our resources to the fullest extent. Fortunately, a great change is taking place in the attitude of the Government and the State towards science, and it is noticeable also in the relations of science to industry and commerce. Since we last met we have lost a number of devoted workers in botany. Apart from those who have passed away in what may be called the course of nature, a sad aspect of the losses sustained in the war is the death of so many brave young men for whom it was anticipated that a bright and successful career was open in the domain of science. Their names are inscribed on the Roll of Honour, and we gratefully bear them in memory.

From the point of view of the scientific exploration of the resources of the Empire, it is satisfactory to note that the publications dealing with the floras of tropical and sub-tropical countries have been continued. These, involving, as they do, so much labour and forethought, are of more than passing interest from the fact that they serve to reveal the distribution of plants that may eventually prove of great economic value. A close investigation of tropical plants is necessary, as allied species or varieties of one and the same species sometimes differ appreciably as regards their economic value.

A new branch of botany has lately come into prominence as one of the results of the devotion to Nature-study and the contemplation of the characteristic features of vegetation as we find it distributed over the earth's surface. Ecology is capable of enormously extending the outlook of botany, and it has so largely added to the interest of field work that we may wonder that the phenomenon of vegetation so long displayed before our eyes had not suggested its sociological aspects long ago. Ecology has its society and journal, and bids fair to establish itself fully in the household of botany. It is hoped that it will mitigate some of the admitted drawbacks of purely laboratory work and revive the old natural history spirit of former days.

The remarkable spread of a comparatively new marsh grass (*Spartina Townsendii*) along certain portions of the southern coast deserves careful study. It is supposed to be a hybrid between *S. stricta* and *S. alternifolia*. It is claimed to be pre-eminent among halophytes on account of the extraordinary vigour with which it spreads over mud-flats, and eventually forms meadows to be measured by thousands of acres in Southampton Water and Poole Harbour. It is a question whether it may not develop into a serious menace to navigable waters. On the other hand, it may prove capable of being utilised in suitable localities as a reclaiming agent. Its economic value in providing material for paper-making or as food for cattle may also receive attention.

The critical study of British plants was supposed to be an exhausted field, but with the necessary insight and careful and critical observation there is much work still to be done. Exchange clubs are active, and additions to local floras are continually being made. New species, varieties, and hybrids are published from time to time. As an instance, *Potamogeton upsaliensis*, hitherto only known in Sweden, has recently been found in East Dorset. Hybrid orchids are being keenly studied, and the occurrence of hybrids in this and other classes of plants opens a wide and interesting field of investigation.

A much desired piece of work is a continuance of Starkie Gardner's interesting investigation of the fossil flora of the Bagshot beds so well shown in the Bournemouth and adjoining cliffs. Some of these have proved exceptionally rich in remains of tropical and sub-tropical plants. So far, in regard to these plant remains, we may say with La Place: "What we know is but little; what we do not know is immense."

My distinguished predecessor, whose work has been largely concerned with the systematic and philosophical side of botany, rightly expressed the general desire for a more cordial understanding between botany and its economic applications. "It is certain," he said, "that our outlook must be widely different after the war, and the changed environment must find us ready to respond in the interest of our country and mankind."

With your permission, and acting on a suggestion made to me, I propose to travel a little outside the usual scope of previous addresses and review the many efforts that have been, and are still being, made to promote the interests not only of the homeland, but also of the Empire as a whole. Before the war it was estimated there were about 3,000,000 square miles of British territory within the tropical zone. A portion of this area, including India, was already producing commodities of the estimated value of 230,000,000*l.* sterling. It is, therefore, in the national interest to keep closely in touch with the conditions and prospects of our tropical Possessions in order that we may render them still more capable of supplying the raw material so necessary to the maintenance of our commercial prosperity.

In recent times one of the most important steps taken in this connection was the establishment, on the recommendation of a Royal Commission appointed by Mr. Joseph Chamberlain, of an Imperial Department of Agriculture in the West Indies. The provision for the upkeep of the Department, approved by Parliament, was at the rate of 17,400*l.* per annum.

When fully organised the Department made grants for teaching science at colleges and secondary schools, and for the maintenance of agricultural schools, botanic gardens, and experiment stations. Special attention was devoted to research work in raising new varieties of sugar-canes and other plants, to the investigation of diseases affecting crops, and to the general amelioration of the conditions under which they were grown. At the end of ten years of strenuous effort it was noticeable that, owing to the expansion and improvement of old industries and the introduction of new, the general conditions in the West Indies were greatly improved. This may be illustrated by the fact that the public revenue of the Colonies had increased from 2,546,724*l.* in 1894 to 3,914,434*l.* in 1911, while the total trade during the same period had increased from 16,270,474*l.* to 26,949,086*l.* There was thus an increase of 65 per cent. in the total revenue and of 60·5 per cent. in the total trade. In reviewing the situation in the West Indies, as the result of the activities of the Imperial Department of Agriculture and those associated with it, the late Prime Minister said: "The work of the Department was universally and gratefully acknowledged by the planters to be largely responsible for the improved state of affairs in all branches of agriculture, and he believed—and he spoke with some experience—it would be difficult to find a case in which any analogous experiment made by the Home Government had attained such speedy and satisfactory results."

A gratifying proof of the appreciation of the work of the Imperial Department of Agriculture in the West Indies was the formation of several Departments on similar lines, first at Pusa in India in 1902, and afterwards in all the tropical Colonies in the New and Old World. Further, twenty competent officers trained in the West Indies are now in charge of the Departments of Agriculture in Ceylon, Mauritius, the Federated Malay States, and Fiji, and on the staffs of the Imperial Department of Agriculture in India and the several Colonies in East and West Africa. Another interesting feature of West Indian progress was the wider appreciation of improved methods of cultivation and of the value of science by members of the planting community. For instance, in 1898 the aggregate amount voted by the local legislatures for staffs, laboratories, and botanic and experiment stations was at the rate of 14,000*l.* per annum. Apart from the funds of the Imperial Department of Agriculture, it is probable that, directly or indirectly, the total amount contributed locally for scientific services is now not less than 60,000*l.* per annum.

There can be no doubt that not only in the West Indies, but also in all parts of the Empire, "enlightenment as to the objects, methods, and conditions of scientific research is proceeding at a rapid rate." Perhaps the most interesting feature of the progress made is in connection with the application of the laws of heredity to the improvement of such highly important crops as sugar, wheat, and cotton. The problems associated with these involve both scientific and economic considerations. As regards the scientific side, it is fortunate that with the beginning of the twentieth century came the rediscovery of Mendel's facts and the stimulating energy of the genetic school which has brought us an entirely new point of view in regard to the increased production of field crops.

Great importance is attached to the improvement of the sugar-cane, as the prosperity of many of our Possessions depends upon it. Further, the requirements of this country approach something like 2,000,000 tons per annum. The sugar-cane, although its origin is unknown, has been cultivated in tropical and sub-tropical countries from remote ages. Up to a recent date its propagation was purely vegetative, as it was supposed to have lost the power of producing mature seed.

Sugar-cane seedlings were observed at Barbados in 1858, but it was only in 1888 that Bovell and Harrison were in a position to utilise the discovery and obtain thousands of self-sown seedlings for experimental purposes. Similar seedlings were also available in Java about the same time. As about this period the standard canes in sugar-growing countries were showing signs of being severely attacked by disease, the discovery of seedlings was a fortunate circumstance. In fact, in some cases it may be regarded as having probably saved the industry. In British Guiana it is reported that in the crop of 1918 seedling canes occupied 83 per cent. of the total areas under canes. Similar results have been obtained at Barbados, where Bovell has continued since 1888 in raising canes of great merit.

In India there is probably a larger area under sugar-cane than in any other country. Its production of sugar is more than 2,000,000 tons. The larger proportion of this consists of a low-grade quality known as jaggery or "gur." Palm-sugar is also produced to the extent of 500,000 tons. Speaking generally, the sugar industry in India is not in a satisfactory condition. In spite of the enormous area under cultivation, India is obliged to increase its considerable imports of sugar from Java and other countries. To obviate this, urgent steps are being taken to improve the character of the canes and establish varieties adapted to local conditions and the circumstances of the sugar-growers.

In the considerable literature of sugar-cane breeding in India Barber has brought together a vast amount of information of singular interest and value. In the few years that have elapsed since he has been in charge of the Coimbatore Research Station he has laid the foundation of lines of inquiry that cannot fail to prove of great value in the permanent improvement of the sugar industry in India.

In his presidential address in 1898 Sir William Crookes stated that the prime factor in wheat production was a sufficient supply of nitrogen. As the supply was then showing signs of exhaustion, he warned wheat-growers of the peril awaiting them. Sir R. H. Rew has now shown that, thanks to the chemist, who came to the rescue, there is practically no limit to the resources of nitrogen. During recent years Biffen, by his successful investigations on Mendelian lines at the Plant-Breeding Institute at Cambridge, has shown that the characteristics distinguishing the numerous wheats can be traced, and the building up of a fresh combination of these characters was possible on practical lines. As the losses caused by disease were so serious, sometimes running to millions of quarters annually, Biffen devoted special attention to the possibility of breeding rust-resisting varieties. He found that the power of resisting the attacks of yellow rust, for instance, was an inheritable character. By crossing Gurka, a Russian disease-resisting wheat, with Square Head's Master, one of the most widely cultivated wheats in this country, Biffen eventually produced Little Joss, which, after trials extending over a period of several years, is said to yield four bushels per acre more than any other variety. Further, it possesses distinct disease-resisting qualities.

Another of Biffen's new wheats is Yeoman. This was raised in order to produce what are known as strong wheats. These are in great demand in this country, as they produce a flour which is much superior for baking purposes to the flour of English wheat. In pre-war days Canadian strong wheats commanded in the market 5*s.* more per quarter than the best English wheat. Yeoman not only possesses the superior quality of Canadian wheat, but combines with it the high-yielding character of certain English wheats.

A well-authenticated report, supplemented with full details, of the value of Yeoman as a field crop was lately published (*Journ. Bd. Agric.*, vol. xxv., 1161). It was cultivated under normal conditions, but without artificial manure, on three fields on a large farm near Wye, Kent. The cropped area was a little more than twenty-seven acres. The total yield was 2072 bushels, or an average of about seventy-seven bushels per acre. One field, previously under beet, comprising three acres two rods and eight poles, yielded 340 bushels, or an average of eighty-six bushels per acre. These results may be compared with thirty-two bushels, the average yield of wheat in this country.

A most desirable improvement in wheat-growing in this country is to obtain a spring wheat combining early maturity with a yield approaching that of winter wheat. The establishment of a National Institute of Agricultural Botany for the further development of plant-breeding and the distribution of pure seed may be regarded as essential to the welfare and safety of the nation.

Wheat-growing is a very important industry in India. It was estimated in 1906–7 that 29,000,000 acres were under cultivation in wheat with a yield of nearly 9,000,000 tons. Of this 90 per cent. was consumed in India. A botanical survey of the Indian wheats was undertaken by the economic botanists at the Imperial Research Institute at Pusa in 1910. In the following years, by the application of modern methods of selection and hybridisation, high-grain qualities were successfully combined with high-yielding power, rust resistance, and stiff straw, so that wheats were produced which gave upwards of forty-one bushels per acre.

Among the best of the new varieties are Pusa 4 and Pusa 12. Owing to an organised system of distribution of seed, it is estimated that the area under Pusa 12 during the last wheat season (1918–19) was about 400,000 acres. The area under Pusa 4 was about 100,000 acres.

The important work carried on at Pusa by Howard and his accomplished wife has followed closely on the methods found so successful at Cambridge. It is interesting to note that in obtaining new kinds by hybridisation between Indian wheats and rust-resisting forms in Northern Europe a difficulty in regard to flowering at different periods was overcome by sending the Indian parents to Cambridge for spring sowing and by carrying out the actual crossing with Biffen's new hybrids in England. From the crosses thus obtained Howard reports that a wide range of wheats has been evolved likely to prove superior to Pusa 4 and Pusa 12.

The admirable work done by Biffen at Cambridge and the Howards in India clearly demonstrates the value of thorough acquaintance with pure botany as a qualification for grappling with questions of economic importance.

In reviewing the gain to Indian wheat-growers the director of the Agricultural Research Institute has recently stated that, in view of the favour with which the new wheats have been received and the cordial co-operation of provincial organisations, "it is a modest estimate to assume that in the course of a very few years the area under Pusa wheats will reach 5,000,000 acres. This means an increase in the near future in the value of the agricultural produce of India, in one crop only, of 75 lakhs of rupees or 5,000,000*l*. sterling." Another crop that has received attention is indigo. In regard to this a new method of growing the seed has been worked out, and the cause of the destructive wilt disease has been traced to the destruction of the fine roots and nodules during the monsoon rains. The remedy in this case is the selection of surface-rooted plants which are now in course of being generally grown.

As in wheat, so in cotton, this country is almost entirely dependent on foreign supplies. The uneasiness caused by the excessive dependence of the great Lancashire cotton industry, with exports of the annual value of more than 100,000,000*l*. sterling, on supplies from abroad, and the occasional shortage, have led to general action being taken to encourage the more extensive growth of cotton within the Empire. Next to the United States, which in some years has supplied seven-tenths of our imports, India comes second, but the East Indian cotton is not well suited to the requirements of the English spinner. Egypt, as the third producing country, supplies cotton of great strength and fineness.

The most valuable of all cottons is that known as Sea Island cotton, owing to its introduction and successful cultivation on the coastal areas in South Carolina, Georgia, and Florida. It is interesting to report that in recent years Sea Island cotton has been introduced back again to the West Indies, which was probably its original home. This was effected by the Imperial Department of Agriculture in the West Indies in 1902, when a pure strain of seed raised from plants immune to wilt disease was obtained in quantity from James Island. This ensured that the industry from the first was placed on a firm basis, and with the hearty co-operation of the planters an important West Indian cotton industry was successfully established. For some years the West Indian cotton has obtained a higher price than the corresponding grades of cotton from the Sea Islands themselves. The fine spinners in Lancashire are now practically independent for their supplies of this cotton from the United States. Further, it is not improbable that, owing to the serious attacks of the Mexican boll weevil on cotton plants in South Carolina and Georgia, the West Indies may become the only source of supply of fine Sea Island cotton. The results so far attained may be realised from the fact that the value of the exports of Sea Island cotton from the West Indies in recent years has reached a total of 2,000,000*l*. sterling. The general conditions in the West Indian islands, owing to their small size and comparative isolation, should enable them to maintain a high purity of cotton. Harland, whose services in the West Indies have been provided by a grant from the Imperial Department of Scientific and Industrial Research, has in hand important investigations with the view of placing the work of cotton selection and breeding on scientific lines. He has shown that the yield of lint per acre depends on a number of factors of a morphological and physiological character. In a general way it may be said that the yield is dependent on the climatic conditions, so an effort is being made to produce varieties which will interact with the environmental conditions to the best advantage. Although Harland's work so far is of a preliminary character, he is able to suggest the conclusion that, following certain lines of selection and breeding, and bearing in mind the relative importance of lint index and lint percentage, it is possible to isolate a strain of Sea Island cotton with a weight of lint per boll 31 per cent. greater than that of the ordinary sorts in cultivation.

As already mentioned, India is the second largest producer of cotton. In 1906–7 it was estimated that there were about 20,000,000 acres under cotton, with a production of nearly 5,000,000 bales. It is unfortunate that the quality of East Indian cotton is not high, in spite of the considerable efforts made in recent years to improve it.

Leake's research work in the United Provinces, carried on for many years, is regarded as probably the most complete yet attempted with cotton in India. A variety known as K.22 has been widely distributed, and the produce in 1916 sold at 31 rupees per maund when local cotton was 25 rupees. Further, the ginning percentage has been raised from 33 to about 40, while the lint is of superior quality.

Leake has also been successful in raising an early-flowering form of cotton on Mendelian lines. The new form differed from ordinary cotton cultivated in the United Provinces in that it assumed a sympodial instead of a monopodial habit. It not only yielded cotton of high quality, but was found by its early-flowering habit to suit the special conditions of the United Provinces.

As Egyptian cotton comes next to Sea Island cotton in quality, it may be useful to refer to what has been done, or attempted to be done, on scientific lines to safeguard the industry. Its importance may be gathered from the fact that the area under cultivation is between 1,500,000 and 2,000,000 acres. Balls has fully reviewed the scientific and other problems that had to be solved in placing the industry on a satisfactory footing. According to Balls, the high-water mark of Egyptian cotton-growing was from 1895 to 1899. Since that time, although the actual area under cotton has been increased by 600,000 acres, the benefit measured in terms of cotton alone has been small. It is probable that the attacks of the pink boll-worm and other pests may have affected the results, but Balls and his colleagues drew the conclusion that "the falling off in yield was due to a rise in the level of the subsoil water or water-table of the country brought about by the extension of the irrigation system during the past decade." The roots of the cotton plant were thus adversely affected at a critical period of growth. This recalls what Howard discovered: that one of the causes of the wilt disease in indigo in India was the destruction of the fine roots and nodules during heavy monsoon rains.

Probably the most remarkable instance on record of the successful combination of science and enterprise in the tropics is the establishment of a cacao-growing industry in the Colony of the Gold Coast, West Africa. Thirty years ago no cacao of any kind was produced on the coast. Owing, however, to the foresight of the then Governor (Sir William Brandford Griffith), who sought the powerful aid of Kew, cacao-growing was started in a small way among the negro peasantry, with eventually extraordinary results. After selecting the locality for the experiments, seeds and plants were obtained through Kew, and a trained man was placed in charge (*Kew Bull.*, 1891, p. 169; 1895, p. 11). The first exports in 1891 amounted to a value of 4*l.* only. So rapid was the development of the industry that ten years later the exports reached a value of 43,000*l.* By this time both the people and the Government had begun to realise the possibilities of the situation, and systematic steps were taken to organise under scientific control a staff of travelling agricultural instructors to advise and assist the cultivators in dealing with fungoid and insect pests and improving the quality of the produce. In 1911 the exports had increased nearly fourfold and reached a total value of 1,613,000*l.*, while in 1916 what may possibly be regarded as the maximum exports were of the value of 3,847,720*l.*

It should be borne in mind that this Gold Coast cacao industry, now one of the largest in the world, has been called into being and developed entirely by the agency of unskilled negro labour, and on small plots from one to five or ten acres in extent. The controlling factors were, first, the selection of suitable land for cacao-growing; next, the selection and supply of seeds and plants of varieties adapted to local conditions; and, lastly, the advice and assistance of trained Europeans backed by the resources of science.

Coming nearer home, Henry, well known from his association with Elwes in the production of "The Trees of Great Britain and Ireland," by historical research and experiment has established the fact that many fast-growing trees in cultivation, such as the Lucombe Oak, Common Lime, Cricket-bat Willow, Black Italian Poplar, Huntingdon Elm, etc., are natural hybrids. It was of high scientific importance to discover the origin of these valuable trees. Further, by artificial pollination Henry has succeeded in raising new hybrids which display the extraordinary vigour characteristic of the first-generation cross. Perhaps the most notable so far is a new hybrid poplar (*Populus generosa*), which makes the strongest shoots of all poplars. It is claimed in the case of hybrid trees that "it is possible to produce much greater bulk of timber in a given time." The common belief that quickly grown timbers are of inferior quality is said not to hold good in respect of any quality in ash, oak, and walnut. In fact, according to Dawson, "with oak, ash, and walnut the quicker their growth the better their quality in every way. They are more durable, more elastic, and less difficult to work" ("Science and the Nation," p. 138). It is further claimed that by hybridising it may be possible to produce disease-resisting varieties and varieties carrying with them other desirable characteristics.

In the tropics breeding experiments in the case of india-rubber trees are likely to prove of great value. In the meantime, selection of seed from the best trees is being carefully carried out in the hope of increasing the general yield of the plantations. In Java the proportion of alkaloids in the bark of introduced cinchona trees (yielding quinine) has nearly doubled by careful selection on these lines.

Plant-breeding experiments with india-rubber trees have already been attempted, but they are not likely to be of much value if they are confined to empirical and haphazard lines. Work of this kind must be lengthy and complex, but it is absolutely essential to ensure the safety of an industry which is estimated to be of the annual value in the Middle East of about 50,000,000*l.* sterling. The Agricultural Department in Ceylon, which is fully alive to the fundamental importance of the selection and breeding of india-rubber trees, has already taken some action in the matter.

Another investigation in hand is to determine whether the latex-yielding quality of Hevea trees can be associated with any definite botanical characters and to what extent such characters are transmissible. Twenty trees of the same age growing in a four-acre block have been selected for differences in leaf and bark characters. These are all tapped on the same system, and the yield of rubber from each tree is recorded separately for each tapping (*Kew Bulletin*, 1917, p. 118).

The value of these and other experiments of a like nature may be realised when, according to Varnet, quoted by Johnson, the yield of rubber from different trees of Hevea growing under similar conditions in the same plantation may vary as regards volume of latex from 4 to 48, and in percentage of weight of dry rubber from 1·286 to 14·164 (*Journ. d'Agric. Tropicale*, 1907).

Bateson a few years ago expressed the opinion that nowhere is the need for wide views of our problems more evident than in the study of plant diseases. Biffen and others have shown that under certain conditions the quality inherent in some varieties to resist disease may be utilised to great advantage. The national importance of such work is impressed upon us by the enormous losses sustained every year by rust in wheat, mould in hops, and the widespread disease of potatoes. One of the most striking instances in recent times was the destruction of the valuable coffee plantations in Ceylon. The industry, an exceptionally valuable one, was wiped out in a comparatively few years by the coffee-leaf disease (*Hemileia vastatrix*). In the light of our present knowledge it is not improbable that this disease may have been checked by seed selection or by raising an immune race of plants; or, more probably, as suggested by Armstrong, by regulating the use of essentially nitrogenous manures, which are known in some cases to intensify the attacks of fungoid pests, and substituting the use of phosphates. As illustrating the occurrence of an incidental result arising from a purely scientific investigation, mention may be made of the discovery of a remarkably tall strain of flax at the John Innes Institution. This, if capable of being established on pure lines, may prove of economic value. It is a hopeful sign that the appreciation of the work done at this institution, under the stimulating energy of Bateson, is increasing day by day. We may mention the great success which is attending the establishment of a school of technical education and research by the Royal Horticultural Society at Wisley. This is maintained by liberal funds, and by means of its well-equipped laboratories and extensive trial grounds it offers unique facilities for solving problems of great value as affecting the future of British horticulture. In sympathy with the work at Wisley, private firms are also setting up laboratories of their own and employing men of high standing so that a just balance may be maintained between science and practice. The progress made in the elucidation of problems in tropical plant pathology shows the necessity not only for well-trained and experienced mycologists and entomologists, but also for the correlation and combination of knowledge gained in their several lines of study. It is suggested that research work should be organised on the broadest possible lines, and combine the biological services of the whole Empire. We have a first step in this direction in the Imperial Bureau of Entomology, with its headquarters at the British Museum. Those acquainted with the efficient work done by this bureau and the excellent publications issued by it will very heartily welcome the establishment of the proposed Imperial Bureau of Mycology to carry on work on similar lines.

In this brief review I have endeavoured, however imperfectly, to place on record some of the activities that have taken place in the domain of botany in recent years. It has only been possible to select a few of the most striking incidents where progress has been made. This has been done in the hope of arousing wider interest in work of prime importance as affecting the interests of the home country and the Empire. Botany in its widest aspects affects so largely the welfare of the human race that it is impossible to slacken our efforts. Advance has necessarily been slow, but the creative impulse of science cannot fail to bring in a large harvest of results. This may be possible by encouraging individual efforts, by organising active co-operation, and by associating with us men who are practically grappling with difficulties that seem almost impossible to solve. I have attempted to show in what vast fields of enterprise botanical science has already rendered signal service. As regards the future, if we enlist the best intellects, imbued with the true spirit of progressive research, we shall ensure a continuance of discoveries that have proved so effectual. We must also call to our assistance some of that wonderful energy developed during the war and divert it to the great work before us.

Certainly one of the outstanding features that emerge from a record of botanical research during the last decade or two is the prominent position now occupied by plant-breeding on Mendelian lines. In proof of this we have the numerous well-equipped plant-breeding institutes established and maintained by Government and private funds. Plant-breeding is now in the forefront in relation to the improvement of crops, and the value of it is officially acknowledged as "a vital element in the national policy." According to the Secretary of the Board of Agriculture, what we want "are new races of plants adapted to intensive cultivation," and he adds: "It is my deliberate opinion that an increase in the production of our land is much more easily attainable in that direction than in any other."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—On Tuesday, December 2, in the hall of Trinity College, a lecture open to the University was given by Prof. Eddington on the theory of relativity. Apart from the interest of the lecture, which attempted—sometimes lightly and sometimes almost dramatically—to present a popular account of the subject, the most striking thing about it was the enormous attendance. Fifteen minutes before the lecture began there was a queue half-way across the Great Court of men anxious to obtain admittance, and during the lecture the hall was entirely filled with dons and students listening breathlessly to hear an intelligible account, if one could be given, of the new theory. The keen interest was due, no doubt, largely to curiosity stimulated by the newspaper accounts of the subject, but also partly to the feeling, to which at last some hope of satisfaction can be given, that a further great unifying principle is needed in natural philosophy. Whatever be the reason, however, the size and appreciation of the audience were no less extraordinary than the subject of the lecture and the brilliance of its exposition.

Mrs. Osborn, the wife of the president of the American Museum of Natural History, has presented a striking portrait of her husband to the Sedgwick Museum. It is proposed to hang this portrait of an old student of Cambridge and an honorary doctor of science of the University amongst the fossil mammals, which have been the subject of his life's work, near the portraits of Darwin and Huxley. The portrait, which is recognised by friends in Cambridge as a remarkably good likeness, is inscribed as follows:—"Henry Fairfield Osborn, LL.D., Sc.D. Camb., a student at Cambridge in 1879, contributor to Comparative Anatomy, Palæontology, Biology, President of the American Museum of Natural History. By Orlando Rouland, New York, 1919."

LIVERPOOL.—The council has appointed Prof. E. R. Dewsnup, professor of railway administration in the University of Illinois, to the chair of commerce, recently endowed by the trustees of the late Mrs. A. W. Chaddock.

MR. A. CONNELL has been appointed to succeed Prof. S. White in the professorship of surgery in the University of Sheffield.

CAPT. L. L. BURCHNALL, scholar of Christ Church, Oxford, has been appointed lecturer in mathematics in the University of Durham.

DR. J. CRUICKSHANK, pathologist to the Crichton Royal Institution, Dumfries, has been appointed

Georgina McRobert lecturer in pathology in the University of Aberdeen.

THE College Board of the London Hospital is offering the Liddle triennial prize (value 120*l.*) for an essay on "The Etiology of Epidemic Influenza." The competing essays must reach the Dean of the London Hospital Medical College on or before June 30 next.

THE New York correspondent of the *Times* announces that by the will of the late Henry Clay Frick all his estate, estimated at 29,000,000*l.*, except 5,000,000*l.*, is bequeathed to public educational and philanthropic objects. The benefactions include the following:—Princeton University, 3,000,000*l.*; Harvard University, 1,000,000*l.*; and Massachusetts Institute of Technology, 1,000,000*l.*

THE council of the Institution of Naval Architects offers for competition a scholarship (value 100*l.* per annum for three years) to be awarded on the results of the Board of Education examinations in naval architecture and other subjects. Candidates must be between eighteen and twenty-one years of age. Full particulars and application forms are obtainable from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2. Entries will close on January 15, 1920.

THE annual meeting of the Mathematical Association will be held at the London Day Training College, Southampton Row, London, W.C.1, on January 7 and 8, 1920. The address of the president, Prof. E. T. Whittaker, will be on "Some Mathematical Problems Awaiting Solution"; and the papers to be presented are: "A Survey of the Numerical Methods for Solving Equations," the president; "The Use of Symmetry in the Teaching of Geometry," C. Godfrey; "Convention and Duplexity in Elementary Mathematics," Prof. E. H. Neville; "The Place of Common Logarithms in Mathematical Training," Miss H. M. Cook; and "The Teaching of Mechanics to Beginners," Mr. R. C. Fawdry.

AN interesting departure in commercial scientific education has been inaugurated by the directors of the Anglo-Mexican Petroleum Co., who have invited Mr. C. R. Darling, lecturer in physics at Finsbury Technical College, to deliver a course of ten lectures to the senior staff on the commercial applications of physics. These lectures are intended to form a broad basis of information which will lead to a fuller appreciation of the specialised lectures to be given by experts connected with the firm. A lecture-room has been provided on the company's premises at 16 Finsbury Circus, and has been equipped with facilities for experimental illustrations. This recognition of the value of science in commerce is a hopeful sign of the times, and an educational scheme of this character cannot fail to lead to increased efficiency in the staff of an industrial firm.

A SPECIAL committee of the Anglo-American Society suggested in the programme for the tercentenary celebration of the *Mayflower* and the Pilgrim Fathers (1620–1920) the foundation and endowment of a chair in American history, literature, and institutions. The sum of 20,000*l.* was required for the endowment of this chair, and this has now been provided by Sir George Watson. It is not proposed that the chair should be exclusively attached to one university, but that it shall be used for the general purpose of stimulating interest and study of America in all the British universities. Neither will the chair be held permanently by one scholar of a single nationality. The scheme provides that it shall be held, for a period of one or two years, alternately by an American and a British scholar or public man, thus drawing upon the best intellectual resources of the two countries, and securing a variety of treatment of the subjects dealt with. The committee points out that as a permanent memorial of America's loyal partnership with Great Britain in the war, as well as of the historic ties of kinship which unite the two peoples and of which the *Mayflower* celebration is a reminder, nothing could be more fitting than the establishment of this educational foundation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Anthropological Institute, October 14.—Sir Everard im Thurn, president, in the chair.—Lieut. E. W. P. **Chinnery**: "Dengora baiari" is the ceremony of initiation of young men and women of the Binandere tribe, Memba River, British New Guinea. Pigs are killed, and each candidate stands on the pig contributed by his parents and receives a loin-cloth, *gonga*, various ornaments, and instruction in social conduct. Dramatic plays of a special instructional character, *iaveto*, are performed by the village people and visitors. Ancestral ghosts are said to reside during these ceremonies in the posts, *gusi*, of the men's house, *oro*, and in the *jijima*, properties of the *iaveto*. The *gusi* during such time are said to be *kotembo-kotembo*, but their connection with the dead ends with the completion of the ceremony. Some time afterwards the *jijima* are smeared with pig-grease, decorated with feathers, cast into the river, and implored in the names of deceased ancestors to change into crocodiles and devour the enemies of the tribe. After "dengora baiari" follows a period of seclusion in a house known as *wawa*; this condition, *iawa da vitari*, is removed after some months by a purification ceremony known as *tuna*. The candidates then bathe in the river and enter the normal life of the tribe.

Zoological Society, November 18.—Prof. E. W. MacBride, vice-president, in the chair.—Major J. S. **Hamilton**: Field-notes on some mammals in the Bahr el Gebel, Southern Sudan.—Prof. J. F. **Gemmill**: (1) The development of the mesenteries in *Urticina crassicornis* (Actinozoa), and (2) the Leptomedusan *Melicertidium octocostatum*.—Rev. A. H. **Cooke**: The radula of the Mitridæ.—Dr. C. F. **Sonntag**: The variations in the digastric muscle of the Rhesus macaque and the common macaque.—E. S. **Russell**: The righting reaction in *Asterina gibbosa*, Penn.—Lt.-Col. S. M. **Copeman**: Experiments on sex determination.—M. **Turner**: The Nematode parasites of a Chapman's zebra.

Geological Society, November 19.—Mr. G. W. Lamplugh, president, in the chair.—Prof. J. E. **Marr**: The Pleistocene deposits around Cambridge. This paper deals with the deposits in the immediate vicinity of Cambridge, and contains new records of sections, fossils, and implements. It is pointed out that, owing to alternating periods of erosion and aggradation, relative height above sea-level is not a trustworthy index of antiquity, and modifications of the classification proposed by W. Penning and A. J. Jukes-Browne are indicated.

CAMBRIDGE.

Philosophical Society, November 24.—Prof. **Eddington** and E. T. **Cottingham**: (1) Photographs of a solar prominence taken during the eclipse of 1919 May 29. (2) The theory of relativity and recent eclipse observations.—W. J. **Harrison**: (1) The hydrodynamical theory of the lubrication of a cylindrical bearing under variable load, and of a pivot bearing. (2) The pressure in a viscous liquid moving through a channel with diverging boundaries.

MANCHESTER.

Literary and Philosophical Society, November 18.—Prof. F. E. Weiss, deputy chairman, in the chair.—Prof. T. H. **Pear**: The elimination of wasteful effort in industry. Owing to the impossibility of being able to distinguish sharply between physical and mental effort in the investigation of the problems of economising human energy, physiology and psychology must work side by side. While in many industries improvement of the external conditions of work, such as temperature, ventilation, humidity, and illumination, was rapidly proceeding, less had been attempted in the direction of improving the methods of work themselves. Examples of such efforts illustrated the importance of certain fundamental principles. The first was the adjustment, both in total length and in distribution, of rest-pauses. By introducing suitably chosen rest-pauses and by modifying the working attitude of girls who were engaged in folding handkerchiefs, the output increased 300 per cent., while the folders worked only forty-five minutes in each hour, and were less fatigued than before. The second principle was the substitution of habitual movements for constant acts of decision. By rearranging the method of "assembling" a braid machine, so that the parts were not only put together in a more efficient order, but were more easily found by the workman, sixty-six units were assembled by a man in one day instead of eighteen. The third was the elimination of useless movement. By this means the separate actions required to lay a brick had been reduced from 18 to 5; the output increased from 120 per man per hour to 350.

PARIS.

Academy of Sciences, November 17.—M. Léon Guignard in the chair.—C. **Moureu** and A. **Lepape**: The stabilisation of acrolein. Preparation of acrolein. A mixture of potassium bisulphate (5 parts) and potassium sulphate (1 part) is recommended as the best catalytic agent for dehydrating glycerol to acrolein, and full details of the best method of carrying out the preparation on the large scale are given.—J. **Carpentier**: An account of the presentation (made on November 10) of colour kinematographs of the Gaumont establishment. Progress in the application of three-colour photography to the kinematograph has been rapid, and it is now practicable to take kinematographic views in colour.—Sir J. J. Thomson was elected a foreign associate in succession to the late M. Dedekind.—G. **Bouligand**: Solutions of the equation $\Delta u=\lambda u$, analytic and limited in an infinite domain, zero on the frontier.—N. E. **Nörlund**: The calculation of finite differences.—H. **Dulac**: Limit cycles. O. **Mayer**: Ruled surfaces of the fourth order.—P. **Humbert**: The approximate calculation of the elements of critical Jacobians of a high order.—E. **Belot**: The structure of our stellar universe, deduced from the dualist and vortex cosmogony.—G. **Fayet**: Return of Finlay's periodic comet. This is identical with the comet discovered by Sasaki at Kyoto (Japan) on October 25. From data calculated by the author it was again found by M. Schaumasse at Nice on November 9.—M. **Michkovitch**: Observation of Finlay's periodic comet made at the Marseilles Observatory with the 26-cm. Eichens equatorial. The positions of the comet and comparison star are given for November 10. The comet was well defined and of about the ninth magnitude.—M. **Giacobini**: Observations of the Sasaki (Finlay's) comet made at the Paris Observatory. Positions are given for November 12 and 16.—P. **Chofardet**: Observations of Finlay's periodic comet (1919*e*) made at the Besançon Observatory. Position given for November 13.—A. **Schaumasse**: Observations of Finlay's periodic comet made at the Nice Observatory. Positions given for November 9, 10, 11, 12, and 13.—A. **Baldit**: The effect produced by the electricity of rain on an insulated wire. An insulated wire exposed to rain behaves as a potential equaliser. The disturbances known to occur in electrical systems with air-cables during rainstorms arise from the terrestrial electric field.—A. **Chéron**: An apparatus for the simultaneous examination of the same stereoscopic plate by two persons.—A. **Lartigne**: A new form for the formulæ of line spectra. The formula, deduced from the point of view of general mechanics, is

$$\lambda_m=\frac{4\times 10^8}{N_0}\left(\frac{p}{2}\right)^3\left(\frac{2}{p}+\frac{1}{m}-\frac{1}{m+2p}\right)\text{Angstroms},$$

in which λ is the wave-length, N_0 the Rydberg universal constant, p a constant, and $m=(q-p)$, differing only slightly from consecutive numbers. For $p=2$, and $m=q-2=1, 2, 3 \ldots 29$, the formula is identical with Balmer's original series for hydrogen.—G. A. **Hemsalech**: The luminous phenomena observed in the neighbourhood of a plate of graphite carried to a high temperature by an electric current.—H. **Ungemach**: A remarkable deposit of chalcostibite in Morocco. This mineral is rare, and has hitherto been found in only three localities, in minute quantities and as small crystals. The deposit at Rar-el-Anz, in Morocco, is extensive, and the crystals are large and well formed. One measured 9×4×1 cm.—R. **Souèges**: The embryogeny of the Polygonaceæ. Development of the embryo in Rumex and Rheum.—MM. P. **Mazé**, **Vila**, and M. **Lemoigne**: The transformation of cyanamide into urea by the micro-organisms of the soil. Of the three organisms chosen one, *B. coli*, has no action upon cyanamide; the others, *B. prodigiosus* and *B. cloacae*, convert the cyanamide completely into urea, traces only of ammonia being found.—H. **Bierry**: Carnivora and the three classes of food. It appears improbable, from both observation and experiment, that carnivora can thrive on a diet deprived of both fats and carbohydrates.—F. **Mesnil** and M. **Caullery**: A normal process of fragmentation, followed by regeneration, in a polychetal Annelid, *Syllis gracilis*.—A. **Krempf**: Development of muscular layers in the larva of an Anthozoa (*Pocillopora cespitosa*) at the primitive stage of tetraradial symmetry.—F. **d'Hérelle**: The *rôle* of the protecting micro-organism in bird-typhus.—C. **Nicolle** and C. **Lebailly**: The evolution of the spirochetæ of recurrent fever in the louse, as followed in a series of sections of these insects.

BOOKS RECEIVED.

Psychologies. By Sir R. Ross. Pp. 69. (London: J. Murray.) 2*s*. 6*d*. net.

La Colloidothérapie: Résultats Cliniques. By Dr. J. Laumonier. Pp. ii+283. (Paris: F. Alcan.) 5.50 francs.

A New Chapter in the Science of Government. By B. Branford. Pp. xlviii+190. (London: Chatto and Windus.) 5*s*. net.

A Study of Trade Organisations and Combinations in the United Kingdom. By J. Hilton. Pp. 138. (London: Harrison and Sons.) 1*s*. net.

Altitude and Health. By Prof. F. F. Roget. Pp. xii+186. (London: Constable and Co., Ltd.) 12*s*. net.

Forest Woods and Trees in Relation to Hygiene. By Prof. A. Henry. Pp. xii+314. (London: Constable and Co., Ltd.) 18*s*. net.

The Hardwoods of Australia and their Economics. By R. T. Baker. Pp. xvi+522+plates. (Sydney: The Technological Museum.)

Alternating Current Work: An Outline for Students of Wireless Telegraphy. By A. Shore. Pp. ix+163. (London: The Wireless Press, Ltd.) 3s. 6d. net.

Telephony without Wires. By P. R. Coursey. Pp. xix+414. (London: The Wireless Press, Ltd.) 15s. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 11.

ROYAL SOCIETY, at 4.30.—C. F. U. Meek: A Further Study of Chromosome Dimensions.—J. M. H. Campbell, C. G. Douglas, and F. G. Hobson: The Respiratory Exchange of Man During and After Muscular Exercise.—Dr. A. D. Waller: The Energy Output of Dock Labourers during Heavy Work.—C. H. Usher: Histological Examination of an Adult Human Albino's Eyeball, with a Note on Mesoblastic Pigmentation in Fœtal Eyes.—J. Gray: The Relation of Spermatozoa to Certain Electrolytes, II.

LINNEAN SOCIETY, at 5.—Prof. W. A. Herdman: Notes on the Abundance of Marine Animals and a Quantitative Survey of their Occurrence.—J. B. Gatenby: The Fertilisation of the Calcareous Sponges.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles A. Ballance: The Surgery of the Heart (Bradshaw Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. H. H. Thomson: The Diagnosis and Treatment of Tuberculosis in Relation to Public Health.

MATHEMATICAL SOCIETY (at Burlington House), at 5.—Major P. A. MacMahon: Permutations, Lattice Permutations, and the Hypergeometric Series.—L. J. Mordell: The Generating Function of the Series $\Sigma F(n)q^n$, where $F(n)$ is the Number of Uneven Classes of Binary Quadratics of Determinant $-n$.—H. Steinhaus: Fourier Coefficients of Bounded Functions.—D. Priabandrinsky: Steady Fluid Motions with Free Surfaces.

INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Civil Engineers), at 6.—Capt. J. M. Scott Maxwell: Scientific Management—A Solution of the "Capital and Labour" Problem.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street, E.C.), at 7.—The Principle of Application of Paint and Varnish, and How it Affects the Works Chemist of the Paint and Varnish Industry.

OPTICAL SOCIETY, at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (28 Victoria Street), at 8.—Debate: Worm *v.* Bevel Drive.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Certain Late Effects of Injuries of the Nervous System.

FRIDAY, DECEMBER 12.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.—Conference of Research Organisations (at Institution of Civil Engineers), at 2.30.—Rt. Hon. A. J. Balfour: Introductory Address.—H. J. W. Bliss: Research Associations and Consulting Work and the Collecting and Indexing of Information.—Dr. W. Lawrence Balls: The Equipment of Research Laboratories.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. Eddington and Others: Consideration of the Theory of Relativity.

PHYSICAL SOCIETY OF LONDON, at 5.—Prof. W. M. Coleman: First Steps in the Experimental Analysis of a Galvanic Cell.—J. W. T. Walsh: Radiation from a Perfectly Diffusing Circular Disc.—Dr. N. W. McLachlan: A Comparative Method of Testing Thermionic Valves for Passing No Reverse Current at High Voltages.—Dr. A. O. Rankine: Recording and Reproducing Sounds by Means of Light.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.—Rev. Dr. A. H. Cooke: An Abnormality of Structure in the Radula of Certain Rhachiglossate Mollusca.—H. Watson: The Affinities of Pyramidula, Acanthinula, and Vallonia.

MONDAY, DECEMBER 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—R. Rankin and Others: Discussion on Some Reflections on Labour.

FARADAY SOCIETY (at the Chemical Society), at 8.—Lieut. W. A. Macfadyen: Electrolytic Iron Deposition.—A. G. Tarrant: The Measurement of Physical Properties at High Temperatures.—J. G. Williams: The Electrolytic Formation of Perchlorate from Chlorate.—Prof. A. W. Porter: The Vapour Pressures of Binary Mixtures.—S. Horiba: Some Relations between the Solubilities of Solutes and their Molecular Volumes.—Dr. E. J. Hartung: (1) An Accurate Method for the Determination of Vapour Pressure; (2) Some Properties of Copper Ferrocyanide.—Prof. E. D. Campbell: The Solution Theory of Steel and the Influence of Changes in Carbide Concentration on the Electrical Resistivity.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—S. Perks: London Town-Planning Schemes in 1666.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. T. Hewitt: Synthetic Drugs (Cantor Lecture).

SURVEYORS' INSTITUTION, at 8.—Discussion on The Future of the Institution.

ROYAL GEOGRAPHICAL SOCIETY (at the Æolian Hall), at 8.30.—Capt. E. H. Keeling: In Northern Anatolia, 1917.

TUESDAY, DECEMBER 16.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting of Fellows.

ROYAL STATISTICAL SOCIETY, at 5.15.—J. E. Allen: Some Changes in the Distribution of the National Income during the War.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—A. J. Wilson: The Application of Liquid Fuel to Heavy-Oil Engines.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Major E. O. Henrici: Precise Levelling.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—N. E. Luboshez: Fancy Lighting in Portraiture.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Capt. W. A. Howells: The Art of Camouflage.

WEDNESDAY, DECEMBER 17.

SOCIETY OF GLASS TECHNOLOGY (at Institute of Chemistry), at 2.—J. Connolly, Dr. M. W. Travers, and Dr. W. E. S. Turner: The Position of the Glass Industry in America.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Major-Gen. Sir Lewis Jackson: Possibilities of the Next War.

ROYAL SOCIETY OF ARTS, at 4.30.—C. Grunwald: The Present Economic Position of Russia, and Some Aspects of its Future Development.

ROYAL METEOROLOGICAL SOCIETY, at 5.—F. J. W. Whipple: The Laws of Approach to the Geostrophic Wind.—G. M. B. Dobson: Winds and Temperature Gradients in the Stratosphere.—Capt. C. J. P. Cave: Quotations from the Diary of Samuel Pepys on the Weather.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary of State for the Colonies: An Earthquake at Rabaul in May, 1919.—R. R. Lempriere: The Raised Beach at South Hill (Jersey).—Prof. S. J. Shand: A Rift-Valley in Western Persia.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Civil Engineers), at 6.—Prof. G. W. O. Howe: High-Frequency Resistance of Wires and Coils.

ROYAL MICROSCOPICAL SOCIETY (at the Northampton Polytechnic Institute), 7.30–10.30.—Conversazione.

THURSDAY, DECEMBER 18.

ROYAL SOCIETY OF ARTS, at 4.30.—P. J. Hartog: Some Problems of Ind an Education.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Adjourned Discussion on A Contribution to the Study of Flotation, H. L. Sulman.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—D. M. W. Hutchison and W. J. Wayte: Electricity in Tin Mining.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street), at 8.—Dr. G. E. Moore: External and Internal Relations.

CHEMICAL SOCIETY, at 8.—Prof. J. Walker: War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes.

FRIDAY, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. W. Burley: Cutting Power of Lathe Turning Tools, Part II.

SATURDAY, DECEMBER 20.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital), at 4.30.

CONTENTS.

PAGE

Parasitic Amœbæ and Disease. By Sir E. Ray Lankester, K.C.B., F.R.S. . . . 369
Astronomical Lectures and Essays. By H. C. P. . 370
The Dominion of Man . . . 371
Our Bookshelf . . . 372
Letters to the Editor:—
Gravitation and Light.—Sir Oliver J. Lodge, F.R.S. . . . 372
The Deflection of Light during a Solar Eclipse.—Prof. A. S. Eddington, F.R.S.; Dr. A. C. D. Crommelin. (*With Diagram.*) . . . 372
Sex-Phenomena in the Common Limpet (*Patella vulgata*). (*With Diagram.*)—Dr. J. H. Orton . 373
A Tribute from Prague.—Prof. Bohuslav Brauner 374
Einstein's Relativity Theory of Gravitation. II. The Nature of the Theory. By E. Cunningham . 374
Lord Walsingham, F.R.S. . . . 376
Notes . . . 376
Our Astronomical Column:—
Comets . . . 380
Wireless Time Signals . . . 380
Leeds Astronomical Society . . . 380
The Jubilee of "Nature": Further Official Messages 380
The British Association at Bournemouth:—
Section K—Botany—Opening Address (Abridged) by Sir Daniel Morris, K.C.M.G., M.A., D.Sc., D.C.L., LL.D., F.L.S., President of the Section . . . 381
University and Educational Intelligence . . . 385
Societies and Academies . . . 386
Books Received . . . 387
Diary of Societies . . . 388

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THURSDAY, DECEMBER 18, 1919.

PHYSIOLOGY AND MEDICINE.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod. Assisted by Dr. Roy G. Pearce and by Others. Pp. xxxii+903. (London: Henry Kimpton, 1918.) Price 37*s*. 6*d*. net.

TEACHERS engaged in giving instruction in physiology to students of medicine are well aware of the difficulty pointed out in the preface to the book before us. The student, mainly out of ignorance, is apt to regard the subject as of no importance in the practice of his profession, and to devote what attention he gives to it simply to what he believes will enable him to pass some particular examinational test. He rarely acquires real and useful knowledge of the fundamental processes at the basis of all the manifestations of vital phenomena, normal and pathological, a knowledge which he usually regards as purely "academic." He fails to realise how great an assistance in the comprehension of complex states he would obtain by the application of such general principles. It is to be feared that this attitude is too much encouraged by that of some clinicians. The student learns from his friends who have passed on to their hospital work what little value physiology possesses, as judged by the remarks made by his clinical teachers. There are signs, however, that a change is taking place. The work of physiologists in elucidating problems which arose during the late war, such as the action of poison gases, the regeneration of muscle and nerve, wound-shock, and so on, had the effect of demonstrating to many enlightened medical officers the necessity of physiological science.

On the side of the physiologists themselves it is perhaps true to some extent, as the preface to Prof. Macleod's book states, that the laboratory courses fail to give the student the conviction that he is learning what will be of use to him in the future. But this conviction is not an easy matter to give, for the reason that the teacher, naturally enough, is not regarded as an impartial judge when he seeks to impress upon his students the bearing of any particular lesson upon the interpretation of disease. Prof. Macleod holds that the chief remedy of the evil "lies partly in the continuance of certain of the laboratory courses into the clinical years, and partly in the study of medical literature in which the application of physiology in the practice of medicine is emphasised." For the latter of these objects the present book is admirably fitted. The author intends it as "an advanced text-book in physiology for those about to enter upon their clinical instruction, and at the same time a review for those of a maturer clinical experience who may desire to seek the physiological interpretation of diseased conditions."

The practice of continuing some course of physiology during the clinical years is being advocated in certain quarters at the present time. A great difficulty is undoubtedly the enormous bulk of clinical knowledge that the unfortunate student has to learn. It would, perhaps, be a valuable step in this direction if the laboratories would arrange from time to time special lectures or practical exercises on aspects of the subject which happen to attract attention at the time, say, for example, "acidosis" and hydrogen-ion concentration at the present time. Suggestions would be made by the clinical teachers. On the other hand, this practice would not solve the problem of giving the student a vital interest in his laboratory work, and it has been suggested that some opportunity might be arranged for the student to see something of hospital work during his physiological course. A note in NATURE of May 15 last states that Sir Edward Sharpey Schafer objects to any systematic clinical instruction at this time. Doubtless with justice. But might it not serve the purpose if an occasional clinical demonstration, appropriate to the physiological problem under discussion, such as the taking of an electrocardiogram in a case of heart disease in connection with the treatment of electrical phenomena in muscle, were given in the hospital? It would, at all events, serve to show the student what he must learn, and impress upon him how little he knows. At the same time, much caution would need to be exercised to avoid the fatal error of limiting physiological teaching to what is obviously of immediate interest in clinical practice.

The book before us does not claim to supersede the general text-books, or to give instructions for the performance of chemical tests and estimations. These latter are only to be learned by practice. Indeed, it would seem that the word "biochemistry" in the title of the book might be omitted, because the author himself states that it treats biochemical knowledge from the viewpoint of the physiologist. Biochemistry, in fact, can scarcely be regarded as an independent science in the sense that physiology is. Its separate teaching and investigation are rather matters of practical convenience, and, unless guarded against, may lead to unfortunate results. Part of it is included in physiology, animal and plant, while the remaining part is a branch of organic chemistry.

Certain aspects of physiology, such as the phenomena of immunity and the details of reactions of the central nervous system, require the space of special works. Some readers may be inclined to think that the portion of Prof. Macleod's book devoted to the nervous system is somewhat meagre in comparison with that occupied in the usual text-books. It gives, however, an excellent general account of the activities of the nerve-centres, and we may call to mind that a large part of the corresponding sections in many text-books is occupied with pure anatomy. It is curious that Prof. Macleod falls into the common practice of describing the receptor organ for position, the semicircular canals, under the head of the cerebellum; but this is possibly to be accounted for as the result of his intentional omission of details of the sense-organs in general, which would have made the book too unwieldy.

Since a review is scarcely complete without a word of criticism, it may be pointed out that the spelling of "edema" and "hemoglobin" is unwelcome to British eyes, and that "neuron" should have a final *e*.

But these are trivialities, and the work as a whole can be highly commended. Circulation, respiration, digestion, and metabolism are especially well discussed. There are, of course, some aspects of these questions on which our knowledge is more complete than at the time the book was written. These are matter for a future edition. In such an edition a short account of the phenomena of immunity, from a general point of view, would be valuable, although this would not be a particularly easy task. The illustrations and diagrams are by no means the least useful part of the book.

W. M. BAYLISS.

MATHEMATICS, PARTICULAR AND GENERAL.

(1) *Analytic Geometry.* By Prof. Maria M. Roberts and Prof. Julia T. Colpitts. Pp. x + 245. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 7s. 6d. net.

(2) *Elementary Mensuration, Constructive Plane Geometry, and Numerical Trigonometry.* By P. Goyen. Pp. viii + 169. (London: Macmillan and Co., Ltd., 1919.) Price 3s. 6d.

(3) *Lectures on the Philosophy of Mathematics.* By James Byrnie Shaw. Pp. vii + 206. (Chicago and London: The Open Court Publishing Co., 1918.) Price 6s. net.

(1) PROFS. ROBERTS AND COLPITTS have wisely included in a single course on "Analytic Geometry" the most important parts of the theory of conic sections, the theory of curves in Cartesian and polar co-ordinates, and the elements of solid geometry treated analytically, thus representing as a connected whole the parts of co-ordinate geometry in which every university student of mathematics should be thoroughly grounded. The book is very sound pedagogically, the treatment being based largely on the intuitive use of geometrical constructions. The figures are well and neatly drawn, and many of the curves are accurately plotted.

One must, however, point out some of the more serious faults, with a view to their elimination from a future edition. Some of the figures are unsatisfactory—*e.g.* those on pp. 117, 136, 152, 159, 168, 178, and 188. A very important point is missed on p. 38. The student should be informed that in a family of curves like

$$ay^2 = x(x-2a)^2,$$

which can be written in the form

$$(y/a)^2 = (x/a)(x/a-2)^2,$$

the value of the parameter a is to indicate the dimension of any curve of the family, so that the family consists of similar curves with the origin as centre of similitude. The method of § 70 is clumsy.

An interesting feature is the discussion on pp. 83–4 of the difficulties arising from the multiple representation of points in the polar system. A definite point on a plane has definite Cartesian co-ordinates if the axes are given, but it has more than one pair of polar co-ordinates even when the pole and original line are given. Thus the points (ρ, θ), $(-\rho, \theta+\pi)$, $(\rho, \theta+2\pi)$, $(-\rho, \theta+3\pi)$, etc., are all really one and the same point. This may cause confusion and error in the practical use of polar co-ordinates. Unfortunately, the authors do not indicate clearly the steps to be taken in order to avoid the danger. This is done by writing any equation $\rho=f(\theta)$ in the more general form $\rho=(-)^n f(\theta+n\pi)$, in which n is any positive or negative integer.

The book is one that can be unhesitatingly commended to the notice of teachers and students. There are numerous exercises, amply illustrative of the principles taught.

(2) There is no doubt that Mr. Goyen is right in claiming for the experimental method of geometrical teaching the advantage of preparing "the way for such subsequent abstract proofs as will enable learners to reinforce the test of experience by the test of reason." The present book depends somewhat on the "test of experience," and its value lies principally in the information given, and not in the process of proof employed to establish the results. Occasionally, indeed, statements are made without attempt at any justification.

Mr. Goyen's book thus caters for the student who wishes to acquire geometrical knowledge rather than geometrical training. It includes the usual geometry of rectilinear figures and circles, with application to ordinary mensuration; the quadrilateral and regular and irregular polygons; and the use of similar figures and some three-dimensional mensuration. A welcome chapter is that on numerical trigonometry, a subject too much neglected in elementary mathematical teaching. Every student who claims to have "done mathematics" should be able to deal successfully with easy problems in "heights and distances."

There are numerous examples. The tables and the answers add to the usefulness of a very useful book.

(3) One of the great defects of scientific teaching, due no doubt to the high degree of specialisation that recent progress has made necessary, is the restricted outlook of the presentation. The pass student learns a certain amount of two or three subjects; the honours man studies one subject to a higher pitch of excellence; but both the pass and the honours men are generally ignorant of two important aspects of their studies: they know little of the historical development of their subjects, and they rarely acquire a view of the whole of any subject, the correlation of its parts,

its foundations, and the contemporary trend of its development.

The ignorance of the history of any science could easily be remedied. Each head of a scientific department should arrange for a historical course in his subject. The interest aroused by such an adequately prepared and well delivered and illustrated historical course would more than repay the time spent on it.

The acquisition of a competent view of any subject is more difficult, and especially in mathematics, as is illustrated by Dr. Shaw's lectures. No student of mathematics can be expected to be familiar with all or even with the majority of the branches of mathematics mentioned by Dr. Shaw. The pass man would probably lay the book down after reading the first chapter—if he gets thus far. The honours student would perhaps go further, particularly if his speciality is pure mathematics and his reading has been ably directed by a teacher familiar with modern mathematical tendencies. Yet Dr. Shaw has dealt with his theme in a particularly persuasive and very elementary manner.

The author considers the "speculative thinker" who desires "to know the content of mathematics," "to hunt for the central principle that controls its evergreen growth," to explore "the source of mathematical reality," and to discover the "methods pursued in the field of investigation" and the "right of this Queen of all the sciences to rule." These problems are dealt with in a brief and clear exposition, which must be read in order to be appreciated. It would be idle to attempt a summary, as this would not convey much to the uninitiated for whom the lectures were written. Suffice it to say that in Dr. Shaw's opinion there is no *single* principle of mathematics, no *single* source of reality, no *single* mathematical method.

These lectures should be read and re-read by all who desire to fathom the depths of the reality of mathematics. They will be inspired to a view of the subject different from the drab and utilitarian view so often prevalent in our colleges. They will learn at least to give his due share of recognition to the mathematician who "sits with abstracted mien, his mental eye turned inward upon some intricate construction of symbols and formulæ," and to respect, perhaps even to share, his joy when he catches the flash of triumph.

S. Brodetsky.

OUR BOOKSHELF.

The Journal of the Institute of Metals. Vol. xxi. Edited by G. Shaw Scott. Pp. xi+508+40 plates. (London: The Institute of Metals, 1919.) 31*s*. 6*d*. net.

Of the new volume of this important journal, no fewer than 216 pages are occupied by the fourth report to the Corrosion Committee by Drs. Bengough and Hudson and the subsequent discussion. The new report embodies the results of a very large amount of experimental work, and is distinctly helpful in regard to the immediate problem of extending the life of brass condenser tubes. A large array of new facts bearing on the baffling question of the mechanism of corrosion is also included, and illustrated by numerous plates. The authors favour the view that direct oxidation takes place without preceding electrolytic action. As Prof. Armstrong points out in the discussion, the theory of corrosion is in a disappointingly backward state, and no satisfactory explanation has yet been given of some of the most familiar facts. The report is a valuable one, and fully justifies the continuance of the work of the committee.

Messrs. Hanson and Archbutt contribute a most useful account of their methods of polishing and etching aluminium and its light alloys, and of identifying the constituents, a task which has presented difficulties to most metallographers. Another paper from the same laboratory, by Dr. Rosenhain and Mr. Hanson, records the properties of some copper alloys which were devised for war purposes, and incidentally describes a convenient method of obtaining clean castings by working under pressure. A note by Lt.-Col. Jenkin on the metallurgical information required by engineers is followed by a lively discussion, the conclusion being reached that the determination of true physical constants is likely to supersede many of the present empirical tests. There are two papers on the effect of cold work on metals, and an interesting discussion on the relation of science to the industry of the non-ferrous metals, in which the respective views of scientific workers and manufacturers are well and clearly expressed. The volume concludes with the usual abstracts of metallurgical literature.

C. H. D.

Golden Days from the Fishing-Log of a Painter in Brittany. By Romilly Fedden. Pp. xviii+233. (London: A. and C. Black, Ltd., 1919.) Price 7*s*. 6*d*. net.

Here is a book full of quiet charm and humour, written by one who is evidently not only an artist and a sportsman, but also a true lover and observer of Nature and her ways. The angler will be fascinated by the vivid descriptions of trout- and salmon-fishing in Brittany. There are no improbable fisherman's yarns to invite his scepticism, but their place is taken by some delightful stories of saints and miracles drawn from the Breton folk-lore, so that the book appeals quite as much to the general reader as to the piscatorial fraternity. It is a pleasant narrative, well suited to while away a winter evening at the fireside and to conjure up visions of sunlit meadows, fragrant pinewoods, and murmuring streams, though tinged, alas! by that vein of sadness which must colour the day-dreams of all of us at the present time, and especially of those who, like the author, have witnessed at close quarters the tragedy of the last few years.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Power from the Sun.

IN the very interesting Trueman Wood lecture delivered at the Royal Society of Arts on December 10, Sir Oliver Lodge discussed the utilisation of solar radiation, and recommended, as the best method of effecting this purpose, the promotion of agriculture of every kind. According to Sir Oliver Lodge, the green leaves of trees and vegetables generally are able to absorb and utilise solar energy without much regard for any hampering limit to efficiency such as the second law of thermodynamics, but in saying this he appears to be unaware of the researches of Dr. Horace Brown, who has shown that the actual amount of energy stored is less than 2 per cent. of that which reaches the vegetation.

Now the total amount of solar energy intercepted by the earth is prodigious, being in the aggregate some 200 billion h.p., or, on an average, about 4,000,000 h.p. per square mile of that portion of the earth's surface that is exposed not too obliquely to the sun's rays. Absorption by the clouds and by the atmosphere, though important, is not so great as might be expected, with the result that even in this latitude and in this climate the energy constantly received throughout the hours of daylight exceeds 1000 h.p. per acre.

If, then, some method could only be devised for efficiently converting this energy into a form in which it could be readily applied for motive power and other purposes, the gain and the convenience would be enormous; for, to take a single instance, sufficient energy to run all the machinery in a factory throughout the working day could be collected from an area in many cases not greater than that subtended by the factory's roof.

Now, of course, for reasons which Sir Oliver Lodge fully discussed, it is hopeless to expect to be able to effect anything of this nature with the heat engine, for with this we should scarcely reach the 2 per cent. efficiency nearly attained by vegetation. But is there any need to allow the radiation to turn itself into heat at all? Solar radiation, as is well known, consists of electromagnetic waves in the æther—waves exactly similar in kind to those employed in wireless telegraphy. The only difference is that, whereas the length of the waves used in wireless telegraphy is a matter of hundreds or thousands of metres, the wave-length in the case of solar radiation is only a very minute fraction of a millimetre.

Even with wireless waves the resulting frequency is too great to allow of the electric currents they induce being directly utilised. The telephones and other instruments employed offer too much impedance to allow such currents to pass, while, apart from this, no mechanical device could move with sufficient rapidity to respond to such frequencies. In wireless telegraphy, however, a method has been devised for converting these rapidly alternating or oscillating electric currents into currents which, though pulsating, are unidirectional. This is accomplished by the application of thermionic or crystal rectifiers or non-return valves, which only allow the currents in one direction to pass and suppress altogether the currents in the opposite direction. In this way the comparatively useless high-frequency oscillatory currents are converted into rapidly pulsating unidirectional currents which behave like continuous currents, and will operate telephones and other electromagnetic devices. Moreover, though in wireless telegraphy it is customary to use the currents in a single direction only, and to suppress the inverse currents altogether, there is no difficulty about utilising both currents by turning them into separate circuits with valves set opposite ways. Under such conditions, seeing that the separate valves let through their respective currents with but little loss, the efficiency of the conversion from the radiant energy absorbed to that utilisable in the form of electric current is quite high, probably not less than 50 per cent., and perhaps considerably more.

Is it too rash to suggest the possibility of some analogous method being applicable to convert into utilisable electric currents the electromagnetic waves of which the radiant energy from the sun consists? The method is quite successful with wireless waves having frequencies of millions per second, but can it be applied to the sun's waves, the frequency per second of which is of the order of billions? No doubt the problem is a difficult one, but we live in an age of marvels, and what would have been said of modern wireless methods only a few years ago?

One thing seems certain. The energy in the sun's radiation is there, and there, too, in most abundant quantity. To make use of it, moreover, requires no Maxwellian "demon" such as is necessary to render available the general stock of heat energy at uniform temperature. Nor, again, does what is suggested run counter to any thermodynamical law such as would preclude full advantage being taken of the great efficiency that is rendered possible by the enormous temperature of the sun.

Anyway, the problem of the application of solar radiation to the production of power otherwise than by means of heat engines seems worthy of attention, and is a problem that would appear much more likely to meet with a speedy solution than the difficult and obscure question of the liberation and utilisation of the internal energy of the atom.

A. A. CAMPBELL SWINTON.

66 Victoria Street, London, S.W.1,
December 15.

Heat of Reaction and Gravitational Field.

A SIMPLE relation between the variation of mass in a physical change of state or chemical reaction and the rate of variation with gravitational potential of the corresponding change of total internal energy can be deduced as follows:—Let m_1 and m_2 denote the masses of the initial and final states of the chemical system and Q the heat evolved, say at constant temperature and pressure, and at the gravitational potential Z. Considering the following isothermal cycle:

(*a*) State 1 to state 2 at Z,
(*b*) State 2 at Z to state 2 at Z+δZ,
(*c*) State 2 to state 1 at Z+δZ,
(*d*) State 1 at Z+δZ to state 1 at Z,

and equating the total change of energy to zero, we get the equation

$$\left(\frac{\partial Q}{\partial Z}\right)_{p,t} = m_1 - m_2.$$

For all ordinary reactions, experiment has shown that $m_1 - m_2$, if not zero, must be very small. It follows, however, from the theory of relativity that if the reaction be exothermic $m_1 > m_2$, whilst if it be endothermic $m_1 < m_2$. Hence in the former case $\frac{\partial Q}{\partial Z}$ is positive, whilst in the latter case it is negative. If we can apply the energy theory to the highly exenergic radio-active changes, it would follow that the energy given out in such changes must be greater in strong gravitational fields than in weak.

F. G. DONNAN.

University College, London, December 10.

A Helium Series in the Extreme Ultra-Violet.

IN NATURE for November 20 Prof. Lyman reports his observation of a helium line at 1640·1, as well as a weak one at 1215·1, close to the strong one 1216, and refers them to orders 3, 4 in the series $4N\{1/2^2 - 1/m^2\}$. If the correct reading for the strong line is nearer the 1215·1, the whole series $m=4 \ldots 8$ is found in his list of ultra-violet lines given in the *Astro. Journ.* (vol. xliii., p. 89, 1916). The following is the list of observed lines with deviations (obs. − calc.) from the calculated values, with $N = 109720$:—

Order	Intensity	λ	$d\lambda$
3	strong	1640·2	−0·34
4	10	1215·1	−0·11
5	5	1086·1	+1·08
6	4	1026·0	+0·66
7	3	992·0	−0·37
8	1	972·7	+0·59

The line 1084·9 is closer to the calculated with $d\lambda = -0·11$, but its intensity of 2 is not in step with the others. In estimating possible errors, those of standards as well as of observation have to be considered. With uncertainties also of formula, the values of $d\lambda$ do not seem excessive.

W. M. HICKS.

Crowhurst, December 11.

The Constitution of the Elements.

IT will doubtless interest readers of NATURE to know that other elements besides neon (see NATURE for November 27, p. 334) have now been analysed in the positive-ray spectrograph with remarkable results. So far oxygen, methane, carbon monoxide, carbon dioxide, neon, hydrochloric acid, and phosgene have been admitted to the bulb, in which, in addition, there are usually present other hydrocarbons (from wax, etc.) and mercury.

Of the elements involved hydrogen has yet to be investigated; carbon and oxygen appear, to use the terms suggested by Paneth, perfectly "pure"; neon, chlorine, and mercury are unquestionably "mixed." Neon, as has been already pointed out, consists of isotopic elements of atomic weights 20 and 22. The mass-spectra obtained when chlorine is present cannot be treated in detail here, but they appear to prove conclusively that this element consists of at least two isotopes of atomic weights 35 and 37. Their elemental nature is confirmed by lines corresponding to double charges at 17·50 and 18·50, and further supported by lines corresponding to two compounds HCl at 36 and 38, and in the case of phosgene to two compounds COCl at 63 and 65. In each of these pairs the line corresponding to the smaller mass has three or four times the greater intensity.

Mercury, the parabola of which was used as a standard of mass in the earlier experiments, now proves to be a mixture of at least three or four isotopes grouped in the region corresponding to 200. Several, if not all, of these are capable of carrying three, four, five, or even more charges. Accurate values of their atomic weights cannot yet be given.

A fact of the greatest theoretical interest appears to underlie these results, namely, that of more than forty different values of atomic and molecular mass so far measured, all, without a single exception, fall on whole numbers, carbon and oxygen being taken as 12 and 16 exactly, and due allowance being made for multiple charges.

Should this integer relation prove general, it should do much to elucidate the ultimate structure of matter. On the other hand, it seems likely to make a satisfactory distinction between the different atomic and molecular particles which may give rise to the same line on a mass-spectrum a matter of considerable difficulty.

F. W. ASTON.

Cavendish Laboratory, December 6.

The Deflection of Light during a Solar Eclipse.

THE fall of temperature that may occur in the higher strata of the atmosphere during an eclipse is somewhat doubtful, but can scarcely exceed half a degree. An attempt was made to measure it directly during the partial, but nearly total, eclipse in England on April 17, 1912, but of the instruments sent up one only was recovered, so that no comparison could be made.

On the average, the solar heat absorbed by the earth's surface and the atmosphere during one day is capable of raising the whole atmosphere about 1·5° C., and, of course, about the same amount must be lost per day by radiation. There is direct evidence that the daily change of temperature as we know it at the surface does not extend to more than 1 km. or 2 km., and from 2 km. to 20 km. the daily range can scarcely reach 1° C. In these circumstances the fall of temperature of the upper strata during an eclipse must be small, say ¼° or ½° at the outside.

Our direct observations of atmospheric temperature very seldom exceed 20 km., and above that height we know neither the value nor the changes to which it is subject. This is perhaps of little consequence since at 20 km. more than 94 per cent. of the whole mass has been passed.

It must also be remembered that the line of lowest temperature will not be the axis of the shadow-cone, but will lag considerably behind it.

W. H. DINES.

Benson Observatory, Wallingford.

THE correction to the Einstein effect indicated by Mr. W. H. Dines's estimate of the depression of temperature in the eclipse shadow is even less than 10^{-11} radians or 10^{-6} seconds of arc. For a vertical ray the deflection caused by a horizontal temperature-gradient of $d\theta°$ C. in dx cm. is approximately

$$(\mu - 1)_G \,.\, H \,.\, \frac{d \log_e \theta}{dx},$$

where $(\mu - 1)_G = 28 \times 10^{-5}$ is the refractivity of air at normal density, and H is the height of the homogeneous atmosphere. For two rays at a mean distance in the atmosphere of a kilometre apart—a liberal estimate—the difference in deflection would be in c.g.s. units

$$28 \times 10^{-5} \times H \times 10^5 \,.\, d^2 \log \theta / dx^2.$$

If the shadow may be considered to have a radius of 500 km., then $d^2 \log \theta/dx^2$ would be of the order of 10^{-18}. From this the initial statement follows.

That is, assuming $\partial H/\partial x = 0$. But more simply conveniently, and accurately the bending of a vertical ray can be expressed in terms of the surface pressure-gradient because the refractivity is simply proportional to the density. So that five barometers, one at the eclipse station and four distributed around it, would yield the corrections for a single ray. The bending comes to $2{\cdot}3 \times 10^{-4}\ \partial p/\partial x$ radians, where p is the surface pressure in dynes cm.$^{-2}$ and dx is in cm.

LEWIS F. RICHARDSON.

Benson Observatory, Wallingford,
December 12.

I, OF COURSE, admit the force of the remarks in the letters which appeared in NATURE of December 11. But the problem of air refraction during a total eclipse is a very complicated one. The air is not in equilibrium. There is, I imagine, a downward rush of cold air in places deprived of the sun's radiation, as well as a lateral motion of the air from all sides towards such places. The whole refraction effect depends on the shape of the changing surfaces of equal density, and the gradient of density perpendicular to these surfaces. The effect observed would be about equal to the ordinary refraction effect caused by the atmosphere at $1\frac{1}{2}°$ from the zenith, and then the rays of light are nearly perpendicular to the surfaces of equal density.

It is well to remember that, perhaps unfortunately, the stars in the neighbourhood of the sun during a total eclipse must be viewed through air of which the distribution of density must not be assumed to be the same as that of the atmosphere in its normal state.

ALEXR. ANDERSON.

EINSTEIN'S RELATIVITY THEORY OF GRAVITATION.[1]

III.—THE CRUCIAL PHENOMENA.

IN the article last week an attempt was made to indicate the attitude of the complete relativist to the laws which must be obeyed by gravitational matter. The present article deals with particular conclusions.

As Minkowski remarked in reference to Einstein's early restricted principle of relativity: "From henceforth, space by itself and time by itself do not exist; there remains only a blend of the two" ("Raum und Zeit," 1908). In this four-dimensional world that portrays all history let (x_1, x_2, x_3, x_4) be a set of co-ordinates. Any particular set of values attached to these co-ordinates marks an event. If an observer notes two events at neighbouring places at slightly different times, the corresponding points of the four-dimensional map have co-ordinates slightly differing one from the other. Let the differences be called (dx_1, dx_2, dx_3, dx_4). Einstein's fundamental hypothesis is this: there exists a set of quantities g_{rs} such that

$$g_{11}dx_1^2 + 2g_{12}dx_1dx_2 + \ . \ . \ . + g_{44}dx_4^2$$

has the same value, no matter how the four-dimensional map is strained. In any strain g_{rs} is, of course, changed, as are also the differences dx.*

If the above expression be denoted by $(ds)^2$, ds may conveniently be called the *interval* between two events (not, of course, in the sense of time interval). In the case of a field in which there is no gravitation at all, if dx_4 is taken to be dt, it is supposed that ds^2 reduces to the expression $dx_1^2 + dx_2^2 + dx_3^2 - c^2dt^2$, where c is the velocity of light. If this is put equal to zero, it simply expresses the condition that the neighbouring events correspond to two events in the history of a point travelling with the velocity of light.

Einstein is now able to write down differential equations connecting the quantities g_{rs} with the co-ordinates (x_1, x_2, x_3, x_4), which are in complete accord with the requirement of complete relativity.[2] These equations are assumed to hold at all points of space unoccupied by matter, and they constitute Einstein's law of gravitation.

Planetary Motion.

The next step is to find a solution of the equations when there is just one point in space at which matter is supposed to exist, one point which is a singularity of the solution. This can be effected completely[3]: that is, a unique expression is obtained for the interval between two neighbouring events in the gravitational field of a single mass. This mass is now taken to be the sun.

It is next assumed that in the four-dimensional map (which, by the way, has now a bad twist in it, that cannot be strained out, all along the line of points corresponding to the positions of the sun at every instant of time) the path of a particle moving under the gravitation of the sun will be the most direct line between any two points on it, in the sense that the sum of all the intervals corresponding to all the elements of its path is the least possible.[4] Thus the equations of motion are written down. The result is this:

The motion of a particle differs only from that given by the Newtonian theory by the presence of an additional acceleration towards the sun equal to three times the mass of the sun (in gravitational units) multiplied by the square of the angular velocity of the planet about the sun.

In the case of the planet Mercury, this new acceleration is of the order of 10^{-8} times the Newtonian acceleration. Thus up to this order of accuracy Einstein's theory actually arrives at Newton's laws: surely no dethronement of Newton.

The effect of the additional acceleration can easily be expressed as a perturbation of the Newtonian elliptic orbit of the planet. It leads to the result that the major axis of the orbit must rotate in the plane of the orbit at the rate of $42{\cdot}9''$ per century.

Now it has long been known that the perihelion of Mercury does actually rotate at the rate of about $40''$ per century, and Newtonian theory has never succeeded in explaining this, except by *ad hoc* assumptions of disturbing matter not otherwise known.

Thus Einstein's theory almost exactly accounts

[1] Previous articles appeared in NATURE of December 4 and 11.

* The gravitational field is specified by the set of quantities g_{rs}. When the gravitational field is small, these are all zero, except for g_{44}, which is approximately the ordinary Newtonian gravitational potential.

[2] These equations take the place of the old Laplace equation $\nabla^2 V = 0$. Just as that equation is the only differential equation of the second order which is entirely independent of any change of ordinary space co-ordinates, so Einstein equations are uniquely determined by the condition of relativity.

[3] The result is that the invariant interval ds is given by

$$ds^2 = (1 - 2m/r)(dt^2 - dr^2) - r^2(d\theta^2 + \sin^2\theta d\phi^2),$$

the four co-ordinates being now interpreted as time and ordinary spherical polar co-ordinates.

[4] This corresponds to the fact that in a field where there is no acceleration at all the path of a particle is the shortest distance between two points.

for the one outstanding failure of Newton's scheme, and, we may note, does not introduce any discrepancy where hitherto there was agreement.

The Deflection of Light by Gravitation.

The new theory having justified itself so far, it was thought worth while for British astronomers to devote their main energies at the recent solar eclipse to testing its prediction of an entirely new phenomenon.

As was remarked above, the propagation of light in the ordinary case of freedom from gravitational effect is represented by the equation $ds=0$.

This Einstein boldly transfers to his generalised theory. After all, it is quite a natural assumption. The propagation of light is a purely objective phenomenon. The emission of a disturbance from one point at one moment, and its arrival at another point at another moment, are events distinct and independent of the existence of an observer. Any law that connects them must be one which is independent of the map the observer uses; ds being an invariant quantity, $ds=0$ expresses such an invariant law.

This leads at once to a law of variation of the velocity of light in the gravitational field of the sun.

$$v=c(1-2m/r).$$

Here m, as before, is the mass of the sun in gravitational units, and is equal to 1·47 kilometres, while c is the velocity of light at a great distance from the sun. Thus the path of a ray is the same as that if, on the ordinary view, it were travelling in a medium the refractive index of which was $(1-2m/r)^{-1}$. In this medium the refractive index would increase in approaching the sun, so that the rays would be bent round towards the sun in passing through it. The total amount of the deflection for a ray which just grazes the sun's surface works out to be 1·75″, falling off as the inverse of the distance of nearest approach.

The apparent position of a star near to the sun is thus further from the sun's centre than the true position. On the photographic plate in the actual observations made by the Eclipse Expedition the displacement of the star image is of the order of a thousandth of an inch. The measurements show without doubt such a displacement. The stars observed were, of course, not exactly at the edge of the sun's disc; but on reduction, allowing for the variation inversely as the distance, they give for the bend of a ray just grazing the sun the value 1·98″, with a probable error of 6 per cent., in the case of the Sobral expedition, and of 1·64″ in the Principe expedition.

The agreement with the theory is close enough, but, of course, alternative possible causes of the shift have to be considered. Naturally, the suggestion of an actual refracting atmosphere surrounding the sun has been made. The existence of this, however, seems to be negatived by the fact that an atmosphere sufficiently dense to produce the refraction in question would extinguish the light altogether, as the rays would have to travel a million miles or so through it. The second suggestion, made by Prof. Anderson in NATURE of December 4, that the observed displacement might be due to a refraction of the ray in travelling through the earth's atmosphere in consequence of a temperature gradient within the shadow cone of the moon, seems also to be negatived. Prof. Eddington estimates that it would require a change of temperature of about 20° C. per minute at the observing station to produce the observed effect. Certainly no such temperature change as this has ever been noted; and, in fact, in Principe, at which the Cambridge expedition made its observations, there was practically no fall of temperature.

Gravitation and the Solar Spectrum.

It was suggested by Einstein that a further consequence of his theory would be an apparent discrepancy of period between the vibrations of an atom in the intense gravitational field of the sun and the vibrations of a similar atom in the much weaker field of the earth. This is arrived at thus. An observer would not be able to infer the intensity of the gravitational field in which he was placed from any observations of atomic vibrations in the same field: that is, an observer on the sun would estimate the period of vibration of an atom there to be the same that he would find for a similar atom in the earth's field if he transported himself thither. But on transferring himself he automatically changes his scale of time; in the new scale of time the solar atom vibrates differently, and, therefore, is not synchronous with the terrestrial atom.

Observations of the solar spectrum so far are adverse to the existence of such an effect. What, then, is to be said? Is the theory wrong at this point? If so, it must be given up, in spite of its extraordinary success in respect of the other two phenomena.

Sir Joseph Larmor, however, is of opinion that Einstein's theory itself does not in reality predict the displacement at all. The present writer shares his opinion. Imagine, in fact, two identical atoms originally at a great distance from both sun and earth. They have the same period. Let an observer A accompany one of these into the gravitational field of the sun, and an observer B accompany the other into the field of the earth. In consequence of A and B having moved into different gravitational fields, they make different changes in their scales of time, so that actually the solar observer A will find a different period for the solar atom from that which B, on the earth, attributes to his atom. It is only when the two observers choose so to measure space and time that they consider themselves to be in identical gravitational fields that they will estimate the periods of the atoms alike. This is exactly what would happen if B transferred himself to the same position as A. Thus, though an important point remains to be cleared up, it cannot be said that it is one which at present weighs against Einstein's theory.

E. CUNNINGHAM.

THE INHERITANCE OF THE NAVAL OFFICER.[1]

It seems good sense to say that a man who dislikes the sea and all that therein is, who has no spirit of adventure, who is, in short, a low-spirited land-lubber, is not in the least likely to make a distinguished naval officer. You never can tell, of course, for Nelson was always sea-sick and often pessimistic, but the chances are against a man such as we have pictured becoming a bright and shining light in the Navy. And that is what Dr. Davenport and his assistant have said, only they have said it very learnedly with a lot of technicalities about "thalassophilia," "hyperkinetism," "nomadism," and "recessives." The study of heredity does not foster a sense of humour, and we cannot wonder. It is a rather dismal science.

But the memoir before us goes much further than we have indicated. It is argued from sixty-eight biographies that distinguished naval officers have clear-cut special gifts, which are more or less Mendelian characters. They are expressed in the lineage, direct or collateral, and likewise find appropriate expression in early youth. If the number sixty-eight affords a sufficiently broad basis for secure induction, and if such characters as a love for the sea are really crisply defined, non-blending, unit characters, then the conclusions reached are of high interest. Both for theory and for action it is very important to know how much a man is made and how much he is born, and this latest product of the industry and enthusiasm of the Cold Spring Harbour laboratory for the experimental study of evolution and heredity is a contribution to the answer to this question. We should notice that, apart from the non-inclusion of those distinguished officers whose biographies failed to furnish any details of lineage or of boyhood, no selection of names was made. Dr. Davenport set out without any theory save the preconception which previous studies have warranted, that the hereditary make-up of a distinguished man is likely to include definite traits, being not so much a melange as a mosaic.

What, then, are the features which may be regarded as part of the natural inheritance of a distinguished naval officer, as contrasted with, let us say, a distinguished clergyman? The first is a love for the sea, a specific susceptibility to its call, a "thalassophilia." Unless this, or some analogous characteristic, such as nomadism, is in the blood, the chances are against the boy becoming a distinguished naval officer. Such is the verdict of biography. The second feature is some form of the spirit of adventure, a willingness to incur responsibilities, a capacity for rapid decision and action in face of difficulties. A few cases of persistent sea-sickness in admirals may be found—Nelson's is known to all—but there seems to be no instance of a distinguished naval officer without some form of the spirit of adventure. Very rarely has it taken the form of quarrelsomeness, or of pugnacity, or of devil-may-care rashness—though instances of these are well known—but a distinguished naval officer without the quality at all is a contradiction in terms. The third character that is normally present is the sanguine or buoyant temperament, which is technically described as hyperkinetic in contrast to the melancholic and fatalistic hypokinetic. Now, it is an interesting fact that a small minority among the sixty-eight were of the hypokinetic type—reserved, taciturn, melancholic, fatalistic—and that two or three of the greatest were strange mixtures of both, like Nelson, passing from the crests to the troughs of temperamental waves, probably enough correlated with changes in blood-pressure that would kill an ordinary man. But the great majority of the famous sea-captains have been markedly hyperkinetic, not only daring pilots when the waves ran high, but also positively defiant in danger.

As it seems to us, Dr. Davenport is too readily satisfied with the evidence that this or that character exhibits Mendelian inheritance, and that he attaches far too little importance to the family tradition and conversation in defining the lines of a boy's development; but he states a strong case in support of the view, which is more convincing in negative than in positive form, that "unless a love of the sea appears on at least one side of the house, hyperkinesis in at least one parent, or, in the case of an eminent naval man, among the male relatives of the mother, one is justified in doubting if the applicant for a naval commission will become an eminent officer." It is easy enough to make fun of this contribution to "the pedigree of the sea-dogs," but the number of round men in square holes is one of the tragedies of the world, and we wonder gravely how long it will be before wasteful methods of selection are replaced by those suggested by expert study of lineage and of childhood. As Mahan once said—and he had a great knowledge of naval officers—"Each man has his special gift, and to succeed must act in accordance with it." Dr. Davenport's memoir is a contribution to the art of discovering special gifts, or of estimating the probability of their presence.

[1] "Naval Officers: Their Heredity and Development." By Charles Benedict Davenport and Mary Theresa Scudder. Publication No. 259 Pp. iv+236. (Carnegie Institution of Washington, 1919.)

NOTES.

The newspapers have lately published a big-game hunter's report that a gigantic dinosaurian reptile related to the extinct Brontosaurus and Diplodocus has been seen living in the Congo region of Africa. Palæontologists, however, receive the story with incredulity, and are decidedly of opinion that it must be founded on mistaken observations. The Dinosauria and all their gigantic reptilian contemporaries, whether on land, in the sea, or in the air, disappeared from every part of the world at the end of the Cretaceous period. If any had survived, some fragments of them would ere this have been found in the Tertiary formations which record the progress of life between that period and the present day. It is no contrary argument to quote Sir Harry Johnston's discovery of the okapi in the Congo forest, for this is merely a kind of ancestral giraffe which is known by fossils to have existed so far north as Greece so recently as the beginning of the Pliocene Tertiary. The okapi is a congruous African animal, but a dinosaur would be an anachronism.

In his Trueman Wood lecture delivered before the Royal Society of Arts on December 10, Sir Oliver Lodge dealt with "Sources of Power Known and Unknown." Power or energy, he said, is the most pressing material need of man. His entire material activity consists in moving matter, and food is mainly used by an animal for developing energy before it has assumed the form of heat. The best engines hitherto devised leave much to be desired in that respect. Even the internal-combustion engine is imperfect so long as it requires a cooling jacket. By the second law of thermodynamics, heat is most efficiently utilised at the highest temperatures. The sun's temperature being 6000° C. approximately, its direct utilisation would offer an efficiency closely approaching unity. The leaves of trees, and vegetables generally, are able to absorb and utilise solar energy in producing wood, coal, and food, and they seem to be able to do this without much regard to any hampering law of efficiency. There are two sources of energy not derived from the sun—the internal heat of the earth and the tides. A beginning has been made in utilising volcanic heat in Italy, but the utilisation of tides involves a use of reclaimed land which might be more valuable for other purposes. Dealing finally with atomic energy, Sir Oliver Lodge gave an admirably lucid account of the "planetary" atom on the basis of Bohr's model, showing that electrons can be "evaporated" or ejected with comparative ease, whereas the projection of an α-particle amounts to a veritable explosion. So far, the vast store of atomic energy becomes available only in radio-active substances, and this is already utilised for therapeutic and other purposes. There is, however, the control of electrons emitted from hot bodies, which has been brilliantly applied to the construction of "valves" for many electric purposes, among them being long-distance wireless telephony.

The successful termination of Capt. Ross-Smith's flight from Hounslow to Port Darwin marks a great advance in the history of aeronautics, and is a good omen for the future of commercial aviation. This remarkable accomplishment leaves no doubt as to the possibilities of the aeroplane with regard to rapid transit to distant parts of the earth, especially when it is noted that the weather conditions were by no means good over the greater portion of the route. The machine used was a Vickers "Vimy," fitted with two Rolls-Royce "Eagle" engines of 350 horse-power each, and the greatest credit is due to the two firms for the remarkable endurance of their products under very trying conditions of both flying and landing. The difficulties attending such a flight are very different from those of the trans-Atlantic journey. In the latter case an endurance of 2000 miles without landing was essential, involving the carrying of an enormous load of fuel. The cross-country route to Australia, on the other hand, provided many possible landing places, but endurance of a different kind was necessary, inasmuch as the machine had to fly day after day with little time for attention and repairs, if the flight was to be completed within the specified time limit. Capt. Ross-Smith left Hounslow on November 12 and reached Port Darwin on December 10, having traversed a distance of 11,294 miles, steady progress being maintained throughout the flight. The feat will rank as one of the greatest in the development of the aeroplane, and the heartiest congratulations are due to the pilot and his companions for their remarkable addition to the list of aeronautical triumphs.

On Monday, December 15, one of the galleries of the new building for the Science Museum, South Kensington, was opened for the exhibition of the existing aeronautics section of the collections and for the development of that section by additions which are being selected under the guidance of a number of expert advisers. The occasion was marked by the formal presentation of the Vickers "Vimy" Rolls-Royce aeroplane which crossed the Atlantic. In the absence of the President of the Board of Education, Dr. Ogilvie, Director of the museum, took the chair and referred briefly to the building scheme which had been put in hand for the museum in 1913, but was interrupted by the war. The gallery now occupied was, he said, in the temporary state in which it had been used for war purposes; it was, however, spacious and well-lit, and its use by the museum for a time now would give an opportunity of preparing a more adequate representation of the applications of science in aeronautics. Sir Richard Glazebrook, a member of the Advisory Council for the museum, reviewed recent progress in aviation, and stated that if this country was to hold the place it had taken in the forefront of aeronautics a complete exposition of the subject must be made available for reference in a central museum, such as the Science Museum. It was a matter for great gratification that the Government was giving serious attention to the promotion of research, and one of the functions of the museum was to aid in this by bringing together examples of the ways in which science gave help to industry and commerce. In presenting the aeroplane to the nation, Mr. Douglas Vickers, for Messrs. Vickers, Ltd., explained that it was one of the Vickers "Vimy" machines—bombing machines to carry a crew of three and a ton of bombs for 1000 miles on a non-stop flight. That standard machine had been varied only so as to take, instead, a crew of two with fuel for a journey of 2500 miles.

Mr. W. Walker has been appointed Chief Inspector of Mines in succession to Sir Richard Redmayne, whose impending resignation we announced last week.

Mr. T. W. Reader has been selected by the Geologists' Association as the first recipient of the Foulerton award. The sum of money which has enabled the association to make this award is the recent generous gift of Miss Foulerton in accordance with the wishes of her late uncle, Dr. John Foulerton, who was for many years secretary to the association.

Prof. H. G. Greenish, Dean of the Pharmaceutical Society's School of Pharmacy, has, we learn from the *Pharmaceutical Journal*, been nominated by the Board of Professors of l'Ecole Supérieure de Pharmacie de Paris as one of five foreign men of science upon whom the University of Paris has decided to confer the diploma of "Docteur *honoris causa*" on the occasion of "Une Séance Solennelle de rentrée pour fêter le retour des étudiants des diverses Facultés," on Saturday, December 20.

On Wednesday, December 10, a memorial tablet with a medallion portrait and a suitable inscription was unveiled in memory of Sir William Ramsay in the presence of Lady Ramsay and a large number of friends and members of the University of Glasgow. The address of presentation was delivered by Prof. G. G. Henderson, of the Regius chair of chemistry, and the custody of the memorial was accepted on behalf of the University Court by the Vice-Chancellor. The medallion is the work of Mr. Paulin, and is an excellent likeness; the design of the memorial is due to Sir John J. Burnet. The mural tablet is placed at the head of the great staircase leading to the Bute Hall and the Hunterian Museum. It is set in an arched recess lined with grey marble, and bears reliefs illustrating Sir William Ramsay's numerous decorations and honours.

An influential committee, with Sir F. G. Kenyon as its chairman, has issued an appeal for the foundation of a school of archæology at Jerusalem to conduct exploration in Palestine, Syria, and Mesopotamia. The school will facilitate the work of scholars, train students, excavators, and administrators, and assist in every way the Palestine Exploration Fund. Its researches will extend from the Stone age and the early cultures down to the later Mohammedan period. The school will catalogue existing remains and co-operate with the archæological departments which, it is hoped, the new Governments will establish. It will hold itself aloof from politics and religious controversies. A site has been secured for the necessary buildings at Jerusalem, and Prof. J. Garstang, of the University of Liverpool, who has already visited Palestine, has been provisionally appointed the first director. The scheme is in every way commendable, and the necessary funds will doubtless be provided without difficulty. Communications should be addressed to the Secretary, British School, c/o Palestine Exploration Fund, 2 Hinde Street, Manchester Square, W.1.

A dozen years ago the expressions "newer physics" and "newer chemistry" would have been taken to refer to those branches of the subjects which centred round the words "electron" and "radium" as opposed to those dealing with surface tension, sound, etc., or with atomic weights and constitutional formulæ to which the term "older" might have been applied. It is interesting to note how the last few years have rendered the two terms inappropriate, and how fields which were considered worked out, or at least not likely to produce returns which would justify the time spent on further research, have proved themselves not merely fertile, but also worthy of cultivation for many years to come. A revision of astronomy and physics in the light of the theory of relativity has to be carried out; the hydrophone has brought new problems in elasticity to light; we want more knowledge of atomic weights, of the action of catalysts, and of the synthesis of nitrates. On surface tension and contact angles a whole industry has been founded, some of the problems of which are dealt with by Mr. H. L. Sulman in a paper read before the Institution of Mining and Metallurgy on "Flotation," a summary of which appears elsewhere in this issue.

The foundation of the Salters' Institute of Industrial Chemistry about a year ago was celebrated on December 11 by a dinner given by the Salters' Company to a number of leading representatives of applied chemistry, the Master, Mr. W. B. M. Bird, presiding. Salters or drysalters have for centuries been the recognised dealers in potashes, dyestuffs, and almost every chemical preparation; and their livery of the City of London has taken a prominent part in the promotion of technical education and of research in chemistry. The Company does this because, as Mr. Bird remarked at the dinner, it believes in the progress of chemical industry through scientific knowledge, and considers it a privilege as well as a duty to assist in such development. The institute established last year is not a building or a laboratory, but a foundation for the award of fellowships to enable post-graduate students to continue their studies, or suitably equipped chemists to carry on research in chemical industry. Grants are also made to artisans attending evening classes for the purchase of books and like assistance in their studies. The director of the institute is Dr. M. O. Forster, and under his capable and sympathetic guidance, with the liberal support of the Salters' Company, the fellowships, which are of the value of 250*l.* a year, promise to exert the same effective influence upon chemical science that the 1851 Exhibitions have upon scientific research generally. The scheme was wisely conceived, and its formation gives worthy cause of congratulation to all who are concerned with it.

The appointment of Mr. G. H. Hardy, fellow and mathematical lecturer of Trinity College, Cambridge, to the Savilian professorship of geometry at Oxford reminds us that the present year marks the tercentenary of the foundation by Sir Henry Savile of the first university chairs of geometry and astronomy in Great Britain. Gresham in 1596 had inaugurated similar professorships in London, but the Gresham College never attained the importance it might have done, and London had to wait two centuries for her university. Both the famous Elizabethans, Gresham and Savile, performed valuable services for their Queen and country, and both were favourites at Court. Savile, who was born near Halifax, Yorkshire, in 1549, was, from 1585 until his death in 1622, Warden of Merton College, Oxford, of which he had been made a fellow in 1570. He founded the Savilian professorships in 1619, and the first holders of them were Briggs and Bainbridge, the former of whom had been the first Gresham professor of geometry. Briggs, who, like Savile, was born near Halifax, is best known for his notable works on logarithms and his intimacy with Napier, and the details of his life are generally familiar. Bainbridge did not rise to the same celebrity as his colleague, which may be partly accounted for by the fact that he was trained as a physician, and while Savilian professor of astronomy he was also Linacre reader in medicine. He was born in Leicestershire in 1582, and died in 1643, twelve years after Briggs. Savile, besides being Warden of Merton, was from 1596 Provost of Eton, where he died and is buried. He is commemorated by a monument in the choir of Merton College, close beneath which are the tombs of Briggs and Bainbridge, the former of whom died in the college, and the latter in a house just opposite.

Mr. C. T. Whitmell, the well-known amateur astronomer, who died at Leeds on December 10 after a brief illness, graduated at Cambridge in 1872, being placed in the First Class in the Natural Sciences Tripos and Senior Optime in the Mathematical Tripos. He was a prominent member of the British Astronomical Association, and contributed very largely to its journal. His interests lay in the mathematical rather than in the observational side of astronomy, though his long series of observations of the phenomenon known as the "green flash" are almost unique. Mr. Whitmell acted as director of the expedition to Spain organised by the British Astronomical Association for the purpose of viewing the solar eclipse in May, 1900. He was a fellow of the Royal Astronomical Society and published several papers in the Monthly Notices. His careful determination of the maximum duration of totality of a solar eclipse supersedes De Sejour's erroneous value. On his appointment as H.M. Inspector of Schools in Leeds in 1897 he identified himself with many of the scientific societies in that city. The Leeds Astronomical Society, which owes much to his interest and devotion, elected him as president in 1898–99. In his earlier years Mr. Whitmell did a fair amount of geological fieldwork, both in England and abroad. He was an active member of the Leeds Geological Association, of which he was at one time president.

A notable figure in the engineering world passed away on December 14 in the person of Sir John Jackson. Born in 1851, Sir John was destined to become one of the most potent agencies of his day in directing the forces of Nature and adapting them to the service of man. As a contractor for large public works, he was responsible for the carrying out of gigantic engineering schemes, which have appreciably altered the topography of many lands, and remain a permanent record for the admiration of future generations. His most notable achievements include the great railway across the Andes from Arica to La Paz, the Hindiat barrage across the Euphrates near Babylon, harbours at Singapore and Simon's Bay, the Keyham docks at Devonport, irrigation works in Mesopotamia, the foundations of the Tower Bridge, London, and the last section of the Manchester Ship Canal. Sir John took a prominent part in political life, being M.P. for Devonport from 1910 to 1918. He was a member of the Royal Commission appointed to inquire into the South African War. Another Royal Commission recently exonerated his firm from the charge brought by the Public Accounts Committee that it had unfairly secured contracts which were not thrown open to competition. Sir John was knighted in 1895, and created a C.V.O. in 1911. Educated at York and Edinburgh University, the degree of LL.D. was conferred upon him by the latter. He was also a fellow of the Royal Society of Edinburgh.

A conference of research associations—the second of a series—organised by the Department of Scientific and Industrial Research, was held on December 12 in the lecture-theatre of the Institution of Civil Engineers. The Right Hon. A. J. Balfour, Lord President of the Council, appropriately presided, the Department of Scientific and Industrial Research being a Committee of the Privy Council. Mr. Balfour, who was warmly greeted on his first public appearance in his capacity of head of the Department, delivered a short introductory address on the national need for scientific research, especially in its application to industry. Three points emphasised by Mr. Balfour were that, though man does not live by bread alone, the amelioration of the material lot of mankind can come only through progress in scientific knowledge; that we must not imitate, but follow the example of the Germans in realising a helpful and close alliance between science and industry; and that, in the prosecution of this aim, the paramount interests of pure science must not be overlooked. Papers were afterwards read by Major H. J. W. Bliss, director of the British Research Association for the Woollen and Worsted Industries, on "Research Associations and Consulting Work and the Collection and Indexing of Information," and by Dr. W. Lawrence Balls on "The Equipment of Research Laboratories." There was a general discussion on the subject-matter of the two papers, from which it was clear that, although there is a large common measure of agreement among the different associations, there is also enough variety of circumstance and character to make it desirable for each association to work out its own salvation in many problems of organisation and method. It is the intention of the Department of Scientific and Industrial Research to continue periodically these conferences of research associations. As the Department, in fostering the associations, is engaged in a novel adventure in Government enterprise, the research associations have to set sail on uncharted seas, without maps or precedent experience to guide them, and these periodical conferences must be of great help to them in mapping out their courses and taking their soundings.

The important question of the future of wheat production, with special reference to the Empire, is dealt with at length in the current number of the Bulletin of the Imperial Institute. The annual production of wheat in the world prior to the war amounted to about 110,000,000 tons, the largest producers being the Russian Empire, with an output of 22,000,000 tons, and the United States, which provided nearly 19,000,000 tons. During the war the production in Europe as a whole, and in Russia in particular, decreased considerably, but outside Europe there was a great expansion. The acreage under wheat in Canada, the United States, Argentina, India, and Australia in 1918 was more than 25 per cent. larger than the average acreage for the five years before the war, and it is considered that at the present time there is a sufficiency of wheat, even without the help of Russia, to meet the requirements of the world. As regards the future also there is reason for optimism. There are vast areas of land suitable for wheat-growing yet to be opened up in Canada, Australia, South America, Siberia, and other countries, whilst the present low average yield of thirteen bushels per acre is susceptible of great improvement. In recent years the increase in the world's production has been due to a great extent to an increased yield per acre, and there is every reason to believe that with the introduction of improved drought- and rust-resistant varieties the rise will be even more rapid in the future.

In the current number of *Parasitology* (vol. xi., Nos. 3 and 4) Dr. D. Keilin describes the larval structure and the complete life-history of a species of fly, *Melinda cognata*, Meig., the larvæ of which live as parasites in the snail, *Helicella virgata*, and he gives a short account of various other dipterous larvæ that have been found in living or dead snails and other molluscs. But the most generally interesting part of his paper is, perhaps, the additional note relating to snails and house-fly larvæ, to which Dr. C. J. Gahan has directed attention in a letter to the *Times*. For if the observations made by M. E. Séguy, which are now for the first time made known, turn out to be correct, as they probably will, a solution of the mystery surrounding the hibernation of the house-fly cannot be far distant. That from nine out of fifty snails collected in midwinter larvæ of *Musca domestica* were obtained may be an unexpected, but is not at all an incredible, statement. If true, the fact would at once go far to explain why the search in winter for larvæ or living pupæ of house-flies in or near the places in which they are usually to be found in summer has hitherto always met with failure; for no evidence has ever been obtained to show that house-flies go through the winter in the adult stage, and they must go through it somehow. The larvæ of some flies are known to live only in one species of mollusc, but there is no reason to think that this will be found true of the house-fly. Those who may search for its larvæ this winter would do well not to confine their attention to one or two common species of snail only; and should they look out also for its pupæ they may find them, not inside the body of the snail, as has been absurdly suggested, but in the earth near by, or in the sheltered hole in the wall where the snail itself is found.

A highly interesting paper on "The Direct Replacement of Glycerol in Fats by Higher Polyhydric Alcohols" is contributed to the *Biochemical Journal* for November by Prof. A. Lapworth and Mr. L. K. Pearson. The work described is the outcome of an endeavour to convert the large quantities of fatty acids produced during the war in the manufacture of glycerol into an edible foodstuff. These authors found that when olein or stearin is distilled under reduced pressure with mannitol in the presence of a little sodium ethoxide, almost the whole of the glycerol present in the original fatty compound is expelled, the greatest yield being attained when the proportion of fat to mannitol corresponds with two molecules of the former to three of the latter. The other products of the reaction are chiefly water, a little alcohol, and a substance many properties of which are similar to those of the original fat. The composition of this latter substance corresponds with that of a mixture of the di-oleates (or distearates) of mannitan and isomannide.

THE first number of the *N.P.L. Review*, edited by members of the staff of the National Physical Laboratory, Teddington, appeared in November. Its thirty-six pages contain a large amount of information on the scientific and other activities of the staff, much of which will prove of interest to the general public as well as to those for whom it is primarily intended. Now that the laboratory is a Government institution, it seems reasonable that its work should be more widely known than it has been in the past, and readers of the review will find in it a clear statement of the way in which the laboratory has been fitted into the organisation of the Scientific and Industrial Research Department. From the articles on the old and new directors it appears that the process of fitting has necessitated a decrease in the responsibility of the office, and under Treasury regulations there seem now to be difficulties in the way of rewarding merit by increase of salary. Seven or eight pages are devoted to notes on the most important work passing through the various departments. All are interesting, and show clearly how the scientific problems of the industries are being solved. The staff of the laboratory is to be congratulated on its new publication.

THE power required for actuating the plant and machinery of the Panama Canal is obtained by utilising the flow of surplus water over the Gatun Dam, the height of which above sea-level enables an average effective head of 75 ft. to be realised throughout the year. The power plant at first installed comprised three turbines, each of a rated capacity of 2250 kilowatts when running at 250 revs. per minute and supplied with 500 cu. ft. of water per second. A flow of 500 cusecs, with a fall of 75 ft., produces nominally 3160 kilowatts, so that there is an efficiency margin of 37 per cent. The demand has been found to be much under-estimated, and it has become necessary not only to provide three additional machines of greater capacity, but also to increase the output of the existing generators. Of the three additional machines only one is yet in position, but when the installation is complete there will be three units of 2880 kw. each and three units of 4500 kw. each, totalling 22,140 kw., and requiring a supply of just over 4000 cu. ft. of water per second. The electric energy is employed to drive the machinery of the locks at Gatun, Miraflores, and Pedro Miguel, of the haulage locomotives, of the permanent machine-shops, of the dry dock, and of the coal-handling plant, besides lighting the locks and many towns comprised within the canal zone—a stretch of country ten miles in width across the isthmus. We are indebted for the foregoing particulars to an article in the *Engineer* of December 5.

MR. E. A. MARTIN, the author of "Dew-Ponds," is bringing out through *Messrs. Allen and Donaldson, Ltd.*, 57 Marsham Street, S.W.1, a book entitled "Life in a Sussex Windmill," recounting his experiences of three years in a somewhat unusual dwelling, and giving particulars of his observations of Nature on the Sussex Downs. The portions of the book which will be of special interest to readers of NATURE are the chapters devoted to the geology of the Downs, the problem of the dry combes, prehistoric man and marling, water-supply, fossil oysters, Sussex iron and wood, and the possible discovery of coal in the county.

THE *Cambridge University Press* has in preparation "The Cambridge Ancient History," the general plan of which will be similar to that of the Cambridge Modern and Medieval Histories. It will be in eight volumes, and, beginning with an account of archæological discovery, will trace the history of Egypt and Babylonia, Assyria and Persia, Greece and Rome, to 324 A.D. The work will be edited by Prof. J. B. Bury and Messrs. S. A. Cook and F. E Adcock.

OUR ASTRONOMICAL COLUMN.

THE DECEMBER METEORIC SHOWER.—Mr. Denning writes that this display was well observed at Bristol on the night following December 13. The early evening was overcast, but after a storm of rain at 10 p.m. the sky cleared, and between 10h. 30m. and midnight meteors were observed to be falling at the rate of thirty-five per hour. The moon rose just before 12h., and during the next hour, when her light and films of thin cloud obscured some of the smaller meteors, the horary rate decreased to seventeen. There were two radiants, viz. at $114^\circ+33\frac{1}{2}^\circ$ (eighteen meteors) and at $107^\circ+24^\circ$ (twelve meteors), but the marked differences in aspect of the members of the two streams were very pronounced. The first-named radiant represented the true Geminids, and they are of moderate speed, with short paths sometimes stellar in aspect, and of a sparkling silvery-white colour.

A brilliant Geminid was seen at 11h. 40m. falling from $131^\circ+10^\circ$ to $138^\circ+0^\circ$, and giving a succession of flashes. It lit up the foggy, humid atmosphere, and was much brighter than Jupiter, slightly to the east of it. This meteor must have been a splendid object as seen from the Eastern Counties of England, and it is hoped that further observations will come to hand. A very conspicuous lunar halo was visible during the early morning hours of December 14.

DISCUSSION ON RELATIVITY.—The meeting of the Royal Astronomical Society on December 12 was entirely devoted to the consideration of the theory of relativity. The discussion was opened by Prof. Eddington, who said that while on the first relativity theory time was adopted as the fourth co-ordinate merely as a convenient system, in Einstein's theory the time-space continuum was inextricably blended, so that what was pure time to one observer was resolved into partly time, partly space for another, differently circumstanced. The distinction between past and future was, however, for sentient beings somewhat greater than that between right and left. If space were re-entrant and finite, the section of the continuum in the time direction would be hyperbolic, so that time would not repeat itself after an enormous interval.

Dr. Jeans said that physicists had other than astronomical grounds for asserting that the foundation-stone of the new system was "well and truly laid." It was originally built on experiments, and since its enunciation further experiments had confirmed its truth. He gave the expressions for a wave-front of light, stating that an observer initially at its source remained central in spite of his own movement.

Sir Oliver Lodge referred to some of the apparent paradoxes that had been uttered, and said he preferred to take the æther, not the observer, as his base of reference, instancing the confused idea of the landscape that one obtained when travelling by train.

Dr. Silberstein pointed out that the star displacements on the plates were not exactly radial, which he took to mean that they were not due to gravity, but to some irregular refracting medium. He further said that Einstein himself regarded the shift of the solar spectral lines as vital to his theory.

Prof. Lindemann and Dr. Jeffreys agreed in thinking that the experiments were by no means decisive against the existence of the spectral shift. The latter further stated that a medium capable of producing the observed shift of the stars by refraction would reflect a great deal of sunlight, whereas the plates showed no trace of such matter near κ Tauri.

FLOTATION PRINCIPLES OF ORE EXTRACTION.

AT the meeting of the Institution of Mining and Metallurgy, held on November 20, a paper entitled "A Contribution to the Study of Flotation" was presented by Mr. H. Livingstone Sulman. After giving a brief historical review of the development of flotation as applied to ore extraction, with the problems that arose in connection with successive phases of the process, Mr. Sulman dealt principally with froth flotation, which he characterised as the final link in a long chain of effort. The essentials of this process are that an aqueous pulp shall be agitated with certain reagents which may be classified as a "froth-producing" material, a "froth-stabilising" substance, and a "gangue-modifying" addition.

The explanation of flotation may be based on the differences shown by various substances in the degree to which they are "wetted" by water and other liquids. "Wetting" is a condition of wide variability, and a theory of flotation must be based largely upon the physics of wetting. The degree of wetting may be influenced by the molecular porosity of the solid surface, and indicated more or less quantitatively by the "contact angle" made between the free surface of the liquid and that of its interface with the solid.

Reviewing the various problems encountered in dealing with flotation, Mr. Sulman devoted considerable attention to the molecular constitution of liquids and solids, gravitation and molecular forces, surface energy and surface tension, interfacial tension which involves consideration of the effects of complete wetting and differential wetting, hysteresis, adsorption, the *rôle* played by immiscible oil, and the action of modifying agents such as acids. In this last connection the theories of flocculation and deflocculation have to be taken into account, including their electrical relationship. Film flotation and differential flotation receive separate attention.

The general summary of the paper gives prominence to the following findings:—Flotation reactions result from the molecular forces acting at the surfaces of solids and liquids; these arise from unbalanced molecular attractions in the surface layers, which in turn are in functional relation to the balanced molecular attractions constituting cohesion for a solid or a liquid. Every solid or liquid, therefore, possesses excess energy at its surface, which may be exhibited in adhesion effects. Liquid-solid adhesion is broadly reciprocal to interfacial tension. The degree of wetting can be relatively quantified within certain limits by the contact angle made between the free surface of the liquid and that of the solid. Contact angles have a minimum and a maximum value; the angular difference between these values is the hysteresis of the contact angle, which permits a wider range of equilibrium for a floating particle.

The dynamical aspect of the subject is concerned with the molecular constitution of the interfaces, with the kinetic effects of molecular motion at the surfaces and interfaces of solids and liquids, and with those in the interior of liquids. Solid surfaces are probably penetrable by the molecules of liquids, which enhances the adhesions between them; such penetrations may give rise to a persistent tendency for the solid to be again wetted by the same liquid. Concentration of foreign molecules at the surface of a pure or homogeneous liquid (positive adsorption) reduces the surface tension of the liquid and confers upon it the property of "frothing."

Frothing reagents useful in flotation produce a froth with water, yet leave a partial strain (mineral-adsorptive energy) at the bubble surface. The mineral adsorption now stabilises the film, especially if the mineral be minutely oil-filmed; still more so if flocculated. To be employed effectively the bubble system must be disseminated throughout the mass of ore-pulp. When water-strain is completely removed from the surface of suspended particles, deflocculation results. Flocculation is greatly increased by mechanical agitation, by minutely oiling the particles, and by contact with air; these are factors necessary to produce standard mineralised froths. Generally, if a substance can be flocculated it can be floated. Electrical phenomena are concomitants of minor order. Flotation depends on bringing about the most advantageous selective adhesions, selective adsorptions, and selective flocculations between the complex of particles in an ore-pulp.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS (ABRIDGED) BY SIR NAPIER SHAW, LL.D., Sc.D., F.R.S., PRESIDENT OF THE SECTION.

Educational Ideals and the Ancient Universities.

A PRESIDENTIAL address before the Educational Section of the British Association is an undertaking that might fairly daunt the bravest of those who are really acquainted with its difficulties. The vast range and variety of the problems of education; the enormous amount of effort that is already expended upon them; the torrents of advice and criticism that are offered by those who are familiar with the details of the various curricula, who know how things ought to be done—if I had had time and capacity to become acquainted with all these things, I suppose I must have avoided the duty of making an address. It is, perhaps, the detachment of my present position from any responsibility for details which gives me the courage to recall experiences, now twenty years old, acquired during a lengthy service in various capacities at Cambridge, and matured by twenty years of the consciousness of the dire need of educational discipline and training for those whose business it is to use science in the service of the State.

With a certain amount of assurance I can even be glad that I am not in touch with the educational controversies of the hour, and confidently trust that my deficiencies will be made good by the contributions of those who know to the discussions which will take place in the Section, but the difficulty that I cannot get over just now is that, from the unavoidable circumstances of the present time, a presidential address is a "back number" before it is delivered, for the simple reason that, according to tradition, it must be printed in advance. In this particular year there is an almost immeasurable gulf of experience between the time of my appointment in 1917 and the delivery of this address; the president himself is in many ways a different person from him who undertook the duty of addressing you two years and a half ago.

At that time I had been a good deal moved by the wearying controversy about the relative merits of classics and science in education, because the physical sciences as taught were such a doleful misrepresentation of the spirit of inquiry about the universe which has moved men in all ages and is as clamant to-day as ever. The mysteries of the firmament, the midnight sky, the storm and calm, the earthquake and the thunder, the sunshine, the rainbow and the halo, the intolerable heat and the pitiless cold, the mariner's compass, the aurora and the mirage, are still as wonderful as ever to the wayfarer and the seafarer, and even the dweller in towns wants to know more about them. Yet our educational system, as I knew it, passed all these subjects by and offered instead the determination of the specific heat of copper, with other things that the specific heat of copper stands for. The same, I believe, is true for many of the most interesting subjects of scholarship in ancient and modern civilisations, learning, and languages. And if an inquirer, young or old, should ask whether, if he went there, the great universities could tell him all about the things of wonder or of beauty that he is conscious of, or about the reminiscences of past generations that he finds around him as he travels through life, he could only be told that in consequence of the perverse malignity of external circumstances they had no money to devote to his enlightenment. The capacity would be there in abundance, but not the means. In three years they would put him in a position to pursue intelligently for himself if he pleased any of the subjects in which his interest had been excited, but the facilities for education would extend only to the point where his interest began.

So I wrote a little pamphlet on "The Lack of Science in Education, with Some Hints of What Might Be," and when I was invited to occupy this chair I thought I might be of some service to education if I pressed the subject further and endeavoured to show how, in spite of the good will of nearly everybody concerned, the peculiar constitution of our chief universities was really standing in the way of the lofty ideal of higher education which must find expression if the education which we all want is really to come to pass in this country.

Circumstances have already vastly changed. Committees have sat upon the teaching of science and the teaching of modern languages. A great Education Act has been passed, and the poverty of the universities has overstepped the limits of starvation and a Commission of Inquiry is promised. So we are now on the high road to making presidential addresses matters of quite subordinate interest. Still, you may be interested to hear what I wrote two years and a half ago in explanation of the peculiar difficulties of our educational system; so here it is. It makes a good deal of play of a certain scene in "The Merchant of Venice," which I shall beg you to regard, for a few minutes only, as a satire upon the state of the universities in the spacious times of Queen Elizabeth, after a period of magnificent activity on the part of founders and benefactors and after a succession of statutes for the universities made by successive monarchs for the governance of those institutions, which were then recognised as of the highest importance in the State. Such a period of reconstruction seems to have come again in our time, and the satire, if it be one, is as true to-day as it was three centuries ago.

I was arrested by the curious sentiment, "If to do were as easy as to know what were good to do, chapels had been churches and poor men's cottages princes' palaces." I wondered whether Portia was in fact intended to personify a liberal education. For other subjects of human activity her statement is palpably absurd. All the experience of the British race indicates to us that the acute divisions between people arise in discussions as to what were good to do; the actual doing is easy if the preliminary question "what were good to do" is really decided. Can anyone doubt that after our experience of the war?

But if it were education that Shakespeare was thinking about, chapels and churches, poor men's cottages and princes' palaces are not inappropriate in that connection; the sentiment stimulates the imagination. Certainly in education to know what were good to do does seem in practice to be infinitely easier than to do. From time to time the newspapers are full of reports of conferences, meetings, congresses, and assemblies all fully assured that they know what were good to do, yet very little happens. Our scheme of education is still unsatisfying. Why?

That is the question which I propose for your consideration. Why is it that all the pious opinions about education come to nothing or to so little?

First of all it must be noted that the resolutions and proposals are not addressed to anybody in particular. Presumably they are intended to form public opinion, but public opinion has no authoritative voice with those who are in charge of the higher educational institutions. The resolutions are sent out like wireless signals from a ship at sea. Any educational institution with a receiver tuned to the proper wavelength can take them in, but if the receiver is not tuned or the operator is inattentive, nothing happens. There is no corporate responsibility for the aggregate of our higher educational institutions.

We may, I think, agree that if we wish for ideals in education in this country we must find them in the universities. If the universities give the encouragement of their example and their licence to teach only to men and women who are really educated in the best sense of the word, their influence will leaven the whole of education throughout the country; and, on the contrary, if when they leave the universities the men and women who have to teach, or to control teachers, are themselves imperfectly educated, it is hopeless to expect a well-balanced, living educational system. Among the universities, for reasons good or ill, into which I need not enter, the older Universities of Cambridge and Oxford have a preponderant influence.

And, to my mind, the outstanding characteristic of the organisation of the older universities is the lack of any recognised door by which their corporate responsibility can be reached. In each case the university is itself a corporate educational institution which includes some twenty colleges, which are also separate corporate educational institutions. You never can tell whether the persons with whom you have business are the university or the colleges, and it is quite possible that when you think to address the one you find yourself confronted with the other. The universities in their corporate capacity are constrained by statutes and traditions handed down by our forefathers to look on in comparative impotence while their ideals are distorted or concealed by the interplay of the interests of the many corporations of which they are composed. The whole complex scheme of management forms a sort of craft or mystery which very few even of the initiated really comprehend.

In January of 1917 the Headmasters' Conference (which consists of men with some academic experience) passed a resolution to the effect that Greek should no longer be required for the entrance examination of the Universities of Oxford and Cambridge, and thereupon the Master of University College, Oxford, spent half a column of the *Times* in explaining that the University of Oxford had no entrance examination at all.

This veil of mystery about matters of national concern is very perplexing for those who want things done in education, but do not know the technicalities of the universities. What is true, for Cambridge at least, is that the university *qua* university has no examination for entrance; it is obliged by its statutes to accept as a member without any question anyone presented by the recognised authority of a college, regardless altogether of his qualification or disqualification for a university career. It is a very remarkable arrangement. The university makes no inquiry as to a student's fitness to profit by its educational system; it leaves all that to the colleges, and many, if not all, of the colleges have an entrance examination. So I offer this paradox for the logician who is interested in higher education.

The university consists of the members of its constituent colleges and a few others. At the discretion of the several colleges, or the non-collegiate students' board, 75 per cent. of the members of the university are required to pass an entrance examination before they are accepted for presentation to the university for matriculation. There are at least four examinations of the university which are accepted by colleges on occasions in lieu of their own entrance examinations. Yet there is no entrance examination for the university.

And this does not end the matter. With the power of selecting its students vested in twenty different bodies, the university becomes a controlling body rather than an educational institution with a definite purpose and programme. The regulations for its students are nearly all of them of a negative character. The discipline and the regimen of the university rest upon the assumption that a student desires to secure from the university not so much attainment as a stamp for his attainments. A member of the university cannot be admitted to a degree unless he has satisfied certain conditions of residence, and also satisfies certain examiners; his name is not accepted for the final examination unless he has satisfied certain other examiners. There is nothing in the regulations or administration of the university to secure that a matriculated student shall study or aspire to take a degree. He might live on in idleness and ignorance for the rest of his natural life; the university has no choice in the matter so long as his college pays the periodical fees. It trusts to the colleges to see that idle or unsuitable undergraduates are invited to go elsewhere.

Here we have one of the many instances of the division of jurisdiction between the colleges and the university which hides the ideals of our system of higher education in an impenetrable fog.

The university is governed by the colleges according to a system which goes back to the time when "The Merchant of Venice" was written, so let us revert to the conversation between Portia and Nerissa which expounds the lottery of the caskets in the well-known scene. The position of the university in the matter of the selection or rejection of its members is exactly that which Portia bewailed to Nerissa. Let me invite you to regard the episode of the caskets as a figurative representation of the lottery by which the University of Cambridge selects those upon whom she bestows her inherited riches—*lucem et pocula sacra*. Cambridge, like Portia, the heiress of all the learning of the good and the great, bound by the fantasy of her ancestral tradition never to choose for herself.

Let us think of Portia as the Vice-Chancellor of the University of Cambridge, desiring above all things the advancement of learning, and of Nerissa as a proctor, whose duty it is, as representing the Senate, the collective body of members of the colleges, to see that the statutes and ordinances are duly attended to. Listen to the conversation:—

"*Portia* [*V.-C.*]: O me, the word 'choose'! I may neither choose whom I would nor refuse whom I dislike; so is the will of a living daughter curbed by the will of a dead father. Is it not hard, Nerissa, that I cannot choose one nor refuse none?

"*Nerissa* [*Proctor*]: Your father was ever virtuous; and holy men at their death have good inspirations; therefore the lottery that he hath devised in these three chests of gold, silver, and lead, whereof who chooses his meaning chooses you, will, no doubt, never be chosen by any rightly but one who shall rightly love. . . .

"*Portia* [*V.-C.*]: If I live to be as old as Sibylla, I will die as chaste as Diana, unless I be obtained by the manner of my father's will."

I need scarcely say that I should not spend so much time over what may seem to many of you far-fetched, and perhaps unseemly jesting, if I did not believe that this fantastic view of the lottery of the caskets contains the suggestion of an element in the governance of our highest educational institutions which deserves your gravest and most serious consideration. What I have in mind at the moment is the unforeseen and undesired result of the competition of the colleges within the university itself as quasi-independent educational institutions. It is this small matter, from some points of view of quite minor importance, which, so far as I can see, prevents our great universities from taking the leading part which they might take in exemplifying the ideals of a co-ordinated national system of education, and makes the success or failure of those great institutions something of the nature of a lottery. They may offer ten thousand different avenues from matriculation to a degree, and yet the student may find himself imperfectly educated in the end.

One may, indeed one must, picture to oneself the idea of the colleges as a number of educational institutions co-operating in an avowed and transparent common purpose of the university to display the highest educational ideals. So I think, if they were willing, they might be, without any sacrifice of their individuality or of those magnificent traditions which have fulfilled the high purpose of their pious founders and benefactors. Let us keep that picture for a while in mind.

I have taken from the Cambridge University Calendar for 1918 a list of subjects selected for teaching in the university and colleges, with the number of professors, readers, lecturers, or teachers assigned to the several subjects.

I find that there are 175 university teachers (professors, readers, lecturers, etc.) and 176 college lecturers. I find that the 175 university teachers between them deal with 73 subjects, an average of $2\frac{1}{3}$ per subject, and are distributed between subjects in the following manner:—

Number of university teachers assigned for a subject

9 8 7 6 5 4 3 2 1

Number of subjects which have the number of teachers specified in the upper line

2 3 1 4 1 3 8 10 42

The 176 college lecturers deal with only 23 subjects, an average of $7\frac{1}{2}$ per subject. They are distributed as follows:—

Number of college lecturers assigned for a subject
33 30 23 18 17 10 5 3 2 1 ?
Number of subjects that have the number of teachers specified in the upper line
1 1 1 1 1 1 3 1 3 9 6

Here we see at once a great difference between the educational systems. The university is obviously striving to meet so far as possible its higher educational responsibilities. There is great differentiation of duty; 42 teachers are responsible each for a single subject; there are only two cases in which a subject has so many as nine teachers, whereas in the colleges the tendency is for the same subject to have a great number of exponents. The favoured subjects are:—Classics 33, mathematics and natural philosophy 30, history and economics 23, natural sciences 18, and divinity 17. All those subjects are also provided for, to some extent at least, in the programme of the university. There may be, and indeed must be, some differentiation within these totals, but it is a differentiation which the college authorities do not think it necessary to disclose. Whatever allowance may be made for that, I think it is obvious that the colleges tend to repeat many times over a stereotyped form, and not to distribute their energies over subjects which, for lack of funds or some other reason, are not represented in the university list. Three subjects appear in the college list and not in the university list, namely, modern Greek, Celtic, and military history. We may be sure that the 176 college lecturers are in themselves fully competent to represent subjects of profound human interest which the university disregards for want of means. That it is the system and not the lecturers that account for this convergence upon a few subjects was evident enough during the war, when Cambridge lecturers were to be found among the most proficient and successful workers with their brains in many departments of activity. The needs of peace are not less urgent than the needs of war.

No one can think that the distribution of teachers and subjects would be what it is if the educational system of the university and the colleges were under the control of a single competent body bent upon manifesting a true ideal of the use of educational endowments, whether in money or men.

Suppose, for example, that the council of the Senate were recognised as responsible to the country for the educational system of the university and the colleges jointly; that, once appointed, they were freed from the referendum of every item of their procedure to the lottery of a vote in the Senate. Imagine what would happen if the university really had an entrance examination and the colleges had to select their members from among the successful candidates. One may speculate upon what such a body would produce, but it is scarcely imaginable that they would plump for concentrating so much of the college teaching in general terms upon classics, mathematics, history, and divinity.

And, in support of the contention that diversity of intellectual effort is a pertinent consideration, I would point out that if recondite subjects are to be studied at all it must be at our own great centres of learning. If there is any part of the world where old customs are dying out, or interesting species becoming rare or extinct, it is for highly centralised countries like ours, at a distance from the scene of action, to take care that the subject is studied while there is yet time. On the spot, where no doubt the material is more readily available, people are too much preoccupied to notice the ultimate effect of their own personal activity. If we should, for example, set about exterminating the vermin of London houses (which, by the way, is above all things a most urgent question of rehousing), it is not from any Londoner, or even from our near neighbours in Cambridge, however interesting the minor horrors of war may be to their biologists, that any protest will be raised about the outrage which the extermination would entail upon the province of natural history.

I have looked through that interesting volume "The Yearbook of the Universities of the Empire, 1914," to see whether the older universities of this country and the Empire had a notably extended or different range of subjects. The differences are mostly in name or in the differentiation of medical and theological subjects. It is interesting to note the gradual formation of university teaching in new lands. It seems to begin with medicine and theology, law, engineering, architecture, commerce, and banking; and next to take in our old college friends mathematics, classics, and natural sciences, but it seldom shows any particular characteristics of local scholarship or specialised learning; in the older institutions there are some suggestive subjects, as Assyrian and Babylonian archæology, classical archæology, African languages (Swahili and Bantu), Irish language and literature, Dutch language and literature, Japanese, Portuguese, Scandinavian languages and Thibetan, phonetics, library science, ancient Indian history and culture, Colonial history, Irish history, Scots history, civic design and civic law, scholastic philosophy, Zend philosophy, rhetoric and oratory, geodesics, acoustics, meteorology, and epidemiology in various forms.

Among the subjects which I have noticed in other connections as not represented by name in any of the universities of the Empire, but still claiming attention from those who would help to make the facilities for education complete, there are, in the first place, the history of the various arts and sciences and of medicine, for which some provision has recently been made at Oxford under Dr. Singer; oceanography, which, through the generosity of Prof. Herdman, has now obtained a footing in Liverpool; geodynamics, for which Cambridge wishes to make provision, historical geography and exploration; Malay and Polynesian languages and antiquities, aerodynamics, meteorological optics, now neglected in this country; terrestrial magnetism, seismology, climatology (past and present), particularly of the Empire; illumination and photography, metrology, the science of precision, British archæology and dialects; and perhaps the technical subjects of radio-telegraphy, ballistics, and ventilation. These are subjects with which alone a fully equipped university is competent adequately to deal, and the country is ill-provided until the educational authorities co-operate to supply between them what is needed. To secure this object I am not at all convinced that State aid is the only possibility. The pious benefactor is no more extinct than he was in the days of Henry VIII. and Queen Elizabeth, but while the universities and their colleges speak with two voices and leave us uncertain as to their ideals, it is impossible that he should not be discouraged.

As one passes in review our own educational institutions, one may judge of their ideals by their results. Judging in that way, and looking at the education of our public schools, we may fairly say that the social or ethical ideal is splendid. It expresses the principle of excellence which I take to mean success in fair competition. It is no doubt Hellenic rather than Christian; it is based upon the literature of the ancient Greeks, and has still strength enough to call forth the most devoted self-sacrifice. In the universities also the same ideal is quite easily recognised. There, if anywhere, you can see the worship of success in fair competition developed into a real religion. For a long time I have thought that we should be much nearer understanding our real position in these things if we could persuade the classical scholars to do for Greek religion what the compilers and translators of the Bible did for the Hebrew—that is, to collect together in the best available translation the literature of the Greeks which formed the basis of their guides to conduct. The appropriate contents of such a collection were sketched out by Dr. James Adam, a college colleague of mine at Cambridge, whose untimely death is still deplored, in his Gifford lectures on the religion of the Greeks. With him the subject was a source of unbounded enthusiasm, and his lectures are a series of sermons on the Testament of the Greeks. But we ordinary readers, unlearned in the Greek literature, are in the position of those who are offered sermons on the Old Testament instead of the Old Testament itself. If you imagine where we should stand if the Old Testament were denied to us except in the original Hebrew, you will understand the position the vast majority of us must occupy with regard to Greek ethics, which are, in fact, the ethics of our ruling classes in the old sense. Therefore I use this opportunity to beg those who are enthusiastic for Hellenistic studies to give us such a Testament. I feel sure it will enable us to understand the ideals of the public schools and universities, and throw an entirely new light upon the supposed conflict of classical and scientific studies, which is possibly only another phase of the other perennial dispute about religious education.

The ethical ideals of our schools and universities are clear, excellent in themselves, and appreciated everywhere. They manifestly excite enthusiasm and develop the spirit of self-sacrifice for their maintenance. But what of the intellectual ideals? The subject is important, because the cultivation of the intellect is the avowed purpose of academic institutions, and the part of education which is necessary for carrying on the world's work. Looking at the actual practice of the universities, we can see that the intellectual ideals are obscured, confused, and enfeebled by the very process of competition between colleges which is so eminently successful in developing the ethical spirit.

But the opportunity for strengthening and clearing our intellectual ideals is now. It may require some sacrifice of prejudices and traditions as between colleges and the university, but the reward will certainly be great.

I suppose that the character of any distinguished educationist a century ago would be summed up in the words, "He spared not the rod"; and to-day perhaps the highest praise is expressed by saying that "He spared neither the ratepayer nor the taxpayer," but even that is not enough. Money without motive power does not make education. We may reserve our highest praise for those educational establishments of which it may be said that in the pursuit of a true ideal they spared "neither their prejudices nor their inherited privileges." It may sound sacrilegious, but it must be said: the Portia of our dreams will not become the *alma mater* that the nation needs if she can never be obtained except after the manner of her father's will.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SHEFFIELD.—Prof. C. H. Desch has been appointed professor of metallurgy in succession to Prof. J. O. Arnold. Since September, 1918, Prof. Desch has been professor of metallurgy in the Royal Technical College, Glasgow, and he was previously Graham Young lecturer in metallurgical chemistry in the University of Glasgow.

VISCOUNT HALDANE, as president of Birkbeck College, was in the chair at the founder's day celebration on December 12. Fifty-eight of the graduates of the college who have taken their degrees at the University of London since 1914, totalling 138, were presented to the president. The Principal (Dr. George Senter), in his report, said that 600 Birkbeck men were known to have been on active service. Of these 331 obtained commissions, and 87 names were on the roll of honour. During the war the chemistry department of the college provided certain drugs needed for war purposes, and the physics department tested more than two thousand optical instruments. Four-fifths of the students in normal times were evening students. Lord Haldane gave an address on "What is Truth?" He said this was a topic on which he had been reflecting for forty-five years—ever since he first entered a university. This question was bound up with another, the same thing in another form, the relativity of knowledge, of which we had heard a great deal just lately. Einstein had told them about it, but he had dealt only with a fragment of the problem of relativity, which covered the whole field of knowledge. The problem of relativity went far beyond the mathematics of astronomy. What was it that Einstein had been trying to tell the world? Even when you could put truth into a nutshell, it was not always possible to keep it there. The problem which Einstein had raised was not new. People had thought of time and space as something they knew all about, of a straight line as the shortest distance between two points. He then explained that to answer the question "What is Truth?" we must realise that the principle of relativity had shown us that the reality and our conception of it are not wholly separate. The observer and the observed could not be separated, and account must be taken of the observer. Sir Frederic Kenyon moved a vote of thanks, which was seconded by Mr. James C. N. White.

THE Manchester Municipal College of Technology is making an appeal to the industrial and commercial community of Manchester and of south-east Lancashire for the sum of 150,000*l.*, with a view to the extension of the present building and equipment on land adjoining the college bought some years ago for that purpose at a cost of 44,000*l.* The present teaching resources of the college are taxed to overflowing with full-time day students, who now exceed five hundred, the majority of whom are proceeding to degrees in the faculty of technology in the University, whilst others are engaged in whole-time post-graduate scientific industrial research. There is every prospect that this number will be considerably augmented in the near future, and the governing body is desirous of making the fullest preparation for the increase, having regard to the serious competition of the chief foreign nations, notably America, Germany, Switzerland, and Japan, in the overseas markets. The urgent need for this extension has been commended by several important firms representative of the chief industries of the area, notably those engaged in the chemical, engineering, and textile trades; and at a recent meeting of the local branch of the Federation of British Industries held in the city the following resolution was unanimously passed:—"That, having regard to the fact that the Manchester College of Technology was the first technical institution of university rank to be established in this country, and being firmly of opinion that the development of the invaluable work of the College of Technology" is of vital importance to the well-being of the industries of the district and county, the executive committee of the Manchester District Branch of the Federation of British Industries confidently commends the appeal for 150,000*l.* (of which 26,000*l.* has been promised absolutely and conditionally) to extend the College of Technology to the sympathetic consideration of all Lancashire producers, being of opinion that lack of whole-hearted support will be to the prejudice of Lancashire industry." This welcome change in the attitude of great industrial firms towards technical training and research leads to the hope that this appeal may meet with the cordial support which its serious and essential importance demands.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 4.—Sir J. J. Thomson, president, in the chair.—A. M. **Williams**: The adsorption of gases at low and moderate concentrations. Part i.: Deduction of the theoretical adsorption isostere and isotherm. Part ii.: Experimental verification of the form of the theoretical isosteres and isotherms.—A. M. **Williams**: The adsorption of gases at low and moderate concentrations. Part iii.: Experimental verification of the constant in the theoretical adsorption isostere.—T. R. **Merton**: The secondary spectrum of hydrogen. It has been found that the presence of a large quantity of helium in vacuum tubes containing hydrogen modifies the secondary hydrogen spectrum in the sense that the relative intensities of the lines are completely altered, some lines being extremely weak in the spectrum of the mixture, whilst others are greatly enhanced and a number of new lines appear. Measurements have been made of the lines which are enhanced or unaffected by the admixture of helium; the changes are shown in a reproduction of a photograph of the two spectra in juxtaposition with a wave-length scale, by means of which the lines which are weaker in the spectrum of the mixture can be identified by reference to Watson's measurements of the spectrum. The secondary hydrogen spectrum is of such complexity that the segregation of its lines into series of mathematically related lines is a task which offers great difficulties. These difficulties can doubtless be lessened by the aid of physical methods of separating the lines into different classes.—T. R. **Merton**: The spectra of isotopes. (1) Interferometer measurements of the principal line in the spectrum of ordinary lead and lead from pitchblende show that in the latter case the line is less refrangible by 0·0050 A. ± 0·0007 A., in close agreement with the results of Aronberg. (2) In the case of lead from Ceylon thorite it has been found that the line is more refrangible than in ordinary lead by 0·0022 A. ± 0·0008 A. (3) The positions of the lines are arranged in the order of their atomic weights. (4) Spectroscopic measurements seem to provide a favourable method of distinguishing isotopic elements. (5) A comparison has been made of the wave-lengths of the principal line in ordinary thallium and thallium from pitchblende residues. The wave-length of the line in the spectrum of thallium from pitchblende has been found to be more refrangible than the line in ordinary thallium by 0·0055 A. ± 0·0010 A. In the case of thallium the measurements may possibly be affected by certain disturbing factors which do not apply to the measurements of the lines of lead. Unless the results are affected by these disturbing factors, it would seem likely that the thallium in pitchblende is an isotope of ordinary thallium.—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. Part ii. It is shown that the catalytic action of metals, like that of certain enzymes, is reversible; in other words, compounds which are saturated in the ordinary sense are capable of interacting with the metal to form a system which breaks down into a more stable equilibrium consisting of hydrogen and a less saturated compound. This is readily demonstrated in the case of cyclohexanol; when a mixture of cyclohexanol and methyl cinnamate is heated at 180° in presence of nickel, a considerable transference into cyclohexanone and methyl β-phenyl propionate is effected. It is necessary that both components of the system should be present in the liquid state. Dehydrogenation has also been effected in the case of hexahydroxylene and dihydropinene mixed with methyl cinnamate in presence of nickel; in these cases a temperature of 230° is required. At this temperature small quantities of an ethyl oleate of unknown structure are obtained from ethyl stearate.—F. **Horton** and Ann C. **Davies**: An experimental determination of the critical electron velocities for the production of radiation and ionisation on collision with argon atoms. The critical velocities for electrons in argon were investigated by methods similar to those employed in a previous research for the determination of the corresponding values in helium, the earlier form of apparatus being modified somewhat to facilitate the detection of the beginnings of radiation and ionisation. As the result of many experiments under different conditions, the values 11·5 volts and 15·1 volts were obtained for minimum radiation velocity and minimum ionisation velocity respectively. No sudden increase of radiation at the second critical velocity was detected, and it was shown that no detectable amount of ionisation was produced at 11·5 volts. The limiting wave-length of the argon spectrum, calculated from the value, 15·1 volts, found for the minimum ionisation velocity, is in agreement with the limit observed spectroscopically in the recent experiments of Lyman.

Royal Microscopical Society, November 19.—Mr. J. E. Barnard, president, in the chair.—H. M. **Carleton**: Note on the Cajal formalin-silver nitrate impregnation method for the Golgi apparatus. The theory of silver impregnation in general was briefly outlined and the technique of the Cajal method described. Mention was made of the impregnation of cell-constituents other than the Golgi reticulum, while the problem of the production of artefacts by the various methods used for demonstrating the Golgi apparatus was discussed. Finally, mention was made of the various changes undergone by the Golgi apparatus during certain physiological processes, *i.e.* glandular secretion, intracellular fat formation, ossifraction, etc.—F. I. G. **Rawlins**: Report on the collection of metallurgical specimens recently presented by Sir Robert Hadfield, Bart. In 1918 a suggestion was made that the society might further interest, and perhaps research, in metallography. To this end Sir Robert Hadfield presented the society with a collection of specimens. These were polished at the Royal School of Mines by permission of Prof. Carpenter, and it is intended that they shall be available for microscopic examination by fellows, in much the same way as the general collection. A catalogue is being prepared, which will be ready shortly, giving brief details of the microstructures, etc.

Linnean Society, November 20.—Dr. A. Smith Woodward, president, in the chair.—Dr. G. C. **Druce**: The occurrence in Britain as native plants of *Ajuga genevensis* and *Centaurium scilloides*, Druce, var. *portense* (Brot.). Although there are previous records of *Ajuga genevensis* from Britain, the records are probably mistakes for *pyramidalis* or other species, and in one instance due to a garden-escape of the true plant.

This discovery of *genevensis* on the Berkshire downs is an undoubted evidence of it as a British species. *Centaurium scilloides* is the *Erythraea diffusa* of Joseph Woods, who discovered it near Morlaix, in Brittany. It occurs on the edge of a headland near Newport, Pembroke.—Prof. R. C. **McLean**: Sex and soma. The author enlarged upon the recently discovered phase of multinucleosis in the developing soma cell of higher plants. The genetic interest of the phenomenon has not received sufficient consideration, and the present paper was designed to direct attention to the possibilities involved.

Aristotelian Society, December 1.—Prof. Wildon Carr, vice-president, in the chair.—G. **Cater**: The nature of inference. The logic of the concrete universal as the medium of judgment and inference was criticised. It was shown by analysis of examples that it does not really succeed in making contact with its differences; their content is only *imputed* to it. On the other hand, the instrument of inference is always an intermediating representation, particular and not universal. Absolutism, the outcome of the theory that the active dominant concrete universal is the instrument of inference, ends in the concept of reality, under the form of eternity, as an exhaustive system of differences, without character, a contentless limit.

PARIS.

Academy of Sciences, November 24.—M. Léon Guignard in the chair.—L. **Maquenne** and E. **Demoussy**: The richness in copper of cultivated soils. The soils examined were in two classes, ordinary arable soil and soil on which fruit-growing had been carried out, and which was therefore liable to contain copper from the liquids used for spraying. All the soils contained copper, but the arable soils some millionths only of their weight. The soil from vineyards was compared with soil from the same district untreated with preparations, and the results from a considerable number of districts are tabulated. One fact was brought out by these investigations: the copper applied in spraying is mainly found in the surface layers, and penetrates the ground with great difficulty. At 30 cm. below the surface the soil of a vineyard contains no more copper than soil from a similar depth in a field growing cereals.—A. **Blondel**: The amplitude of the oscillating current produced by audion generators.—Ch. D. Walcott was elected a foreign associate in succession to the late M. Metchnikoff.—E. **Kogbetliantz**: The unicity of ultra-spherical developments.—L. E. J. **Brouwer**: The classification of closed ensembles situated on a surface.—M. **Portevin**: Study of the influence of various factors on the creation of internal longitudinal strains during the rapid cooling of steel cylinders. The determination of the internal longitudinal strains was carried out by measuring the variations in length produced during the removal of concentric layers of the cylinder by turning. The strains produced depend on a number of factors, including the temperature of immersion, the nature of the liquid (oil, water), the temperature of the water, time of immersion, and diameter of the cylinders. The results are summarised qualitatively in the present communication; full numerical data will be published elsewhere.—R. **Bayeux**: The ozogenic power of the solar radiation at the altitude of the Mont Blanc Observatory. At an altitude of 4360 metres sunlight does not produce ozone from oxygen. Hence it is concluded that the ozone found at lower altitudes is not formed by the direct action of the sun, and the therapeutic effects of the suncure cannot be attributed to ozone.—E. **Henriot**: The calculation of double refraction.—M. **de Broglie**: The X-ray spectrum of tungsten.—MM. **Ledoux-Lebard** and A. **Dauvillier**: The reticular distance of calcite and its influence on the determination of *h*. A recalculation of some data given in an earlier communication.—G. **Baume** and M. **Robert**: Some properties of pure nitrous anhydride and of its solution in nitrogen peroxide. The fusibility diagram of the system ($N_2O_3-N_2O_4$) is normal, with a single eutectic near the freezing point of pure nitrogen peroxide. Pure nitrous anhydride does not appear to be capable of existence except at very low temperatures in the solid state, or in the liquid state under a pressure of nitric oxide. At temperatures above $-100°$ C. N_2O_3 dissociates, the liquid phase containing N_2O_4, and the gaseous phase NO.—W. A. **Noyes**, jun.: The potential necessary for electrolysing solutions of iron. In a cell composed of iron anode and cathode and a solution of a ferrous salt absolutely free from ferric salt, it is impossible to deposit iron with a lower voltage than 0·66 volt. This is reduced by increase of temperature, falling to a minimum value of 0·13 at 109° C.—L. **Chelle**: The detection and estimation of traces of hydrocyanic and thiocyanic acids in a complex medium. Hydrocyanic acid can be completely removed by a rapid current, and retained by washing the air with alkali. Chromic acid converts thiocyanic acid into hydrocyanic acid. The results of quantitative experiments are given.—A. **Goris** and Ch. **Vischniac**: The constitution of primeverose, primeverine, and primulaverine.—J. **Bougault** and P. **Robin**: The oxidation of the hydramides. A study of the oxidation of benzhydramide, anishydramide, and piperhydramide by iodine and sodium carbonate. The corresponding cyanidine is produced in each case.—G. **Mouret**: Some effects of the lamination of rocks observed in the western part of the Central Massif of France.—P. **Morin**: The coefficients of flow of the watercourses in the Central Massif.—M. **Dechevrens**: Modification and complement to the method of observation of telluric currents with the aid of naked subterranean conductors.—L. **Daniel**: Experimental researches on the causes of the immersion of the leaves of the water-lily. The immersion of the leaves instead of floating on the surface is not due, as has been suggested, to the effect of the depth of water.—M. **Molliard**: The action of acids on the composition of the ash of *Sterigmatocystis nigra*.—H. **Guilleminot**: The second postulate of the calculus of probabilities and the law of option in the evolution of living matter.—L. **Boutan**: The rotation of the anal region of the larval shell in Gasteropods.—A. **Pézard**: The modifying factor of normal growth and the law of compensation.—M. **Barthélémy**: The definite survival of dogs bled white, obtained by a means other than blood transfusion. The solution injected was a 6 per cent. solution of gum arabic containing 6 parts of sodium chloride per 1000.

SYDNEY.

Linnean Society of New South Wales, September 24.—Mr. J. J. Fletcher, president, in the chair.—K. G. **Blair**: Notes on the Australian genus Cestrinus, Er. (fam. Tenebrionidæ), and some allied genera. The paper discusses the synonymy of the somewhat obscure genus Cestrinus, Er. (fam. Tenebrionidæ), as well as Achora, Pasc., and Adelodemus, Haag.—Dr. H. S. H. **Wardlaw**: The venous oxygen content of the alkaline reserve of the blood in pneumonic influenza. The skin of persons suffering from pneumonic influenza often assumes a distinctly bluish or plum-coloured tinge, and several hypotheses have been put forward to account for this. One question which arises is whether this colouring of the skin is a cyanosis in the generally accepted sense of the word, *i.e.* whether the colour is due to an abnormally large proportion of reduced hæmoglobin in the blood. In the paper the results are given of investigations involving determinations of the oxygen capacity and degree of oxygen saturation of the venous blood of persons suffering from pneumonic influenza; in some cases the acidity and reactivity were determined by means of the hydrogen electrode. The samples of venous blood from cases of pneumonic influenza showed no indication of decreased oxygen capacity or of deficient oxygenation. The concentration of hydrogen ion produced by the addition of a measured quantity of acid showed no indication of acidosis; the alkaline reserve was not reduced.—Dr. R. J. **Tillyard**: The Panorpoid complex. Part 3: The wing-venation. Amongst the new discoveries may be mentioned the proof that the basal cell of the forewing in the butterflies is an *areocel* of very specialised construction, and that all the higher groups have had the venation of the anal area of the hindwing reduced, not by loss of 3A, as hitherto supposed, but by loss of 1A after fusion with 2A to form a Y-vein. A summary is given of the phylogenetic results, and a phylogenetic table with the positions of the more important fossils marked along the lines of descents. The Trichoptera and Lepidoptera are shown to be very closely allied, being a true dichotomy from a common ancestral stem, probably in the Trias. The Megaloptera and Planipennia are even more closely allied, and can only doubtfully be kept as separate orders. The Diptera are traced back to the Triassic Paratrichoptera, themselves an early offshoot of the older Mecopterous stem. The three orders Mecoptera, Paratrichoptera, and Diptera differ from all the rest in having the cubitus only two-branched, and thus lie outside the main line of advance of the complex.

BOOKS RECEIVED.

Calculation of Electric Conductors. By W. T. Taylor. Pp. 34. (London: Constable and Co., Ltd.) 10*s*. 6*d*. net.

The Present Position of the Theory of Ionisation. Pp. 178. (London: The Faraday Society.) 12*s*. 6*d*.

Action de la Chaleur et du Froid: Sur l'Activité des Etres Vivants. By G. Matisse. Pp. ii+556. (Paris: E. Larose.)

The Theory of Relativity. By H. L. Brose. Pp. 32. (Oxford: B. H. Blackwell.) 1*s*. 6*d*. net.

Timbers and their Uses. By W. Winn. Pp. vii+333. (London: G. Routledge and Sons, Ltd.) 10*s*. 6*d*. net.

The Adventurer's Handbook: Being the Manual of the Order of Woodcraft Chivalry. Pp. xiv+119. (London: The Swarthmore Press, Ltd.) 2*s*. 6*d*. net.

The Hill of Vision: A Forecast of the Great War and of Social Revolution with the Coming of the New Race. By F. B. Bond. Pp. xxv+134. (London: Constable and Co., Ltd.) 7*s*. 6*d*. net.

The Coal Consumption of Power Plants, and Bonuses for Coal Saving. By R. H. Parsons. Pp. 23. (London: The Electrical Review, Ltd.) 1*s*. net.

Musings of an Idle Man. By Sir R. H. Firth. Pp. xii+359. (London: John Bale, Ltd.) 7*s*. 6*d*. net.

Engineering Descriptive Geometry and Drawing. By Capt. F. W. Bartlett and Prof. T. W. Johnson. 3 parts. Pp. vii+206; v+207–374; v+375–617. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 27*s*. 6*d*. net.

The Psychology of the Future. By E. Boirac. Translated and edited, with an introduction, by W. de Kerlor. Pp. xiii+322. (London: Kegan Paul and Co., Ltd.) 10*s*. 6*d*. net.

Pictorial Atlas of English History. Arranged by E. J. S. Lay. Pp. 48. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Experiments with Plants. By J. B. Philips. Pp. 207. (Oxford: At the Clarendon Press.) 3*s*. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 18.

ROYAL SOCIETY OF ARTS, at 4.30.—P. J. Hartog: Some Problems of Indian Education.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. J. D. Grant: Tuberculosis of the Larynx: Treatment, especially in the Home.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Adjourned Discussion on A Contribution to the Study of Flotation, H. L. Sulman.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers) at 6.—D. M. W. Hutchison and W. J. Wayte: Electricity in Tin Mining.

CONCRETE INSTITUTE, at 7.30.—M. S. R. Adams: The Use of Elliptical Vaulting as a Primary Factor in Contemporary Architecture.

SOCIETY OF ARCHITECTS, at 8.—Prof. H. Adams: The Need for More Care in Warehouse Design.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street), at 8.—Dr. G. E. Moore: External and Internal Relations.

CHEMICAL SOCIETY, at 8.—Prof. J. Walker: War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes.

FRIDAY, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. W. Burley: Cutting Power of Lathe Turning Tools, Part II.

JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—Sir E. Tennyson d'Eyncourt: The Influence of the War on Engineering (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. J. C. Mottram: The Leucocytic Content in Radium Workers.—Adjourned Discussion on Major Cooper's Paper: The Artificial Stimulation of Muscle, with Demonstration of a New Form of Faradic Coil.

SATURDAY, DECEMBER 20.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital), at 4.30.

CONTENTS.

	PAGE
Physiology and Medicine. By Prof. W. M. Bayliss, F.R.S.	389
Mathematics, Particular and General. By Dr. S. Brodetsky	390
Our Bookshelf	391
Letters to the Editor:—	
Power from the Sun.—A. A. Campbell Swinton, F.R.S.	392
Heat of Reaction and Gravitational Field.—Prof. F. G. Donnan, F.R.S.	392
A Helium Series in the Extreme Ultra-Violet.—Prof. W. M. Hicks, F.R.S.	393
The Constitution of the Elements.—Dr. F. W. Aston	393
The Deflection of Light during a Solar Eclipse.—W. H. Dines, F.R.S.; Lewis F. Richardson; Prof. Alexr. Anderson	393
Einstein's Relativity Theory of Gravitation. III. The Crucial Phenomena. By E. Cunningham	394
The Inheritance of the Naval Officer	396
Notes	396
Our Astronomical Column:—	
The December Meteoric Shower	400
Discussion on Relativity	400
Flotation Principles of Ore Extraction	401
The British Association at Bournemouth:—	
Section L—Educational Science—Opening Address (Abridged) by Sir Napier Shaw, LL.D., Sc.D., F.R.S., President of the Section	401
University and Educational Intelligence	405
Societies and Academies	406
Books Received	408
Diary of Societies	408

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THURSDAY, DECEMBER 25, 1919.

THE PROFESSION OF CHEMISTRY.

The Profession of Chemistry. By Richard B. Pilcher. Pp. xiv+199. (London: Constable and Co., Ltd., 1919.) Price 6*s*. 6*d*. net.

THE late Sir Henry Roscoe, in his autobiography, relates that when he had made up his mind to follow chemistry as a profession his decision caused astonishment and even dismay among his friends and relations, who asked him if he intended to open a shop with red and blue glass bottles in the window. This, he added, was not an extraordinary question in the early 'fifties. Some persons would consider it as not more extraordinary to-day. Fairly well informed people have gradually learned to understand that there is a distinction between the professional chemist and the pharmacist, but the general community still regards the shopkeeper who dispenses medicines and sells drugs and anything else that he thinks may appeal to his clients as a chemist, because he calls himself such. This needless confusion in the public mind exists nowhere else in Europe, and would not exist here if our Legislature and the Public Departments concerned with the issue of Royal charters, and, it may be added, our lay Press, were better acquainted with the functions and aims of the science of chemistry as distinguished from the art and craft of pharmacy.

An eminent foreign physicist, passing through one of our country towns in company with the writer of this review, chanced to see, on the facia of the local druggist, the term "Family Chemist," whereat he was considerably astonished and perplexed. The appellation was wholly unintelligible until it was suggested, as the only way of escape from a laboured explanation, that it might possibly mean a "chemist with a family." As he glanced in turn at the heterogeneous objects in the window—the photographic appliances, hot-water bottles, weed-killers, toilet soaps, electric torches, safety razors, vanishing cream, egg-preservatives, hair-brushes and sponges—and commented on the character of the show-cards his wonder grew. Why a man who dealt in such articles should term himself a *chemist* was incomprehensible to a fellow-countryman of Scheele, who, by the way, always called himself an *Apotekare*; and, further, why the *soi-disant* chemist should advertise himself for the purposes of business as "a family man" was still more inexplicable, unless, as was surmised, he considered it as some justification for his charges. But he was evidently a man of enterprise, since, in addition to his other activities, he traded in spectacles and sheep-dips, sold British and foreign wines, developed photographs, and was the local agent of one of the smaller insurance companies.

That the misunderstanding as to the true vocation of a chemist is widespread is the common experience of teachers when consulted by the parents of boys who have developed a taste for scientific chemistry. The "man in the street," as a rule, has a very hazy idea of the department of knowledge or of human activity with which chemistry is concerned. He cannot be wholly ignorant of its applications, but he seldom knows them as such. Even generally well-informed people are unaware what the profession of chemistry comprehends. It is to meet this lack of knowledge that the registrar and secretary of the Institute of Chemistry has been induced to put together this book.

In a special chapter Mr. Pilcher deals with the claim of pharmacists to the title "chemist," and shows how it has arisen. They base it apparently on the teaching of Paracelsus—no very reputable authority—that "the true use of chemistry was not to make gold, but to prepare medicines." But chemistry was studied, as an art, long prior to the fifteenth century, and was applied to industry and manufacture by the ancient Egyptians and Far Eastern nations centuries before the Christian era. Many of the earliest chemists, it is true, were physicians, and practised their art, like Paracelsus, in connection with their profession. But there was never any exclusive association of chemistry with medicine, and there is no justification, therefore, for the vendors of drugs on this score to assume the title of chemist. Strictly speaking, the pharmacists are the direct descendants of the Apothecaries, who in their turn were descended from the thirteenth-century Spicers, who dealt in galenicals —*i.e.* roots, herbs, and other vegetable products. The Apothecaries gradually took upon themselves the functions of the physicians, whilst the drug-vendors usurped those of the Apothecaries in preparing and compounding medicines. The Apothecaries were originally incorporated with the grocers, and down to the beginning of the reign of James I. such drugs and medicines as were then in use were sold in common by the grocers. In 1617 the Apothecaries obtained their charter, which enacted that the grocers should no longer keep an Apothecary's shop, and that no surgeon should sell medicines. The Society of Apothecaries then proceeded to take action against the frauds and artifices of the grocers and drug-vendors, and established a manufactory of medicinal preparations for the use of their own members. Although Robert Boyle drew a clear distinction in his writings between chemists and the druggists or drugsters, as he indifferently calls them, by the middle of the eighteenth century the popular confusion was such as to draw forth a protest from Berkenhout, who complained that "persons, who know nothing more of chemistry than the name, naturally suppose it to be a trade exercised by shopkeepers called *Druggists* and *Chemists*, who are thought to be chiefly employed in preparing medicines. . . . Chemistry, therefore, they imagine belongs exclusively to physic."

Space will not permit us to follow Mr. Pilcher's historical account in further detail, but it is interesting to note that it was only after the Chemical Society was established in February, 1841, that the "Chemists and Druggists" began to organise themselves, and "at a public meeting of the Trade held at the Crown and Anchor Tavern on April 15th" of the same year, it was resolved "that for the purpose of protecting the permanent interests, and increasing the respectability of Chemists and Druggists, an Association be now formed under the title of the Pharmaceutical Society of Great Britain."

Notwithstanding the various Pharmacy Acts, it cannot be seriously contended that the pharmacist has established any prior or prescriptive rights to the title "chemist." Scientific chemists existed in this country long before 1852, and were so termed: we have only to name Boyle, Black, Priestley, Cavendish, Dalton, Davy, and Wollaston in proof of this fact; pharmacists themselves could only designate such men as *chemists*, but they were in nowise pharmacists or druggists. Perhaps, therefore, the pharmacists would still further increase their respectability by dropping their pretensions to a title to which they have no valid right.

The chemist, properly so-called, will find little in Mr. Pilcher's book with which he is not already familiar, or will not wholly agree. The work, indeed, is not specially addressed to him. It is primarily intended for those who intend to take up chemistry as a profession, and to practise ultimately either as a consultant or as an analytical chemist, research chemist, or works chemist, or who seek to enter one of the Government Departmental or Municipal Laboratories, etc., and on leaving school wish to begin the necessary training. The book may be recommended to parents and also to schoolmasters, who are often the best judges of a boy's aptitudes, but, from their lack of knowledge of the many openings that chemistry affords, and of the proper course to pursue in order to enter the profession, are at a loss to offer sound advice.

Mr. Pilcher has a pleasant literary style; his book is eminently readable, and contains many facts of general interest. It is not often that he will be found tripping, but the sentence at the bottom of p. 120 concerning the appointment of Medical Officers of Health as Public Analysts requires amendment. Certain of the lines have apparently been transposed either in the galley or during the paging of the book.

FLOWERING PLANTS AND FERNS.

(1) *A Dictionary of the Flowering Plants and Ferns.* By Dr. J. C. Willis. (Cambridge Biological Series.) Fourth edition, revised and rewritten. Pp. xii+712+iv. (Cambridge: At the University Press, 1919.) Price 20*s.* net.

(2) *The Living Cycads.* By Prof. C. J. Chamberlain. (University of Chicago Science Series.) Pp. xiv+172. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1919.) Price 1.50 dollars net.

(3) *British Ferns and How to Identify Them.* By J. H. Crabtree. Pp. 64. (London: The Epworth Press: J. Alfred Sharp, n.d.) Price 1*s.* 6*d.* net.

(1) IN the fourth edition of his "Dictionary of the Flowering Plants and Ferns," Dr. Willis has achieved the ideal form in arrangement, the sweeping together of the whole of the material into one alphabetical sequence. Part i. of the original edition, a somewhat sketchy and unequal account of the morphology, natural history, taxonomy, distribution, and economic uses of the phanerogams and ferns, has been eliminated, and the gain of space has been usefully employed in enlarging the scope of the main portion of the work. Dr. Willis claims that he has now found it possible to include all the genera, and though the expert in taxonomy may note a few omissions, the general botanist or student for whom the work is intended will not be critical on this heading. The book is, in fact, a remarkable compendium of botanical information, including not only the genera, which are referred to their family, and accorded some descriptive matter varying from a bare statement of geographical distribution to a paragraph, but also the families, which are treated in detail according to their relative size and importance. A useful feature is the inclusion of a great many popular names of plants and a large number of botanical terms, though the latter are much more exhaustively treated in Dr. Daydon Jackson's classic work. There are also a few general articles, such as one on "Collecting," and on concepts such as the leaf, inflorescence, fruit, etc., in which numerous cross-references are given to other headings.

There are occasional suggestions that the author might perhaps have spread his net a little more widely for his sources of information; and a brief list of standard works of reference, such as Dr. Jackson's "Glossary of Botanic Terms," Britten and Holland's "Dictionary of English Plant Names," and others, might with advantage have occupied one of the blank spaces at the beginning or end of the volume.

(2) The little volume entitled "The Living Cycads" is one of the University of Chicago Science Series, which aims at providing a medium of publication intermediate between the short article of the technical journal and the elaborate treatise; the volumes are written not only for the specialist, but also for the educated layman. Prof. Chamberlain has travelled round the world in order to study in their native habitats the widely separate genera of this group, remarkable for the peculiar habit, form, and structure of the plants, and for their great botanical interest as the surviving remnants of a line which reaches back through Mesozoic into Palæozoic times. During the last fifteen years the author has spent long periods of study in Mexico, Cuba, Africa, and Australia, and the work in the field has been continued in the laboratory by himself and his pupils. The subject-matter is divided into three

parts. Part i., "Collecting the Material," gives an eminently readable account of the different genera and species in their homes, illustrated by some excellent photographs. It will interest the educated layman as well as the botanist. Part ii., "The Life History," is a concise account of the Cycads in their various stages, including vegetative structures, reproductive structures, fertilisation, and the embryo and seedling. It is written with great clearness and is also well illustrated, but the mere educated layman will not get far beyond the first chapter. In part iii., "The Evolution and Phylogeny of the Group," we pass from the record of fact to speculation. This will interest the botanical student, who will follow easily at any rate the development of the different types of female sporophyll from the foliage-leaf, while he will be struck with the comparative uniformity of the male cone throughout the group. The evolution of the gametophyte and of embryogeny presents greater difficulty. Botanists will look forward to reading the much more extended technical account of the living Cycads on which the author has been at work for many years; and the results of this work will be of the greatest interest to those who are investigating the evolution and phylogeny of the Gymnosperms.

(3) Mr. Crabtree's little book on the British ferns makes a delightful introduction to their collection and study. The habitat and form are described in twenty-eight species (about three-fourths of the British species), and each description is accompanied by a full-page photographic reproduction of the plant as it grows and of a portion of a fertile leaf showing the sori on the pinnæ. The latter are sometimes wanting in clear definition. An introduction gives a very brief account of the life-history of a fern, and also directions for collecting, drying, and mounting. The author recommends mounting in a book. This was the custom in the old herbaria, but the plan of mounting on separate sheets which may be kept in a box or portfolio is much to be preferred. It allows intercalation of additional specimens or replacement of old ones, as well as alterations in arrangement, all of which are impracticable with the book-form.

OUR BOOKSHELF.

Ireland: The Outpost. By Prof. Grenville A. J. Cole. Pp. 78. (London: Oxford University Press; Humphrey Milford, 1919.) Price 3*s*. 6*d*. net.

A BRAVE and poetic effort is here made to present what Vidal de la Blache would call the personality of Ireland. The country is viewed as an outpost of Eurasia, from which her people and her civilisation have been derived in successive and overlapping waves. Prof. Cole's name assures the picturesque interest of the structural sections, and the maps and views are most helpful. A laudable effort is also made to set forth the present state of the problem of the peopling of Ireland, and this chapter is a welcome change from the too common fanciful remarks about Celts. No two writers would make the same sketch on this subject, and several would dissent from Prof. Cole's identification of the archæologically named Beaker folk with the "Bronze age" invaders of Ireland and with the monuments of New Grange. Nevertheless, Prof. Cole has made a suggestive summary that may well make a basis for discussion. The very short mention of Roman times and of the days of the saints is a little disappointing perhaps, as the story of those days emphasises the initiative of Ireland.

Separate accounts of the barrier of Leinster and the Irish plain, the uplands of the north and the Armorican ranges of the south, are full of interest with many a picturesque phrase and much fine human sympathy. The section on exits and entrances and communications hints at future developments of train ferries and of trans-Atlantic services from the West, while it gives a fresh criticism of the railway system.

The book should promote a more sympathetic understanding of Ireland's problems, and must be useful to the student and teacher, as well as to the general body of British citizens.

H. J. F.

British Rainfall, 1918. On the Distribution of Rain in Space and Time over the British Isles during the Year 1918. By Hugh Robert Mill and M. de Carle S. Salter. The Fifty-eighth Annual Volume. Pp. 242. (London: Edward Stanford, Ltd., 1919.) Price 10*s*.

TABULAR matter of great precision and of considerable scientific value as recorded by about 5000 observers constitutes the bulk of the information set out in this volume. The British Rainfall Organisation is to be congratulated on the high standard of the work which for the last time is produced under practically private management. Dr. H. R. Mill, after acting as director of the Organisation for nearly twenty years, has given over the control, which has now passed to the Meteorological Office.

An article on the development of the British Rainfall Organisation since 1910 shows considerable activity in the production of rainfall maps. A series showing the annual rainfall of the British Isles from 1865 to 1914, on a scale of nineteen miles to an inch, has been completed. A map on the scale of half an inch to a mile, showing the relation of rainfall to geographical features, is stated to be in contemplation.

Mr. Carle Salter contributes an article on "The Relation of Rainfall to Configuration," and he deals with the physical processes of rain formation.

Rainfall maps are given for each month, showing the actual fall in inches and the percentage of average. A coloured map shows the relation of rainfall in 1918 to the average of 1875–1909. The rainfall was more than 30 per cent. above the average in Merionethshire, Central and North Lancashire, North Dumfriesshire, and part of co. Kerry. The areas of deficient rainfall during 1918 occurred chiefly in the east of Great Britain.

C. H.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Polarisation of Light Scattered by Helium Atoms.

ABOUT a year and a half ago I published an experimental investigation of the *degree of polarisation* in the light scattered at right angles by various dust-free gases (Proc. Roy. Soc., A, vol. xcv., p. 155). I believe the results then obtained to be in the main quite correct, but there is an important point on which I have completely to withdraw what I then said. This refers to the results on helium, which was then found to behave differently from the other gases, giving much less complete polarisation than any of them. The result given was that the weak image (vibrations parallel to incident beam) had 42 per cent. of the intensity of the strong image (perpendicular vibrations). This was given on the results of two independent series of photographs, which were, indeed, obtained under conditions much more difficult than those for the common gases, but were considered at the time to give adequate evidence. I do not even now know what was wrong with them; but on repeating the work with a much improved apparatus, which it has taken many months to design and construct, I have obtained an entirely different, I might say opposite, result.

I now find no intensity large enough to be observed in the weak image, and certainly not 3 per cent. of the intensity in the strong image. It may be possible to lower this limit still further; but, in any case, if helium is outstanding at all, it is in the direction of polarising more, and not less, completely than the generality of gases. The details will be published later, but I write to make the correction as soon as possible, so that no one who speculates theoretically on the subject may be misled by reliance on my former result.

RAYLEIGH.

December 21.

Gravitation and Light.

IT should perhaps be stated, in connection with Mr. Cunningham's remarks (NATURE, December 18, p. 395), that my difficulty with regard to Dr. Einstein's theory must extend to the deviation of light by the sun as well as to its change of period. According to the theory, the velocity of light *diminishes* near the sun; on the other hand, the scale of time is increased, so that the wave-length is not altered. Now, the space being nearly flat, the path of a ray is, with such heterogeneous time, determined fundamentally by minimum number of waves, and not by minimum time; therefore, it should not be altered.

On the other hand, passing from kinematics to dynamics, Dr. Einstein requires in another connection that light should consist of discrete bundles or *quanta* of energy. Let it also be granted that inertia and gravitation are attributes of all energy. It seems to follow that each of these bundles of energy will swing round the sun in a hyperbolic orbit, and that its velocity will be *increased* when near the sun. It is well known that this would account for half the observed deflection. But, again, physical optics could not exist without the idea of transverse waves and their phases, which must be grafted on somehow to the bundles of energy. Now the supposed gravitational derangement of the fourfold extension from the flat being very slight, it can be agreed that the change in extent of each element of it is of the second order. The expansion of scale of time near the sun requires thus a compensating shrinkage of radial lengths; and this second-order effect, the cause of the adjustment for Mercury, will, on the phase-principle of Huygens, just double the previous result. This would amount in all to the observed deflection of the rays.

But amid these uncertainties and apparent contradictions the view asserts itself that the very important astronomical determination is to be regarded as a guide towards future theory rather than as the verification of the particular theory which suggested it.

JOSEPH LARMOR.

Cambridge, December 20.

Radio-activity and Gravitation.

IN connection with the interesting letter of Prof. Donnan in NATURE of December 18, it may be of interest to mention some experimental results which have a bearing on this question. Some years ago Dr. Schuster suggested to one of us that it would be of interest to test whether the rate of transformation of radio-active substances was influenced by the intensity of gravitation. An accurate method of testing the rate of decay of radium emanation over a period of about a hundred days was developed, and it was intended to compare the rate of decay of samples which had been transported to suitable portions of the earth's surface. The outbreak of the war interfered with this plan.

Since, according to Einstein's theory, a gravitational acceleration is in no sense different from a centrifugal acceleration, experiments have been performed in the Cavendish Laboratory to test whether the rate of decay of radio-active substances is affected by subjecting them to the high centrifugal acceleration at the edge of a spinning disc. For the purpose of measurement the γ-ray activity was determined by a sensitive-balance method. Although the radio-active material was subjected to an acceleration of more than 20,000 times gravity, the change observed, if any, was certainly less than one part in a thousand.

This result is not in disaccord with the relation deduced by Prof. Donnan, for a simple calculation shows that his relation predicts an effect very much smaller than can be detected by measurements of this character.

E. RUTHERFORD.
A. H. COMPTON.

Cavendish Laboratory, December 19.

Mortality among Snails and the Appearance of Blue-bottle Flies.

THE residential parts of Calcutta are remarkably free, as a rule, from both house-flies (Musca, spp.) and blue-bottles. This is doubtless due to the excellence of the municipal sanitary arrangements, for at Sibpur, a few miles away, blue-bottles (*Pycnonoma* or *Lucilia dux*) are not only extremely troublesome in the houses, but are also probably connected with frequent epidemics of enteric, unknown in the better parts of Calcutta. For some years past I have noticed in the compound of the Indian Museum that Pycnonoma from time to time becomes relatively numerous, and on several occasions I have been able to trace the flies to their breeding-ground. This has always been the dead bodies of the snail *Achatina fulica*, the largest land mollusc in Bengal.

A. fulica, the shell of which may attain a length of at least 4 in., is not an indigenous species, but was introduced for purposes of dissection by a keen malacologist some sixty-five years ago from Mauritius, whither it had been brought in some unknown manner from tropical Africa, its original home. Col. Godwin Austen [1] has told the story of its introduction into Calcutta, while Mr. E. E. Green [2] has published a report on its prodigious increase in Ceylon, when once its eggs had been carried (accidentally on a cabbage-leaf) into a suitable locality. Fortunately, it is largely a feeder on decaying vegetable and animal matter, and therefore does little harm to crops or gardens, and has even its value as a scavenger. Since, however, I found the maggots in the dead snails, I have noticed that the appearance of blue-bottles in this part of Calcutta invariably coincides with a heavy mortality in the mollusc, which appears to be subject occasionally to some kind of fatal epidemic and also perishes in large numbers after egg-laying at the beginning of the rainy season and during dry spells in and at the end of that season. In one instance investigated the mortality was due not to disease or weakness or to meteorological conditions, but merely to the fact that the snail was enormously abundant and that large numbers of individuals were crushed by people walking on garden paths in the evening.

I have thought these facts worth putting on record as illustrating the delicate balance of Nature and the danger of introducing apparently harmless or even seemingly beneficial animals into a new country.

N. Annandale.

Indian Museum, Calcutta, November 19.

[1] Proc. Mal. Soc., vol. viii., p. 147 (1908).

[2] "Report on the Outbreak of *Achatina fulica*" in Circulars and Agricultural Journal of the Royal Botanical Gardens, Ceylon (1910).

Remains of a Fossil Lion in Ipswich.

In 1910 I discovered a rich bone-bed in a section of Stoke Hill at Ipswich, the deposit in which it occurred being 30 ft. below the surface. The results of the researches then undertaken were published in vol. xiv., part 1, of the Proceedings of the Suffolk Institute of Archæology and Natural History.

As a portion of Stoke Hill is now being cut away for railway sidings, a continuation of the same section is exposed, and with the permission and kind assistance of Mr. A. Woolford, G.E. Railway District Mechanical Engineer, I have been able to work for the past month upon it.

To the animal remains found in 1910, which included large cave-bear, mammoth, large horse, *Bos primigenius*, smaller ox, deer, and bird, I have now added teeth of the largest cave-lion yet discovered, with the exception of the Crayford specimen in the Spurrell collection. These were identified for me by Dr. Smith Woodward and Dr. Andrews, who also examined and named a large assortment of teeth and bones from the site. The list of remains is daily being added to, and a massive skull of deer, with other bones, a tooth, and an antler with a base measuring 10 in. in circumference, still await identification. The position of the tines suggests reindeer. With the help of a grant from the Percy Sladen Research Fund, I am able to continue the work with the care that it requires, and am employing special workmen for the purpose.

The question of the relation of Glacial deposits to these ancient land-surfaces is, of course, of paramount importance, especially as a small number of worked flints have been found closely associated with the animal remains. For this purpose pits are being dug to a considerable depth below our present ground-level in order to ascertain the constituents of the strata below.

Nina F. Layard.

Rookwood, Ipswich, December 17.

Promotion of a Plumage Bill.

May I announce through the columns of Nature the formation of a "Plumage Bill Group," designed to fight the plumage trade by means of publicity to the facts and of pressure upon the Government to bring in a Bill forbidding the importation of all birds' skins for millinery purposes, except poultry, ostrich, and eider-duck? Sir Charles Hobhouse is the president of this group; Lt.-Col. Swinburne, of 23 Eaton Place, S.W.1, its treasurer; and Mr. W. Dewar, of 8 Kenilworth Court, Putney, S.W.15, its hon. secretary. The group is in need both of funds and of assistance, and the former will be very gratefully received by the treasurer, and the latter as gratefully considered by the secretary and the committee.

We feel that a vigorous effort must be made to end the yearly massacre of the world's most beautiful and interesting species of wild bird—a massacre so merciless and extensive as seriously to threaten the extermination of a large number of species, and thus to throw out of gear the great work of evolution. Nor is there any honest or valid argument for the traffic, since this immense drain upon natural resources is for no other purpose than to feed the profits of a small band of East End traders and to satisfy the frivolity of some women.

H. J. Massingham.

December 17.

The Deflection of Light during a Solar Eclipse.

There can scarcely be a downward rush of cold air in places deprived of the sun's radiation during an eclipse as suggested by Prof. Anderson. This would happen only if the upper layers of the atmosphere were cooled more than the lower, and if the cooling were sufficient to bring the temperature-gradient near to the adiabatic. As it is, however, the effect of an eclipse should be to cool the lower layers more than the upper, and so to decrease the temperature-gradient. Moreover, if cooling caused convection movements, we should have upward currents as well as downward, and a development of cumulus clouds would result from the passage of the moon's shadow.

C. J. P. Cave.

Ditcham Park, Petersfield, December 19.

INDUSTRIAL RESOURCES OF INDIA.[1]

As explained in a preface by Sir Thomas H. Holland, the president of the Indian Munitions Board, this handbook was originally prepared in connection with the exhibit of the Board at the exhibitions held in Bombay and Madras in the winter of 1917–18. It was intended to show what had been done to develop India's industrial resources for war purposes. It has now been enlarged so as, in some measure, to indicate the general industrial development which has taken place during, and on account of, the war, and it discusses the possibility of future progress.

The Board was created in 1917 with the view of relieving the United Kingdom, so far as possible, from the necessity of meeting India's demands for war purposes, and particularly for the supply of the forces in India, Mesopotamia, and Egypt. Its functions consisted not only in utilising Indian resources to the utmost extent, but also in controlling and regulating imported

[1] Indian Munitions Board. Industrial Handbook, 1919. Revised Edition. (Calcutta: Superintendent, Government Printing, 1919.) Price 2s. 3d.

material so as to avoid waste and overlapping on the part of different departments of the public service.

After a short account of the history and organisation of the Board and of its relations to indigenous industries, we have a series of reviews of industrial development in Bengal, Madras, Bombay, the United Provinces, the Punjab, Burma, and the Central Provinces. The book then deals with specific industries, viz. the chemical and metallurgical industries; the future of hydro-electric power in India; electrical and engineering manufactures; hides, tanning, and leather; tan-stuffs and tannin extracts; the supply of timber and bamboos; textiles; shipbuilding; railway material; petroleum; calcium carbide; paper-making; paints; glass; the coconut industries of the west coast of the Madras Presidency; soap; bitterns; Portland cement; lac; glue and gelatine; industrial alcohol; medical and surgical appliances; jute, hemp, and flax; pine resin; magnesite and mica; hardware; sandalwood oil; and it concludes with an account of miscellaneous articles purchased by the Indian Munitions Board, and a description of the Tata iron and steel works at Jamshedpur (Sakchi).

With regard to the reports of development in the several presidencies and provinces, each has been entrusted to a member of the Indian Civil Service, usually the Director of Industries or the Controller of Munitions. With one exception, all tell the same story of the strong stimulus which has been given to native industry by the war. "It has taught India its dependence on other countries and the danger of such dependence," writes Mr. Peterson; "it has tended to make the Presidency (Madras) more self-supporting and less dependent on the United Kingdom"; while it has arrested temporarily the development of some industries, it has opened up new possibilities, and diverted energy into new channels (Mr. Innes); Mr. Mead reports that the cotton mills in Bombay, Ahmedabad, and other places in the Presidency have prospered exceedingly during the war; glass-works have been established, and there have been considerable increases in the export of castor, ground-nut, and sesamum oils, and of castor and ground-nut cake; large quantities of casein are being exported, mainly to the United Kingdom and America, and the industry is rapidly extending; chemical manufactures have been established, with the result that many products formerly imported are now made successfully in India. There has been a great development in the utilisation of indigenous timber, and the ample deposits of suitable clays have been turned to increasing account in the production of tiles, bricks, and pottery. Mr. Silver states that "the war has given a strong stimulus to various industries in the United Provinces. The mills and factories of Cawnpore have been engaged almost entirely on war work," working continually, night and day, providing the many woollen and cotton items required for Army purposes. In spite of the very large call for men for the Army, "the Punjab has undoubtedly developed some of its industries very considerably" during the war, writes Mr. Townsend. This is especially seen in the manufacture of textiles, wood and metal work, cutlery, glass, leather, and certain minor industries. The Controller is sanguine that "the experience gained by many thousands of unskilled labourers in the manufacture of useful articles will prove to be not without its value to them after the war." "The effect of the war in developing industries in Burma was less marked than in some other Indian Provinces," reports Mr. Hardiman. This was due partly to its distance from war theatres, but mainly to the small extent to which its raw material is worked up owing to the shortage and high cost of labour, the lack of cheap fuel, and the paucity of roads and railways. The chief assets of Burma are its exportable surplus of rice; the large area of its reserved forests; its minerals and oil-bearing regions. Burma is largely undeveloped, but it has evidently great possibilities; at present it suffers from lack of capital and the reluctance of the Burman to submit to the discipline of an organised industry.

The effect of the war on the industrial development of the Central Provinces has, in the opinion of Mr. Corbett, been adverse, owing, he thinks, to the depletion of staffs both in the Government service and in private employment, the impossibility of recruiting experts, the difficulty of procuring machinery and stores, and the shortage of fuel and of transport. It has retarded the growth of agriculture, and has not permanently benefited forestry. On the other hand, the collection of tanstuffs has undoubtedly derived great impetus from war demands, and has been put on a more scientific and permanent basis. Cement and pottery works are now established as very profitable industries, but a number of smaller industries have suffered from the lack of expert supervision and the impossibility of obtaining adequate plant.

The general impression one derives from the reports of the provincial controllers is confirmed and amplified by the reports of the experts on the present condition and future prospects of the main industries of India. These latter reports constitute a very valuable feature of the book, and are of great interest. We would specially indicate the detailed account of the chemical industries of India by Profs. Sudborough and Simonsen; the report on the metallurgical industries by Dr. Leigh Fermor; that on the leather industry and on tanstuffs by Mr. McWatters and Mr. Fraymouth; on petroleum by Mr. Watt; on Portland cement by Messrs. Musgrave and Davy; and the several reports on lac products, glue and gelatine, and industrial alcohol by Dr. Gilbert Fowler, of the Bangalore Institute of Science. Lastly, we would refer to the account of the Tata iron and steel works at Sakchi (Jamshedpur) by Mr. Tutwiler, the general manager. These were started in 1912. They are on a very large scale, properly organised and laid out, and fitted with modern appliances and labour-saving machinery. They are being rapidly extended and developed, and are certain to exert a profound influence on the industry of the East, not only in India, but also in Ceylon, Java, Manchuria, China, Japan, Australia, the United States, the Argentine, etc., with all of which countries they are building up an export trade in iron and steel castings, machinery, fencing wire, nails, tools, galvanised products, tinplate and enamel ware, etc. An interesting feature is the description of what is being done to promote the intellectual and physical well-being of the workers by the provision of hospitals, convalescent homes, schools, co-operative stores, credit societies, an industrial bank, a concert hall, a restaurant, a reading room, etc.

There can be no question that India is on the eve of most momentous changes, political, social, and industrial—changes which have been largely affected and accelerated by the war. All who are interested in her future will do well to study carefully this official account of her present industrial position. It will amply repay perusal.

THE REFORM OF THE CALENDAR.

THOSE who have concerned themselves with the question of a reformed calendar will find much interesting matter in a report[1] published by a committee which was appointed early in the year by the Paris Société d'Encouragement pour l'Industrie nationale. In 1884 the Abbé Croze, chaplain of La Roquette prison, suggested a competition of schemes to M. Flammarion's journal, *L'Astronomie,* and presented anonymously prizes to the value of 5000 francs, with the rather incompatible conditions that the first day of the year should be always a Sunday, and that the week of seven days and the year of twelve months should be retained. From that time until the outbreak of war, enthusiasts had been making proposals, and, though they had reached little agreement among themselves, they had succeeded in 1910 in inducing the International Congress of Chambers of Commerce at London to pass a resolution in favour of reform, and the Swiss Government to promise diplomatic action. The projects have been reported from time to time in these columns. Since the close of the war, proposals of the kind have been renewed, and the report of the French committee is a useful document.

For the Western world there are two calendars of importance existing. There is the Gregorian calendar and there is the ecclesiastical calendar, founded on the Council of Nicea, which rules the movable festivals of the Churches. Hence there are two quite distinct questions before the reformers. One is to remove the conventional luni-solar element from the latter, and to fix Easter so far as possible relative to the Gregorian calendar. Another is to reform the Gregorian calendar itself, more or less drastically. But yet a third plan has been proposed by a French engineer, M. Paul Delaporte, which consists practically in ignoring these questions and in using a special subsidiary calendar purely for the purposes of industry.

The French committee, under Gen. Sebert, has formulated a number of resolutions which appear sensible and on the whole conservative. This is perhaps natural, in view of the peculiar French experience of ill-considered calendars. It supports the proposal to keep the variation of Easter within the narrowest possible limits—a week instead of a lunar month. This view has the assent of all lay opinion, and it is believed that it is no longer opposed by any ecclesiastical authority. On this point agreement in detail should be reached quickly and carried into effect without delay. Another resolution favours the substitution of the Gregorian for the Julian calendar, a hope which political events may have brought nearer to realisation. On the general manner of reform the committee expresses itself in favour of the continuity of the week. This excludes at once a number of schemes, the latest of which was proposed by M. Deslandres. At the same time, it threatens to make the change so slight as scarcely to be worth making at all. But it leaves open such a possibility of a perpetual calendar as the succession of thirty-five, twenty-eight, twenty-eight days in the month, with thirty-five days in December when the date ends in 0 or 5 generally and twenty-eight days in all other years, with the addition of those dates ending in twenty-five and seventy-five and those divisible by 400. This rule is not more complicated than the corresponding Gregorian rule, and the objection lies not so much to the variation in the length of the year as to the unequal months. Of course, a symmetrical calendar is out of the question, and no change in the present system can offer serious advantage without raising some such objection and meeting with firm opposition in consequence.

M. Delaporte, mentioned above, is properly impressed with the difficulty of ousting the present calendar, and suggests his scheme as an auxiliary, not as a substitute for it. Strictly speaking, his project does not seem to be a calendar at all, because it lacks continuity. He takes the Gregorian year as he finds it, and divides it from the beginning into thirteen months of four weeks each. This is the Comtist calendar without trimmings, but the one or two days at the end of the year must be provided for "à part." He furnishes in the report different mechanical and tabular modes of exhibiting the correspondence between his scheme or "Chronos" and the Gregorian calendar for a year. He claims that the method of reckoning weeks continuously through the year has proved itself advantageous in industrial practice. It is very possible. No doubt the advantage would be increased by uniformity of practice secured by agreement over a wide area. But the ordinary diary gives for each date the number of days elapsing from the beginning of the year, and if on this basis a business man cannot divide up his year to suit the requirements of his calling, suggestions from outside will scarcely help him.

[1] "Commission pour la réforme du calendrier." Bulletin de la Société d'Encouragement pour l'Industrie nationale, tome cxxxi., p. 70.

At any rate, no scientific liability is involved if he persists in the use of the necessarily unequal calendar month when a more convenient uniform period might be substituted. The French committee approves of M. Delaporte's economic calendar for its own special purposes, and recognises that it stands apart from the question of a civil calendar properly so called. H. C. P.

NOTES.

PROMINENCE has been given in the daily papers to an interview with Dr. J. O. Arnold, who has recently resigned from the chair of metallurgy at the University of Sheffield, relating to a new alloy tool-steel, the cutting powers of which are claimed to be far in advance of those of any rapid-cutting tools at present in the market. The element conferring this property is stated to be molybdenum. It was reported in the interview that Dr. Arnold had taken out British and American patents, but that, owing to the veto of the War Office, the Admiralty, and the Ministry of Munitions, he was not allowed to exploit his discovery, and that he was forbidden to communicate its details except under censorship to anyone in Great Britain. Meanwhile, representatives of the United States Government were said to be conducting inquiries in Sheffield. On December 19 it was announced, however, that Dr. Arnold had received notice from the Government that the restrictions had been removed. Until more information is forthcoming as to the precise chemical composition of the steel tools in question it will be well to suspend judgment on the matter. That rapid-cutting tools can be made with molybdenum as the alloy basis has been known for many years. Such tools, however, have hitherto been regarded as peculiarly sensitive to heat conditions, and therefore liable to injury by improper treatment. This has stood in the way of their exploitation in practice.

MORE than ninety years ago alcohol was synthesised from ethylene gas by Hennel. The gas was absorbed in sulphuric acid, with which it combined to form ethyl hydrogen sulphate. On distilling this with water alcohol was obtained in the distillate. Until recently the process has remained a purely laboratory operation. During the war, however, investigations were made into the practicability of utilising for the commercial production of alcohol the small proportion of ethylene present in the gas given off from coke-ovens. A good deal of progress was made and the possibility proved, but the process was not fully worked out. It appears that this has now been successfully accomplished. In a paper read at a meeting of the Cleveland Institution of Engineers, Middlesbrough, Mr. E. Bury, of the Skinningrove Iron and Steel Works, states that practical working has given a yield of 1·6 gallons of alcohol per ton of coal carbonised. The best results were obtained by absorbing the ethylene at a temperature of 60°–80° C. It is calculated that the coal used for coke-making in this country would yield more than 23,000,000 gallons of alcohol yearly, and the ethylene present in ordinary coal-gas, if similarly treated, would supply a further 27,000,000 gallons.

WE have received from the Royal Statistical Society a copy of a petition which has been forwarded to the Prime Minister urging the immediate appointment of a Royal Commission or Select Committee to inquire into the existing methods of the collection and presentation of public statistics and to report on the means of improvement. The lack of co-operation between the different Departments charged with the preparation of statistics, and the consequent lack of co-ordination between their publications, excellent though these are in many respects, and the absence of any sufficient information on points that are now of the first importance (*e.g.* wages, incomes, and home production), are so notorious that some action in the direction indicated is most urgently called for. Adequate information is the very basis of right reform, but in scarcely any case is it forthcoming. The petition received the most widespread support from members of both Houses, from learned societies, from county and municipal authorities, and from those interested in social questions and the use of statistics generally—support which will, we hope, secure its acceptance.

THE Electricity Supply Bill has had many vicissitudes in its passage through Parliament. In its final form it elicited little opposition, if no great enthusiasm. The appointment of Commissioners is universally welcomed. They can do much to co-ordinate the working of new schemes, and can effect great economies by standardisation. They will erect one or two super-stations which will effect an economy of fuel. They will probably also use a certain number of internal-combustion engines, which, theoretically at least, have a higher economy than steam turbines. The appointment of district boards with powers of compulsory purchase was strongly opposed by the electric supply companies, mainly on the ground that it was a breach of the Parliamentary bargain made in 1888. It was pointed out that electric supply was initiated by private enterprise, and that many of the pioneer companies had an anxious and unremunerative time in their early days. To take away the opportunity they had of bettering their financial position in the few remaining years of their concession was not just. The Government, influenced by the strong opposition to the suggested district boards, and possibly also by the approach of the end of the session, dropped all the contentious proposals. There is now a golden opportunity for the companies, both private and municipal, to enter into combination as "joint electricity authorities" for themselves, and it would be good policy for them to make a move in this direction, but at present we see no signs of such a movement. The proposals for district boards, which were all thoroughly discussed in Committee, will doubtless be revived either in this or in a future Parliament.

THE report of the Council of British Ophthalmologists on the desirability of a special qualification in ophthalmology presents a strong and well-considered case. The qualifications required by the principal hospitals of candidates for the post of ophthalmic surgeon—usually the fellowship of the College of Surgeons of England, Edinburgh, or Ireland—furnish no evidence of special knowledge of ophthalmology. The council concludes that there should be a special examination for those who propose to devote themselves to this branch of medicine; and that, owing to the importance of a sound knowledge of the general principles of surgery, pathology, etc., this examination should form part of the examination for a higher degree or diploma, such as the M.S. or F.R.C.S., rather than that it should be a special examination in ophthalmology alone. The council rightly lays stress upon an exhaustive curriculum, including anatomy, pathology, optics, systematic and clinical ophthalmology, and operative surgery. The Council of British Ophthalmologists is doing excellent work in striving to improve the teaching and practice of ophthalmology. It has already reported upon the teaching of these subjects to undergraduates, the lighting of test types, and other matters. It deals with aspects of medicine which are not catered for by the ordinary medical societies, but are of great importance to medical men in their relationship to the general public. It is eminently desirable that the excellent example which the council has set should be followed by other branches of medicine.

THE last day of this year marks the bicentenary of the death of John Flamsteed, first Astronomer Royal of England, and the rector of the parish of Burstow, Surrey, where he is buried, uncommemorated, we understand, by any monument. Flamsteed was born four years after Newton, and was a native of Derbyshire, being the son of a well-to-do maltster. Though prevented by illness from attending a university, he was devoted to mathematical studies, and in 1671 sent a paper to the Royal Society. Three years later he published his "Ephemerides," a copy of which, being presented to Charles II. by Sir Jonas Moore, led to Flamsteed being appointed on March 4, 1675, "our Astronomical Observer" at a salary of 100*l.* per annum, his duty being "forthwith to apply himself with the most exact care and diligence to the rectifying the tables of the motions of the heavens and the places of the fixed stars, so as to find out the so much desired longitude of places for the perfecting the art of navigation." The observatory at Greenwich, constructed partly of brick from old Tilbury Fort and of timber and lead from the Tower of London, was designed by Wren and built at a cost of 520*l.*, the money being derived from the sale of spoilt gunpowder. The struggles and disputes, the dogged perseverance, and the memorable achievements of Flamsteed have their place in the history of astronomy, but it may safely be said that never has king or Government made a better investment than when Greenwich was built and Flamsteed made passing rich on 100*l.* a year.

AT the general meeting of the Association of Economic Biologists on December 10 and 11 more than seventy new members were proposed, and Sir David Prain was elected president for the forthcoming year. Exhibits were made by Messrs. W. F. Bewley, E. E. Green, A. D. Cotton, and W. B. Brierley. Papers were read by Mr. W. F. Bewley on "Sleepy Disease, or Wilt of Tomato," Mr. W. E. Hiley on "A New Instrument for Measuring the Light Intensity in Woods," and Mr. F. R. Petherbridge on "The Life-history of the Strawberry Tortrix, *Acalla comariana*." December 11 was devoted to a symposium on "The Integration of Mycological Research with Practice in Agriculture, Horticulture, and Forestry." Sir Daniel Hall discussed the administrative problems involved and the organisation which the Board of Agriculture proposes in this connection. The training of investigators was treated by Prof. V. H. Blackman. The special needs and difficulties of agriculture were dealt with by Dr. E. J. Russell, of horticulture by Mr. F. J. Chittenden, and of forestry by Prof. W. Somerville. Sir David Prain discussed the part which the newly formed Imperial Bureau of Mycology will play in linking the investigator with the practical man. The meeting was presided over by Prof. F. W. Keeble, and in the discussion following the principal speakers a large number of members took part. The symposium was of great value in co-ordinating many divergent lines of thought, and there can be little doubt that the more frequent adoption of this method at scientific meetings would be conducive to that synthesis which is so great a desideratum in all natural science.

AN interesting and valuable gift which has more than a local interest has just been received by the Plymouth Institution. This is the fine vase presented to Sir William Snow Harris in 1845 by the Emperor Nicholas I. of Russia. Harris, who was born in Plymouth and educated at the Grammar School there, was trained as a doctor in Edinburgh, and for a time practised in his native town. After his marriage in 1824, however, he abandoned his profession to devote himself to the study of electricity. From 1819 onwards he was a frequent lecturer at the Plymouth Institution, where in 1822 his subject was "The Application of Fixed Conductors to Ships' Masts." In 1827 the Lord High Admiral—afterwards William IV.—while on a tour of inspection to the dockyards, visited the institution, and with some naval officers witnessed Harris's experiments. Two years later a Royal Society committee under Davy reported favourably on the proposals, but it was not until 1839, when the matter was referred to another committee, that Harris's new conductors were introduced into the British Navy, although the Russian Navy was already using them. The Copley medal had been given to Harris in 1835, and other honours followed. He was awarded a Civil List pension in 1841; the Emperor of Russia gave him a valuable ring and the vase in 1845; two years later he was knighted, and the Government afterwards made him a grant of 5000*l.* He died in the house overlooking the Hoe in 1867, and his name is inscribed on one of the panels in the Plymouth Guildhall. Harris's fixed conductors replaced the temporary conductors introduced by Watson in 1762, and led to a great diminution in the loss of ships through lightning. His scientific work and his improvements are a notable instance of the benefits conferred upon the community by local scientific societies, and no fitter place for the preservation of the beautiful vase presented to Harris could be found than the institution which saw the birth of his discoveries.

IT is announced in *Science* that Dr. Frank Schlesinger, director of the Allegheny Observatory of the University of Pittsburgh, has been elected director of the Yale Observatory.

THE Physical and Optical Societies' annual exhibition, to be held on Wednesday and Thursday, January 7 and 8, 1920, at the Imperial College of Science, South Kensington, will be open both in the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.). Prof. F. J. Cheshire will give a discourse on "Some Polarisation Experiments" at 8 p.m. on January 7 and at 4 p.m. on January 8, and Prof. A. O. Rankine will give a discourse on "The Use of Light in the Transmission and Reproduction of Speech" at 4 p.m. on January 7 and at 8 p.m. on January 8. Admission in all cases will be by ticket only, obtainable by members of various societies through the secretaries. Others interested should apply direct to the Secretary of the Physical Society, National Physical Laboratory, Teddington, S.W.

THE weather of the past autumn was so abnormal that a few facts concerning it are worth recording. At Greenwich for the whole autumn the mean temperature was 47·7°, which is 3·0° below the normal. There are only three autumns in the last hundred years with lower means—46·8° in 1829, 47·4° in 1840, and 47·0° in 1887. The autumn rainfall was 3·23 in., which is 49 per cent. of the average. There have been only two autumns in the last hundred years with a smaller rainfall—1834 with 2·84 in., and 1858 with 2·80 in. October was the driest month of the year with the exception of May, whereas it is normally the wettest of the twelve months. From October 26 to November 16 inclusive, twenty-two days, the maximum temperature at Greenwich was below 50°, and from November 10–16, seven days, it was below 40°. There has been no similarly long period without a temperature of 50° at the corresponding time of year during the last seventy-eight years. This cold period was due to an abnormal distribution of atmospheric pressure, the barometer being high over Iceland and the neighbourhood, whilst it was low to the south-east and south of England, causing a steady drift of cold north-east and east winds over the British Isles.

In the Journal of the Bihar and Orissa Research Society for September last Mr. M. H. Shastri discusses the contributions of Bengal to Hindu civilisation. In the religious sphere western Bengal was the scene of origin of Buddhism and Jainism. It was the aborigines of Bengal who taught the Vedic Aryans how to tame the elephant and to manufacture silk and cotton cloth. It was from the local performances of mystery plays that the Indian theatre was founded in Bengal. The writer's views in some instances may be open to comment, but the article is an interesting contribution to Indian history.

We have received the annual report of Livingstone College for the year 1918–19. The college gives training in elementary medicine, surgery, and hygiene to missionaries going to spheres of work abroad far from medical aid. During the war the college was transformed into an auxiliary hospital, but has now resumed its proper work. The fees of students do not suffice to cover expenses, the deficit being met by donations, and further donations to the college funds are urgently needed.

In the *Quarterly Journal of Experimental Physiology* (vol. xii., No. 3) Sir E. Sharpey Schafer shows that the fatal result of section of both vagus nerves is due not to pneumonia, resulting from absence of sensation in the parts supplied by these nerves and lack of protection from foreign matter entering the lungs, but to paralysis of certain muscles of the larynx, leading to obstruction of the glottis and slow asphyxia. If this obstruction is prevented, animals live indefinitely with scarcely any abnormal symptoms. In the same journal Prof. Halliburton points out that the waves in the blood-pressure seen during asphyxia are correctly designated as "Traube" waves. Those described by S. Mayer are of a different nature, and being artificial have no physiological significance.

The *Veterinary Review* for November (vol. iii., No. 4) provides a valuable summary of literature on current veterinary science and practice. Among the reviews is one giving a full *résumé* of the methods employed in the examination of milk at the Intercommunal Laboratory at Brussels, with details of the method of scoring. A maximum of 150 points is given for all kinds of milk, and samples of sterilised and pasteurised milk must obtain not fewer than 120 points; aseptic raw milk, 115 points; and ordinary milk, 100 points. The scoring is based upon number of bacteria present, catalase test, reduction test, fermentation test, microscopic characters of films, and kind of bacteria present.

The Thomas Vicary lecture on "The Surgical Tradition" was delivered in the Royal College of Surgeons of England on December 3 by Sir John Tweedy. In 1646 Mr. Edward Arris, and in 1655 Mr. John Gale, gave sums of money to the Company of Barbers and Surgeons for the purpose of lectureships. In 1745, on the dissolution of the union between the Barbers and the Surgeons, these funds became vested in the Surgeons, and afterwards in the Royal College of Surgeons, and "Arris and Gale" lectures have been delivered ever since 1810. Early in the present year the Barbers' Company founded a lectureship at the Royal College of Surgeons to perpetuate the memory of Thomas Vicary, Master of the Barbers' Company in 1540, and the former association between the Barbers and the Surgeons. Sir John Tweedy, who is a past-president of the Royal College of Surgeons and a past-master of the Barbers' Company, first reviewed the life of Vicary, who was Serjeant-Surgeon to Henry VIII., Edward VI., Mary, and Elizabeth, and also resident surgical governor to St. Bartholomew's Hospital. Sir John Tweedy then surveyed the progress of surgery from the period of Egypt and Greece, dealing in succession with the times of Celsus and Galen, the Arabian writers, Lanfranc and Ambroise Paré, concluding with a notice of Dr. J. F. D. Jones, who discovered the true principles of the ligature of arteries in 1805.

Some very interesting notes on the migration of birds over the Mediterranean Sea, by Mr. C. Suffern, appear in *British Birds* for December. The author holds that there are at least three main routes of migration, apart from the Gibraltar line. One of these runs from Cape Bon to Sardinia, Corsica, and the Riviera. Another from Egypt to Crete and Greece. The third seems to run from Africa to Malta, Sicily, and Italy.

Mr. M. A. C. Hinton, in the *Scottish Naturalist* for November-December, describes a new species of field-mouse from Foula, thus adding another to the list of insular forms which have been brought to light by an intensive study of these northern islets. The Foula field-mouse (*Apodemus fridariensis thuleo*)—one of the *Apodemus sylvaticus* group—most nearly resembles the field-mouse of Fair Isle, from which it differs in its smaller size and conspicuously larger feet. Very carefully prepared tables of external and internal measurements enable an exact comparison to be made with other British species of the *sylvaticus* group.

The 1918 Report of the Agricultural and Horticultural Research Station, Long Ashton, Bristol, states that, as is the case with all such stations, the normal work has been considerably interrupted owing to war conditions, and its place has been taken by technical and advisory work, as well as by some few instruction courses for officers. This outside work included investigations into the utilisation of cider-fruit by the jam trade and for other purposes, miscellaneous experiments in connection with fruit and vegetable preservation, and an extensive series of experiments on potato-spraying for the prevention of potato disease. The last-named experiments include investigations into the use of Burgundy mixture and of other copper sprays, and discuss what proportions of soda and copper sulphate are most advantageous in the former mixture. The normal experimental work with cider for the season 1917–18 had to be reduced considerably, and the varieties tested were those which had been examined in former years. The trial orchards for cider-production have received rather scant attention, though some new orchards have been added. Other work includes the study of "reversion" and resistance to "big bud" in black currants; the preserving value of various spices and essential oils; the influence of concentration of sugar solutions upon the growth of micro-organisms; as well as a large amount of advisory work and several special investigations which arose out of it.

Some improvements on his well-known classification of climates are proposed by M. W. Koppen. A summary of his suggestions, without a map, is given in

Revue générale des Sciences for October 15. The three main divisions are tropical or *zone mégathermique*, temperate or *zone mésothermique*, and cold or *zone microthermique*. These are based on considerations of temperature. Two other divisions are placed on the same level, one embracing hot deserts and the other cold deserts, but in their case amount of precipitation is an important determining factor. Subdividing these zones, M. Koppen finds eleven principal climates, which he names as follows: (1) Tropical forests, (2) savannas, (3) steppes, (4) deserts, (5) temperate with dry winter, (6) temperate with dry summer, (7) temperate humid, (8) cold with wet winter, (9) cold with dry winter, (10) tundra, and (11) perpetual ice. In addition to these main climates M. Koppen recognises a large number of secondary and transition climates. With the help of these lists he gives two or three reference letters to every climate on the globe. We gather from the summary that he distinguishes some fifty different climates. Thus the climate of Brisbane is indexed as *Cfa*, which designates a warm temperate climate with rainfall at all seasons, and the mean of the warmest month not above 22° C. Cairo is indexed BW*h*, which means an arid climate of the desert type, with a mean annual temperature above 18° C.

IN a paper read before the London Mathematical Society in 1903 Sir Joseph Larmor showed that when the disturbance propagated into a medium is determined by considering each element of an advancing wave-front to constitute a source of disturbance, as Huygens did two centuries ago, the problem of finding the strengths of these sources was indefinite from an analytical point of view. Many distributions could be found over the wave-front which would give the same total effect. In a further paper read before the society on November 13 Sir Joseph shows that, although analytically the problem is indefinite, physically one specification only is permissible.

IN the *Biochemical Journal* for November Prof. W. D. Halliburton and Messrs. J. C. Drummond and R. K. Cannan describe some experiments made to ascertain the food value, if any, of the synthetic product prepared from olive oil and mannitol by Lapworth and Pearson. The synthetic oil possessed a taste and odour recalling those of olive-oil, but somewhat less pleasant; insufficient oil was at hand to make experiments on the higher animals, so rats were employed in the work described. From the results so obtained Halliburton, Drummond, and Cannan conclude that "mannitol olive-oil" is utilised by the animal organism practically to the same extent as olive-oil itself, and no toxic action was observed to follow its prolonged administration to rats.

A SHORT account of the methods used in France at the present time for the production of radium bromide and other radio-active substances is given by M. Demenitroux in *La Nature* for November 1. Pitchblende from Joachimsthal being no longer obtainable, the industry is dependent on carnotite from Colorado, autunite from Portugal, and certain rare-earth minerals from Madagascar. These contain fewer than 15, and in some cases not more than 4, milligrams of active material per ton. The first operation consists in the separation of the barium, and this process is a long and costly one. The radio-active materials are separated with the barium, and the second operation is the separation of the two from each other. This is done by fractional crystallisation, a tedious but certain process which involves, as a rule, 500 successive crystallisations of the material. Finally, one of the tubes used in medicine containing 100 milligrams of radium bromide is obtained from 12 tons of the ore, 3 tons of hydrochloric and 1 ton of sulphuric acid, 5 tons of carbonate of soda, and 10 tons of coal. The present cost in France of the hydrated bromide of radium, $RaBr_2,2H_2O$, is 500 francs per milligram.

HITHERTO it has been stated in the literature that chloropicrin can be distilled unchanged at ordinary pressure. Messrs. J. A. Gardner and F. W. Fox have observed, however (Journal of the Chemical Society for October), that when the pure anhydrous substance is distilled at atmospheric pressure a small amount of a yellowish-red gas, resembling diluted nitrous fumes, is invariably produced, and can be seen in the atmosphere of the condenser and receiver. These authors show that this is due to a slow decomposition of the boiling chloropicrin into carbonyl and nitrosyl chlorides, according to the equation

$$CCl_3.NO_2 = COCl_2 + NOCl.$$

If 200 c.c. of the substance are boiled gently, the rate of decomposition is approximately 2 c.c. per day. This observation will account for the divergence between statements made on the physiological activity of chloropicrin. Further, the experiments of Frankland, Challenger, and Nicholls, showing that under some conditions chloropicrin is quantitatively reduced to methylamine, and under others to ammonia, would be explained by the reduction in the first case of chloropicrin *per se*, and in the second of its decomposition products. In some reactions chloropicrin seems to act as a nitro-compound, *e.g.* it can be substituted for nitrobenzene in Skraup's method of preparing quinoline; whilst in others the results can be explained as due to the carbonyl and nitrosyl chlorides.

THE latest catalogue of second-hand books of Messrs. W. Heffer and Sons, Ltd., Cambridge (No. 184), comprises a number of works on history and economics from the library of the late Rev. Dr. W. Cunningham; also books on architecture and archæology, and old travels to the East.

MR. FRANCIS EDWARDS, 83 High Street, Marylebone, W.1, has just circulated a Catalogue (No. 396) of autograph letters, historical documents, and manuscripts. Many of the letters are the work of explorers and men of science. The section devoted to manuscripts contains several items of great historical value.

AMONG forthcoming books of science we notice the following:—A "Peat Industry Reference Book," the late F. T. Gissing (*Charles Griffin and Co., Ltd.*); "The Life and Inventions of Sir Hiram S. Maxim," P. F. Mottelay (*John Lane*); "Military Psychiatry in Peace and War," Dr. C. S. Read (*H. K. Lewis and Co., Ltd.*); "The Life and Letters of Silvanus Phillips Thompson, F.R.S.," Jane S. and Helen G. Thompson (*T. Fisher Unwin, Ltd.*); and "The Life of Sir William White, K.C.B., F.R.S.," F. Manning (*John Murray*).

IN reference to our notice of the *Daily Telegraph* Victory Atlas (November 13, p. 276), Messrs. Geographia, Ltd., take exception to the remark that "a mistake is made in the area of the Slesvig plebiscite." This criticism, which had reference to the course of the frontier of that area, was based on the abstract of the Treaty of Versailles published in Treaty Series, No. 4, and our reviewer wishes to examine the German large-scale maps of Slesvig before accepting the boundary shown by Messrs. Geographia, Ltd. Meanwhile, we regret if his reading of the text and maps of the abstract gave a wrong impression of the accuracy of the *Daily Telegraph* Atlas.

OUR ASTRONOMICAL COLUMN.

BARNARD'S PROPER-MOTION STAR.—It was shown in *Mon. Not.* for November, 1916, that this star was observed by Lamont at Munich in 1842, being Mun. (1) 15040. Further confirmation of this is given by K. Graff in *Ast. Nach.* (4989 and 5007). He has surveyed the region with the 60-cm. refractor at Bergedorf, and gives visual magnitudes on the Harvard scale, and colour on the Osthoff scale, of twenty-eight stars in the region. The Barnard star is of mag. 9·37 and colour 3·4, being the reddest star in the field. There are nineteen individual measures of its magnitude, ranging from 9·22 to 9·60, but they are not grouped in a manner suggesting variability. The magnitude of the star Mun. (2) 6966, which Bauschinger observed in 1886 in an unsuccessful search for Mun. (1) 15040, is 10·79 and colour 2·0. Its proper motion is small, and it must have been extremely near the Barnard star in 1843. As there was some doubt whether the star B.D. +4° 3561 was the Barnard star or Mun. (2) 6966, Prof. Kustner has re-examined the original zones at Bonn, with the following interesting result. Zone 462 was observed on 1854 May 30, the air being very clear. The following two stars were recorded in the region:—

	Mag.	R.A. 1855·0 h. m. s.	N. Decl. 1855·0 ° ′
(a)	... 9·5	17 50 43·8	+4 16·5
(b)	... 9·5	17 50 44·3	+4 17·9

Zone 472 was observed on 1854 July 24, the air again being clear; on this night a single object was recorded in the place, thus:—

(c)	... 9·3	17 50 41·9	+4 17·3

In editing the B.D. it was assumed that objects (*a*) and (*c*) were the same, and their mean was taken as the position of +4° 3561, while object (*b*) was omitted as insufficiently observed. However, making use of our later knowledge, it is fairly certain that (*a*) is Mun. (2) 6966, (*b*) is the Barnard star, while (*c*) is probably the two objects observed as one (the telescope was small and the magnifying power low). This would account for the greater brightness recorded on July 24, which is unquestionably too high for Mun. (2) 6966. In view of these facts, the two stars must divide the claim to the title B.D. +4° 3561, but another early observation of the Barnard star (1854 May 30) has been established with tolerable certainty.

Mr. Graff estimates the diameter of the Barnard star as 1/20 of the sun's, or half that of Jupiter. This is based on its absolute magnitude and an estimate of its surface brightness from the character of the spectrum. It seems, however, unlikely that so small a body could ever attain the temperature necessary for a sun-like state. Prof. Eddington considered that a mass 1/8 of the sun was the minimum for the attaining of a sun-like condition. If we assume a density eight times the sun's, or twice that of the earth, this would give a diameter 1/4 of the sun's. It seems unlikely that the actual value is less than this.

THE GREAT SOLAR PROMINENCE OF LAST MAY.—Several reproductions of the photographs of this object, taken by the eclipse expeditions, have recently appeared (*Observatory*, November, and the British Astronomical Association's Journal, October). The Monthly Notices for June contained some photographs taken with the Cambridge spectroheliograph. The *Astrophysical Journal* for October gives some beautiful photographs taken at short intervals with the Yerkes 40-in. refractor. The first photograph was taken at 1h. 17m. G.M.T., about midway between the Sobral and Principe pictures. The prominence then formed a great arch, extending from −42° to +6° in latitude, and 4·5′ high. It was rising rapidly, and 1¼h. later it had broken away from its terminal columns. Successive plates show that the rising continued steadily, and at 7h. 57m. G.M.T. its height was 17′, or more than a solar radius. It rose from 200,000 km. to 760,000 km. in 6h. 40m. Mr. Evershed also secured many photographs of the object at Kodaikanal, but the longitude of Yerkes was more favourable for securing its most dramatic stage. The prominence had been in existence since March, but on the eclipse day it suddenly changed from the quiescent to the eruptive type. The Yerkes observers direct attention to a claw-like marking at the base of one of the columns, from which they infer that this base was exactly on the sun's limb.

ATOMIC DISINTEGRATION AND HEAT ENERGY.

SIR OLIVER LODGE, in the Trueman Wood lecture to the Royal Society of Arts, referred to last week, asked whether atomic energy may not already be being unconsciously utilised. The recognition of radio-activity as a process of natural transmutation, in which a large and previously unknown store of energy associated with the atomic structure is released in the disintegration of the atom and its change into totally different kinds of atoms, dates, of course, from the early years of the century. The natural conclusion is that, before this energy can be rendered available, artificial transmutation must be possible, and that this transmutation certainly does not occur in any other case than in that of the radio-elements, and then only spontaneously and in a manner not to be altered by artificial means.

Sir Oliver Lodge appears, however, to think that internal atomic energy may be being already unconsciously made use of, and cites two possible cases. The first is vision. The retina is supposed to contain a substance the atoms of which are capable of accumulating a few million impulses of æther-waves of luminous frequency. This causes the atom to eject one or more electrons, and it is these electrons rather than the original light-waves which stimulate the nerve-endings. Even accepting this as an interesting and suggestive new photo-electric theory of vision, which accounts satisfactorily for the extreme sensitiveness of the eye, the energy involved is surely the energy of the exciting radiation rather than internal atomic energy. Photo-electric effects in general are not supposed to be different from or more fundamental in character than other electro-chemical effects.

In the other example it is the energy of the electrons emitted by an incandescent wire which is in question. It is possible to welcome and recognise the very great advance which the use of this phenomenon, by means of the thermionic valve, has achieved in wireless telegraphy and telephony, without accepting the view that any new form of energy is utilised. The emission of electrons is, indeed, described as analogous to the evaporation of molecules from a surface, the velocities being distributed in accordance with Maxwell's law for a monatomic gas. It would seem sufficient to ascribe the energy of the electrons to heat energy, at least until it is proved that it is not so derived. The mere latter-day interpretation of many of the changes studied by the chemist and electro-chemist in terms of the electron does not alter their character, which is well understood by chemists not to be of the type they would regard as transmutational, or to involve the kind of energy disclosed by radio-activity, or, indeed, any other kind than what has been familiar in chemical, electro-chemical, and physical changes since these subjects began to be studied.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION M.

AGRICULTURE.

OPENING ADDRESS (ABRIDGED) BY PROF. W. SOMERVILLE, D.SC., PRESIDENT OF THE SECTION.

DURING the past four years—or since the ploughing programme began to take shape—grass-land has been officially cold-shouldered in no small degree. The cause was obvious and the reasons were good. The result of compulsory and voluntary ploughing has been that, whereas in 1914 the total area in Great Britain under temporary and permanent grass (hay and pasture) was practically 21.500,000 acres, it was barely 19,500,000 acres in 1918, a reduction, namely, of about 2,000,000 acres. During the same period the arable area, other than temporary grass, increased from about 10,500,000 acres to 12,500,000 acres. In Ireland during these years the area under grass (permanent and temporary) fell from about 12,500,000 acres to less than 11,250,000 acres. The United Kingdom at the present time comprises about 30,500,000 acres of permanent and temporary grass and 15,500,000 acres of land under crops other than grass and clover. This is over and above some 16,000,000 acres of mountain land used for grazing.

A considerable proportion of the grass-land of this country is of so high a quality that any improvement, and certainly any economic improvement, is hard of accomplishment. Satisfactory as are the high-class pastures of this country, it by no means follows that there is nothing more to learn about them. It is often very difficult to determine the factor or factors that go to the making of high-class pastures. Such pastures are to be found on most of the geological formations of this country; they are met with north, south, east, and west; and even altitude, within the limit of at least 700 ft., seems to have little effect. An immense amount of attention has been given to the botanical composition of the herbage of the more famous of the pastures of Britain. The result that emerges most conspicuously from these researches is that one may have a dozen pastures which are about equal in feeding value and yet may vary widely in respect of botanical composition. Thus Fream found that in the case of forty-eight English and eight Irish pastures, each of which was the "best" in the district selected, the Gramineæ might be as low as 11 per cent. and as high as 100 per cent.; Leguminosæ might be entirely absent or as high as 38 per cent.; while of miscellaneous herbage, most of which would be designated as "weeds," there might be none or up to 89 per cent. As regards individual genera and species, Fream found, for instance, that Agrostis was almost always present, and on five occasions was the most abundant plant; while *Holcus lanatus* gave an almost identical result. By a different method Carruthers arrived at a very similar conclusion. The latter also found that *Hordeum pratense* was the most abundant species on what is perhaps the finest grazing in England, namely, Pawlett Hams, near the mouth of the Parret, in Somerset. This investigator even found that on one of the "famous ancient pastures of England" the predominant grasses were Fiorin and Hassock, and in this connection makes the following remark, "In this field the hassock-grass, which made up a large proportion of the pasture, was freely eaten, and the cattle were in good condition."

In Hall and Russell's investigations Agrostis and Holcus might on occasion each exceed 20 per cent., and it is stated that "wherever *Holcus lanatus* occurs it is more abundant on the fatting fields." Even miscellaneous herbage could bulk more than 29 per cent. on a pasture so good that it could fatten five bullocks on four acres without cake. Armstrong found in a field representative of "the richest type of old grazing land found in the Market Harborough district" that, amongst grasses, *Poa annua* came second (12·3 per cent.) in point of abundance. There will be general agreement that four of the grasses just mentioned, Fiorin, Yorkshire Fog, Squirrel Tail, and Hassock, are accounted "bad," and yet it is hard to apply this term to plants which are the most abundant constituents of some of the finest pastures in England. While there is much that is disconcerting in these investigations, some facts do emerge with satisfactory consistency:—(1) That the great majority of high-class pastures contain a large proportion of perennial ryegrass and white clover; (2) that crested dogstail is almost always present, though rarely predominant; (3) that meadow fescue is practically negligible; and (4) that of the two Poas, *pratensis* and *trivialis*, the former is very rare, while the latter is very common.

The obvious deduction to be drawn from these investigations is that the quality of a permanent pasture is only in a minor degree determined by the relative abundance of its constituent plants, or, in the words of Hall and Russell, "We can only conclude that the feeding value of a pasture is largely independent of the floral type." Factors of much greater weight are depth and physical character of the soil, soil moisture and temperature, density of the herbage, and the natural or induced composition of the soil as regards plant-food, and especially in respect of phosphoric acid.

It seems that the lesson that may be learned from a study of the old pastures of England is that we need not include in a seeds mixture for permanent purposes plants which never bulk to any considerable extent in old grass-land, but that we should include all those which are usually naturally abundant. Take, as an illustration, the case of perennial ryegrass. In the eighties of last century, when much interest was taken in the subject of the best way to lay down land to grass, an almost violent controversy arose over the desirability or otherwise of including perennial ryegrass in a seeds mixture for permanent pasture. The main opponents of ryegrass were Faunce de Laune and Carruthers, who would have excluded this species in all circumstances. It is a common experience of those who have laid land away to grass with ordinary commercial seed that perennial ryegrass does not persist, but neither, for the matter of that, does white clover. And the probability is that the cause in both cases is to be found in the same direction. Both these plants, as usually grown in this and other countries for seed, are the progeny of a long line of cultivated ancestors, grown under somewhat forcing conditions which may be said to undermine the "constitution." They have adapted themselves to their artificial environment, and such adaptation has taken the form of early maturity and the production of a large yield of "bold" seed which is easily marketed. Gilchrist has, of late years, directed attention to the merits of wild white clover, which, as regards persistency, is on an altogether different plane from the cultivated or Dutch white. The price that farmers are willing to pay for the seed of wild white clover is the best proof of the sharp distinction which they draw between the two varieties. What we now want is similar work on grasses, and particularly on perennial ryegrass, and it is satisfactory to know that such work has actually been started.

Important as is the position of the fine old pastures of England in the agricultural economy of the country, and interesting though it may be to examine questions of seeding, a much more important line of inquiry is opened up by the problem of the improvement of our second- and third-rate pastures. What proportion of the grass-land of the country falls into the lower categories it is impossible to say, but the most superficial acquaintance with rural England is sufficient to carry conviction that the aggregate area of such land is enormous. Most of the poor grass-land of the country is associated with the heavier classes of soil, and has been abandoned to grass on account of the high costs of cultivation, including, in many cases, the necessity of drainage. It is, for arable purposes, essentially wheat-land, with an occasional crop of beans, and the regular intervention at comparatively short intervals of a bare fallow. Other areas of poor pasture, smaller in aggregate extent than the clays, but still of much importance, are to be found on all the geological formations of the country. Of the 14,500,000 acres of permanent grass in England and Wales, 70 per cent. is under pasture and only 30 per cent. under hay, and of the poorer classes of grass-land it is certain that the proportion that is grazed is still greater. It is evident, therefore, that the improvement of pasture is relatively a more urgent matter than the improvement of meadows, though with more than 4,250,000 acres of permanent grass made into hay in England and Wales during 1918, the latter problem is also one of enormous importance. The most famous experiments on the effects of manure on permanent hay are those started in 1856 by Lawes and Gilbert on the meadow at Rothamsted, and continued ever since on the lines originally laid down. The results have thrown a flood of light on the principles of manuring, which has been of the greatest assistance in the elucidation of problems in agricultural chemistry and soil physics. They have also shown unmistakably the effects of the more important elements of plant-food on the yield of hay and on its botanical composition, but, even supported as they were by elaborate chemical analysis of the produce, they leave us uncertain in regard to the feeding value of the herbage.

A very large number of experiments have been carried out which had for their object the determination of the quantitative results attributable to the use of manures, singly and in combination. In many cases these experiments were supported by a botanical, and not infrequently by a chemical, analysis of the resultant herbage, but it was felt that we were still in a state of much uncertainty in respect of the quality of the hay—that is to say, its effect on animals consuming it. This induced Middleton in the winter of 1900–1 to carry out a feeding experiment with sheep at Cockle Park, and in 1905–6 and 1907–8 Gilchrist continued and amplified this work. The sheep were accommodated in a special house. The various lots of sheep all got equal quantities of roots, cake, and hay. The hay employed was the produce of variously manured plots on old grass-land which I laid out in 1897. The soil is a clay loam on a boulder clay subsoil. This set of experiments includes the eight-plot test, and it may be interesting to see what influence nitrogen, phosphoric acid, and potash respectively have on the produce. The quantitative figures refer to the average annual yield for twenty-one years, 1897–1917, while the figures which indicate the relative values of the produce, as determined by the live-weight increase of sheep, are based upon the feeding tests already specified. The hay from the unmanured plot, No. 6, is assumed to be worth 4l. per ton. The results are set out in the accompanying table:—

Plot	Manuring per acre per annum	Average annual yield of hay	Value per ton of hay as determined by feeding
		cwt.	s. d.
6	Unmanured	19¼	80 0
7	30 lb. N in Sulphate of Ammonia	23	72 0
8	50 lb. P_2O_5 usually in Basic Slag	20	93 0
9	50 lb. K_2O in Muriate of Potash...	16	80 0
10	30 lb. N + 50 lb. P_2O_5	30½	84 0
11	30 lb. N + 50 lb. K_2O	21	72 0
12	50 lb. P_2O_5 + 50 lb. K_2O	26	101 9
13	30 lb. N + 50 lb. P_2O_5 + 50 lb. K_2O	30½	89 2

Nitrogen derived from sulphate of ammonia, and used at the rate of 30 lb. per acre per annum, has consistently increased the yield and as consistently reduced the quality. When used alone the nitrogen has increased the crop by 3¾ cwt. per acre, and reduced the feeding value of the hay by 8s. per ton. When added to phosphates, the nitrogen has increased the yield by 4¼ cwt. and reduced the quality by 9s. per ton. When nitrogen was added to potash the yield has been raised by 5 cwt. per acre, and the value lowered by 8s. per ton. When used as an addition to both phosphates and potash the nitrogen has increased the yield by 4½ cwt. per acre, while the value has fallen by 12s. 7d. per ton. Even if the quality of the hay be disregarded, the use of nitrogen has always been attended by an adverse financial balance; when quality is taken into account this undesirable result is greatly emphasised.

As regards phosphoric acid, an increased yield has been consistently obtained by its use, accompanied in every case by a marked improvement in the quality of the hay. Taking the arithmetical mean, the increase in quantity has been nearly 8½ cwt. per acre, while the increase in quality is represented by 16s. per ton.

The behaviour of potash is rather peculiar. It has quite distinctly reduced the yield when used alone or when used in combination with nitrogen only, while in both these sets of circumstances it has had no influence one way or other on the quality of the hay. When added to phosphates it has proved powerless to increase the yield, but it has raised the feeding value of the hay by 8s. 9d. per ton. When added to both nitrogen and phosphates the potash has been practically inoperative so far as yield is concerned, but it has improved the quality by 5s. 2d. per ton.

These results show that very erroneous conclusions may be reached if, in experimental work on meadow hay, attention is given only to the weights of produce secured. Thus, in these Cockle Park experiments, on the average of twenty-one years, if quantity alone be regarded, sulphate of ammonia used by itself has involved an annual loss of 6s. 4d. per acre, whereas, if the reduced quality of the hay be taken into account, the loss is increased to 15s. 7d. per acre. On the other hand, a quantitative gain of 4s. 2d. per acre per annum from the use of phosphate and potash is raised to one of 32s. 5d. owing to the superior quality of the hay. While there is a certain relationship between the chemical composition, the botanical analysis, and the feeding value of the hay, there will probably be general agreement with Middleton when he says that "without an appeal to the animal, the relative values of samples grown under different treatment cannot be measured." In my view, this form of research may, with advantage, be largely extended.

Turning now to the improvement of pastures, as contrasted with meadows, it may be remarked that while no sharp line can be drawn between these two classes of grass-land in respect of ameliorative treatment, there are certain distinctions which must be kept in view. In a meadow the plants are allowed to grow up to full maturity, whereas in a pasture they are cut over daily, or at least very frequently, by the grazing of the animals. It is difficult to arrive at a decision as to whether a larger gross weight of dry material is got from a given area treated as pasture, in contrast to being hayed, but the probability is that the aggregate quantity is greater. Take the analogy of a patch of lucerne. Cut three or four times in the season, it may yield six tons of dry matter per acre, cut once it would certainly yield much less. Or take the case of cocksfoot; this springs so quickly in the aftermath that the foliage may shoot up 6 in. almost in as many days, whereas there would be no such growth were the hay not cut over. It is a matter of observation, too, how quickly red clover springs up after cutting, and trees and shrubs which may be growing only a few inches annually when unrestrained may send up stool shoots several feet in length if cut over. It is difficult, however, to bring the question to the test of figures.

If there is any doubt as to the greater weight of dry matter produced under a system of grazing, there can be none in respect of its digestibility. This would appear to be the reason why sheep and cattle will fatten on a pasture, whereas the animals would only remain in store condition on the herbage if made into hay.

At one time experiments on the improvement of pasture took the form of temporarily enclosing an area, to which different methods of treatment were applied and of determining the results in terms of hay. Supplementary to such quantitative determination, chemical analysis and botanical separations were often made, but it is evident from the work of the investigators already quoted that the results so obtained may be a very untrustworthy index of the feeding value of the herbage. In any case, the competition between the various classes of plants may be very different in a hay field and in a well-grazed pasture. Again, in a hay field the produce is reaped and cleared off with all the plant food which it contains. In a pasture, on the other hand, there is the daily conversion of vegetable substance into manure and its immediate return to the land. Reflections of that sort induced me in 1896 to arrange a series of experiments where a direct appeal was made to the animal. We all know that among a lot of animals there are certain individuals which possess idiosyncrasies which result in their thriving better or worse than the others. By careful selection, however, and especially by keeping them under observation for a probationary period, this objection may be largely eliminated. The greater the number of animals, the more completely is any disturbance due to individual peculiarities got rid of, and for this reason sheep are usually employed in preference to cattle. No one who looks into the details of these "manuring for meat" experiments can doubt that, not only in broad outline, but even in the finer details, the results are perfectly trustworthy. Involving as they do considerable outlay on fencing, water, weighing machines, etc., and necessitating the use of large areas of uniform land, such experiments were not likely to be undertaken with great frequency, but I have been able to find reports of nine in England, twelve in Scotland, two in Ireland, and one in New Zealand. Two of them are situated at Cockle Park, of which the original in Tree Field has now completed its twenty-third season, while the other in Hanging Leaves has a record of sixteen years.

The outstanding feature of these experiments is the great and profitable effect of phosphates. In this material the farmer is placed in possession of an agent of production the effects of which on the output of meat, milk, and work from the pastures of this country are only limited by the supplies. In many cases the increase of meat is trebled, and even quadrupled, with a return on the original outlay that runs into hundreds per cent. As between the various sources of phosphate there is unmistakable evidence that basic slag is the most effective, not only in respect of aggregate yield of meat, but also, and more particularly, when the net financial return is considered. This conclusion is also reached by Carruthers and Voelcker in a long series of pasture experiments carried out in 1896–99 for the Royal Agricultural Society of England. In these experiments, however, the effects were only estimated by ocular inspection. The primary effect of phosphates is due to the marked stimulus that they give to the growth of clovers and other Leguminosæ, and as these plants revel in a non-acid soil the alkaline character of basic slag appears exactly to suit their requirements.

In regard to the quantity of phosphatic manure that can most effectively be employed per acre, it would appear that in the case of inferior pasture a heavy initial dressing, say 200 lb. of phosphoric acid or more per acre, is likely to be nearly twice as effective as half this dressing, and therefore actually much more profitable. To secure the best results the Leguminosæ must be rapidly brought up to their maximum vigour, so that they may fully occupy the ground before the grasses have had time to react to the effects of the accumulated nitrogen.

One of the most striking results of these pasture experiments is the long period over which the action of phosphates persists. Even at the end of nine years the meat-producing power of half a ton per acre of basic slag is far from being exhausted. It is not suggested that this persistent action of slag—and no doubt this applies also to any other effective phosphate—is due to unappropriated residues. It is much more probably due to two other causes: (*a*) to the fact that on a pasture, in contrast to a meadow, manurial elements are kept in circulation from the soil to the plant, and from the plant to the animal, and so, to a large extent, back to the soil again; and (*b*) to the accumulation of nitrogen in the form of humus. Poor, unprofitable grass is chiefly associated with clay, and it is fortunate that it is precisely on such land that clover responds so markedly to phosphatic manuring. But conspicuous results have also been obtained on deep peat, on light stony loam, on thin chalk, and on chalk covered by clay with flints. Middleton has very fully discussed the conditions under which phosphatic dressings may be expected to give results, and ascribes an important place to soil moisture, on which white clover is directly very dependent. The only conspicuous case of failure of phosphates to improve pasture was encountered in Norfolk, where a "manuring-for-mutton" experiment was started in 1901. The soil at that station was a hot, dry, sandy gravel containing 60 per cent. of sand, and there both the basic slag and superphosphate were unable to produce any improvement. Wood and Berry attribute this result partly to the presence of abundant natural supplies of citric soluble phosphoric acid, but chiefly to lack of moisture. In reporting on the R.A.S.E. experiments Carruthers and Voelcker in 1900 had already directed attention to the dependence of basic slag on soil moisture.

We may now look at the effect of supplementing phosphates with certain other substances. And, first of all, as regards potash. At most of the manuring-for-mutton stations, both in England and Scotland, there was a plot devoted to the elucidation of the effect of this substance, and although in the great majority of cases the phosphate-*plus*-potash plot has shown more live-weight increase than phosphates alone, it is only in very rare instances that the gain has been a profitable one. Even on thin soil overlying chalk, potash has had little action on pasture. There are several rather conspicuous instances of quite moderate dressings of potash doing positive harm. Thus, at Cockle Park, whereas potash gave an appreciable increase in live-weight in the first nine years, it proved positively and progressively injurious during the next two six-year periods. Even on a "light stony loam" in Perthshire, Wright found that, although in the first two years potash when added to slag gave a conspicuous return, in the next three years "the advantage was wholly with the slag-alone plot." The most notable beneficial effect of potash was obtained in Dumfriesshire on a station where the mineral soil was overlaid by 10 ft. of peat. There the use of kainit supplying 100 lb. of potash per acre at the beginning of the experiment has in seven years produced 70 per cent. more meat than phosphate (slag) alone, while the financial gain has been improved by nearly 50 per cent.

Potash has had great influence both on the yield and composition of the hay on the meadow at Rothamsted, and it would seem that this substance has more effect on a meadow than on a pasture. The reason is probably to seek in the fact that in a pasture the top layers of the soil are constantly being enriched by the potash brought from the subsoil by plants and returned through their excreta. In any case, pasture plants on clay soil are in possession of abundant supplies of potash, and it is only where pasture occupies sandy, gravelly, or peaty soil that this manurial element need be seriously considered.

Lime as an addition to superphosphate was tested at the three original manuring-for-mutton experiment stations, a total of 30 cwt. per acre being applied in three dressings in nine years. A noticeable effect was produced at all stations, and at two of them the gain was a profitable one. The effects of lime can be followed for twenty-one years at Cockle Park, where the soil naturally contains 0·59 per cent. of calcium carbonate. During that period an aggregate of 5½ tons per acre was applied in seven dressings, the phosphate to which it was added being superphosphate in the first nine years and basic slag in the next twelve. The area receiving the lime was the same throughout. The action of the lime has proved to be a progressively decreasing one. On the average it produced an annual increase of 22 lb. live-weight in the first nine years, and of 8 lb. in the next six years, whereas in the concluding six years of the period it has actually caused a reduction in live-weight of 8 lb. per acre per annum.

The addition to superphosphate of moderate dressings of nitrogen in the form of sulphate of ammonia or of nitrate of soda was tried at the three main manuring-for-mutton stations, and at two others. There is no need to go into a detailed discussion of the results. The evidence is overwhelmingly against the use of nitrogen on pastures. It undoubtedly stimulates the vigour of the non-leguminous herbage, but this reacts on the growth of the clovers, with the result that the production of meat is sometimes, as at Cockle Park, actually and substantially reduced.

At the three original stations dissolved bones were also tried, the comparison being with equal quantities (200 lb. per acre in nine years) of phosphoric acid derived respectively from basic slag and superphosphate. The dissolved bones supplied in addition from about 30 lb. to 40 lb. of organic nitrogen. All manures were applied as to half in the first year, and, as to the other half, at the commencement of the fourth season, the experiment being continued for nine years at Cockle Park and Sevington (Hants) and for eight years at Cransley (Northants). At Cockle Park slag acted substantially better than dissolved bones, though the latter surpassed the effect of superphosphate; at Sevington dissolved bones proved inferior to both the other manures; while at Cransley the position was reversed. But when the cost is considered there is no question of the superior merits of basic slag. This superiority is continued and emphasised at Cockle Park, where the experiments are now at the end of their twenty-third year. A similar result was also obtained in the series of pasture experiments conducted by the Royal Agricultural Society of England already referred to. There dissolved bones or bone-meal was tried at ten centres, with the result that "in Herefordshire some benefit was observed, but in the other places no real improvement could be detected as compared with the unmanured part of the field. So far as these investigations go, therefore, they indicate that no further experiments need be made with bones on pasture land."

With these results before us it is needless to pause to consider whether the comparative failure of bones, dissolved or raw, is due to the inferior quality of their phosphate or to the fact that they supply the land with nitrogen.

A form of pasture improvement which has had, and still has, much support amongst farmers is feeding with cake. The manure applied to the land through cake residues is a "general" manure, supplying nitrogen, phosphates, and potash, of which that which has the highest value attached to it is the nitrogen. At eleven of the stations in England and Scotland reported on in the Supplement to the *Journal of the Board of Agriculture* in 1911, linseed or cotton cake, or a mixture of these cakes, was used for two, four, or five years, and at every one of them the live-weight gain secured was insufficient to pay for the outlay, the debit balance per acre per annum being in one case nearly a pound. In connection with the improvement of pasture, however, it is the residual effect of the cake that has most interest. This matter was put to the test at eight of the manuring-for-mutton stations in the following manner. At the three original stations cake was fed all through the season for two years, and none given for the next four. At five of the other stations cake was fed for two or four years, and was then suspended for one, two, or three years. In this way the improvement of the herbage effected during the years when cake was fed had an opportunity of manifesting itself in the form of live-weight increase in the years immediately succeeding, when no cake was given. In every case the residual effect was found to be appreciable, having a money value per ton of cake consumed of as much as 4*l*. 14*s*. at one station, and 3*l*. 11*s*. at another, the average for the three stations where the residues were followed for four years being fully 3*l*. per ton, a figure which is of the same order as, though somewhat higher than, those adopted by Voelcker and Hall in their revised table of 1902.

A method of improvement of poor pasture that deserves notice consists in scattering the seed of a "renovating" mixture over the surface, usually with concurrent harrowing, rolling, and manuring. This procedure was practised in the series of experiments conducted by the Royal Agricultural Society of England, the seed mixture consisting of four natural grasses in addition to white clover and yarrow. In their final report Carruthers and Voelcker stated that re-seeding had not been successful, a result which they thought was "entirely due to the prevalence of dry seasons, the germinating plants being killed before they could get hold of the soil." A more successful result is reported by Middleton, who on a poor pasture on clay soil in Essex sowed, in the spring of 1903, 12 lb. per acre of wild white clover seed, with and without basic slag, kainit, and lime, this treatment being unaccompanied by harrowing. There were no Leguminosæ naturally present in the field. Helped by abundant rain in the summer of 1903, the seed germinated well, and "in 1904 the results were very marked." It was, however, only when the seeding had been accompanied by basic slag that "there was the luxuriant growth which one expects in pastures where Leguminosæ are present." I also have reported on an experiment where renovating a thin, poor pasture with 6 lb. per acre of wild white clover seed was entirely successful, and here, too, the beneficial effects were only secured in the presence of basic slag.

When a responsive pasture is treated for the first time with, say, half a ton of basic slag per acre, the effects reach their maximum usually in the third season. From then onwards there is a steady diminution in the yield, though even after nine years from the time of the initial dressing the improvement is far from being exhausted. At Cockle Park, for instance, the plot dressed once with half a ton of slag was, at the end of nine years, producing three times as much mutton as the continuously unmanured ground, while at Sevington and Cransley the yield at the end of nine and eight years respectively was 70 per cent. to 80 per cent. greater. None of the other stations was carried on for so long a period, but up to the end of the sixth year most of them show residual fertility which is as great as the original rental value of the land. That is a very important result, but in the interests of the country it is still more important to endeavour to secure that the level reached at the period of maximum productivity shall be maintained.

From this rapid survey of grass-land experiments the following conclusions may legitimately be drawn:—

(1) That the quality of a pasture is not primarily dependent on its botanical composition, though, as a rule, the presence of white clover and other Leguminosæ is indicative of high feeding value.

(2) That poor pastures, especially on clay soil, can be rapidly and profitably improved by the use of phosphates, especially basic slag.

(3) That, as a rule, phosphates alone are necessary to effect and maintain the improvement, and that, of supplementary substances, potash and lime are occasionally worthy of attention.

(4) That the improvement of poor pasture is very dependent on the presence of Leguminosæ, and especially of white clover.

(5) That renovating with the seed of wild white clover may, in the absence of natural Leguminosæ, be a necessary preliminary or concurrent operation.

(6) That cake can rarely be used at a profit, and that, as an agent in improving poor pasture, it occupies an unsatisfactory position.

(7) That nitrogen, whether in the form of artificial manure or as cake residues, when added to phosphates for pasture, is always unnecessary and frequently detrimental.

(8) That in the case of hay on permanent grass-land, equal weights of produce may have very different feeding values.

(9) That few forms of agricultural expenditure are more certain in their results than the judicious use of manures on grass-land, and that the meat- and milk-producing capacity of the country can be largely and rapidly increased, with great pecuniary gain to the farmer, and still greater economic advantage to the nation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Mr. C. Grant Robertson, tutor in modern history since 1905 to Magdalen College, Oxford, and a stimulating lecturer upon national development, has been appointed to succeed Sir Oliver Lodge as Principal of the University.

CAMBRIDGE.—Mr. K. J. J. Mackenzie has been re-appointed reader in agriculture. Other appointments are:—Mr. W. J. Harrison, University lecturer in mathematics; Mr. A. Wood, University lecturer in experimental physics; Mr. A. G. Tansley, University lecturer in botany; and Mr. F. Balfour Browne, University lecturer in zoology.

DURHAM.—Members of the University are invited to help in compiling the definitive edition of the Roll of Service and Roll of Honour. The latest date for receiving forms framed to include all details of military service is December 31. The address of the University offices is 38 North Bailey, Durham.

EDINBURGH.—The University Court has made the following appointments to three newly instituted chairs:—Dr. G. M. Robertson to the professorship of psychiatry, Dr. J. H. Ashworth to the professorship of zoology, and Mr. T. P. Laird to the professorship of accounting and business method.

The following appointments have also been made:—Dr. F. E. Jardine as lecturer on applied anatomy, and Dr. David Lees as lecturer on venereal diseases.

The Right Hon. Lord Lyell of Kinnordy has presented to the geology department forty-six volumes which had formed part of Sir Charles Lyell's library when he was preparing his "Principles of Geology."

The late Mr. Samuel Elliott, of New York, has bequeathed to the University Court the sum of 1500*l.* to be held in trust by it for the purpose of applying the income in providing scholarships or prizes in connection with the classes of the professors of rhetoric and English literature and of ancient history and palæography, the scholarships or prizes to be known as the James Elliott scholarships or prizes, in memory of the testator's brother, James Elliott, who was a student and graduate of the University.

At the last meeting of the Munitions Committee, South-East of Scotland Area, a sum of 500*l.* was set aside to be expended in providing additional equipment for the engineering laboratory.

LIVERPOOL.—Mr. T. E. Peet has been appointed to the Brunner chair of Egyptology, and Dr. J. Share Jones to the chair of veterinary anatomy.

LONDON.—Dr. Sydney Russell Wells has been elected Vice-Chancellor in succession to Sir Cooper Perry, who has been appointed to the post of Principal Officer.

Sir Richard Glazebrook has been appointed to the Zaharoff chair of aviation tenable at the Imperial College of Science and Technology, founded by Sir Basil Zaharoff, who gave to the University the sum of 25,000*l.* for this purpose.

Dr. A. P. Newton has been appointed, as from September 1, 1920, the first occupant of the newly established Rhodes chair of Imperial history tenable at King's College.

Prof. W. Bulloch has been appointed, as from January 1, 1920, the first occupant of the newly established Goldsmiths' Company's chair of bacteriology tenable at the London Hospital Medical College.

The following doctorates have been conferred:—*D.Sc. in Applied Statistics:* Mr. E. H. Chapman, an internal student, of the Sir John Cass Technical Institute, for a thesis entitled "The Application of Statistical Methods to Meteorological Problems." *D.Sc. in Botany:* Mr. S. C. Harland, an internal student, of King's College, for a thesis entitled "Manurial Experiments with Sea Island Cotton in St. Vincent." *D.Sc. (Engineering):* Mr. N. A. V. Piercy, an internal student, of East London College, for a thesis entitled "On the Flow in the Rear of Aerofoils."

Dr. Thomas Lewis, of the cardiographic department of University College, has been awarded the William Julius Mickle fellowship, of the value of 200*l*., in recognition of the important work which he has carried out on the nervous mechanism of the heart.

OXFORD.—Dr. F. W. Keeble, who has been elected to the Sherardian professorship of botany in succession to Prof. S. H. Vines, was formerly professor of botany and dean of the faculty of science at University College, Reading. In 1914 he was appointed Director of the Royal Horticultural Society's gardens at Wisley, and in the following year became concurrently Director of Horticulture in the Food Production Department of the Board of Agriculture. Since last year he has been Assistant Secretary to the Board.

DR. FRITZ PANETH has recently been appointed to a professorship in chemistry at the University of Hamburg, which was founded in the spring of this year. After obtaining his doctorate at the University of Vienna Dr. Paneth proceeded to England, and worked for some time in the laboratories of Prof. Soddy at Glasgow, and of Sir Ernest Rutherford at Manchester. Later he was chemical assistant in the Radium Institute at Vienna, and after the appointment of Prof. Hönigschmid to a chair of chemistry at the University of Munich in 1917, Dr. Paneth directed the work of the chemistry department of the German Technical High School in Prague.

THE University of Manchester, which before the war was preparing to issue an appeal for funds to enable it to make due provision to meet its expanding needs, has now made, in addition to that of the College of Technology, which requires 150,000*l*. for its much needed extension, an appeal for a sum of 500,000*l*., towards which 76,000*l*. has been promised, in addition to 10,000*l*. for a chair of colloid chemistry as announced at the public meeting held in the Town Hall on December 9, to meet the urgent demands which, among other claims, the great influx of students in all departments has made upon its resources. There was recently opened a large new building for the faculty of arts (languages, literature, history, and philosophy), which, as a consequence, enables the departments of chemistry, engineering, medicine, and commerce to be accommodated more adequately. But the pressure, especially in respect of students in medicine and chemistry, and the growing need for facilities in economics, sociology, and courses of training for social work, cannot be satisfactorily met in present circumstances. A new system of post-graduate training has been instituted and a new degree therein established, which is certain to retain and attract a large body of well-prepared students to the great advantage of the University and of all concerned. The provision of hostels is an urgent need, together with that of extra-mural teaching in tutorial classes, for which there is a strong demand on the part of working men and women throughout the area covered by the University. A considerable increase in equipment, and especially in that of the teaching staff, in all departments is a pressing requirement, and altogether, having regard to the supremely and increasingly important place the University takes in the life of the city and district, makes this appeal for a large addition to its financial resources one that should commend itself to the liberal support of the great and wealthy community which it so effectively serves.

A DEPUTATION of members of the governing body of the Imperial College of Science and Technology, introduced by Lord Crewe, and received on December 15 by Mr. Balfour and Mr. Fisher, put forward the request that the college should be empowered to award degrees, either by being constituted a university or by granting its own degrees as a college. At present each of the constituent colleges of the Imperial College grants its own diplomas in the form of associateships of the Royal College of Science, the Royal School of Mines, and the City and Guilds' Institute respectively, while the Imperial College itself awards a diploma for a course of advanced work. There is, however, a great difference in the market values of a diploma and a degree, and it is on this account that the movement to make the college a degree-conferring institution has the support of most past and present students. The question of constituting another university in London has already been considered by two Royal Commissions and adversely reported upon, and the demand for the foundation of the new university will need to be strongly supported before it can have the promise of success in the face of these two reports and of the certain opposition of London University. The simplest course, and the one that would arouse least opposition, would be to grant the college the power of conferring degrees. Whichever plan is adopted, it is to be hoped that the position of past students of the constituent colleges will be effectively safeguarded. We assume that, whether the Imperial College grants a degree or a diploma, adequate provision will continue to be made for the study of pure science. It is becoming increasingly difficult to obtain the necessary funds for carrying on scientific research not directly concerned with industry, and the neglect of this part of the work of the college would eventually have a disastrous effect on technical education and industrial progress. A strong case can, no doubt, be made out for several distinct universities in London, and the appeal made on behalf of the Imperial College has been followed by a letter from Profs. W. H. Bragg and E. H. Starling in the *Times* of December 22, in which like claims are made for the freedom of King's College and University College "as regards teaching, research, and the granting of degrees."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 11.—Sir J. J. Thomson, president, in the chair.—C. F. U. **Meek**: A further study of chromosome dimensions. The degree of somatic complexity of an animal cannot be correlated with (*a*) the lengths of the chromosomes composing its complex; (*b*) the diameters of the chromosomes composing its complex; (*c*) the total volume of the chromosomes composing its complex; and (*d*) the number of the chromosomes composing its complex. There are many different chromosome diameters. The chromosomes composing the spermatogonial complex of an animal are not necessarily identical in diameter with those composing its secondary spermatocyte complex. All chromosomes composing an individual complex are not necessarily of the same diameter.—J. M. H. **Campbell**, C. G. **Douglas**, and F. G. **Hobson**: The respiratory exchange of man during and after muscular exercise. Support is given to the view that muscular work may involve the metabolism of a higher proportion of carbohydrate to fat than is the case during rest. In the case of the severer degrees of work, serious shortage of oxygen, as indicated by the production of lactic acid, may lead in the earlier stages of the exercise to temporary great exaggeration of the hyperpnœa, accompanied by washing out of preformed CO_2 from the body and an abnormally high respiratory quotient, phenomena which are absent in the case of lighter work.—A. D. **Waller**: The energy output of dock labourers during heavy work. Part i. The paper contains the results of observations on dock labourers by a simplified method, which consists in measurements of the CO_2 discharge at convenient intervals throughout the working day or night with the least possible interruption of work.—J. **Gray**: The relation of spermatozoa to certain electrolytes (ii.). The paper embodies an attempt to apply the facts of recent chemistry to the behaviour of the living cell.

Royal Anthropological Institute, December 9.—Sir Everard im Thurn, president, in the chair.—J. H. **Hutton**: Leopard-men in the Naga Hills. The Naga tribes generally regard the tiger as having the same origin as man, in that the first tiger and the first man were brothers, sons of one mother. No clear distinction is drawn between leopards and tigers, the same word being ordinarily used for both animals. The practice of lycanthropy among the Naga tribes differs from that followed in India, Burma, and Malaysia, in that no actual metamorphosis is believed to take place, in which respect it seems to differ from the form which lycanthropy takes in most parts of the world. The Naga method is to project the soul from the human body into the body of a leopard, usually, but not necessarily, during sleep. By this process the two bodies become intimately associated, and violent emotions affecting the one body are perceptible to the other. On the death of one, the other dies. The acquisition of the powers of a lycanthropist is not desired, but feared and disliked. The practice is assumed involuntarily at the dictation of spirits whose will the subject of it is more or less powerless to resist. The closest parallel to the Naga practice seems to be found in Nigeria, where there are beliefs ("Golden Bough," vol. ix.) which resemble those of the Naga tribes closely. In the Naga Hills and Assam this particular form of lycanthropy seems to be connected with migration from the north as distinct from other immigrations from the east and south.

Linnean Society, December 11.—Dr. A. Smith Woodward, president, in the chair.—Prof. W. A. **Herdman**: Notes on the abundance of marine animals and a quantitative survey of their occurrence. On a former occasion the author considered the plankton food-supply of edible fishes for the purpose of showing the fundamental importance of a very few organisms, about half a dozen kinds of diatoms and the same number of Copepoda. In the present paper he extended the same conclusions to the shallow-water and littoral common animals which are the food of our bottom-feeding fishes.—J. B. **Gatenby**: The germ-cells and early development of *Grantia compressa*. The spermatids of Grantia are described for the first time. They lie inside chambers formed of mesogleal cells. The mitochondria (chromidia) and Golgi apparatus of oocytes and other cells are described.

MANCHESTER.

Literary and Philosophical Society, December 2.—Prof. F. E. Weiss, deputy chairman, in the chair.—C. E. **Stromeyer**: A method by which roots of numbers can be easily and rapidly found by division sums.—L. V. **Meadowcroft**: A discussion of the theorems of Lambert and Adams on motion in elliptic and hyperbolic orbits. Lambert's theorem (1761) on the motion of a body in an elliptic orbit, under the influence of a central gravitational force, can be stated in the following purely geometrical form. The area of any focal sector of an ellipse can be expressed in terms of the focal distances of its extremities, of the chord which joins them, and of the axes of the ellipse. To J. C. Adams is due the most elegant form of the proof. The present author shows that this can be translated from analytical into geometrical terms. An independent proof based on geometrical considerations is thus suggested. Such a proof is given, and also an analogous proof for the corresponding theorem on the area of a focal sector of a hyperbola.—W. E. **Alkins**: Morphogenesis of *Reticularia lineata*. After a *résumé* of earlier work (including Day's) on variation in Brachiopoda, by using Day's specimens the author had constructed skeleton solid figures showing the distribution of length and width, and of length and depth, among 945 individuals of *Reticularia lineata*, Martin, from a restricted locality in the Carboniferous Limestone of North Derbyshire. Day's conclusions were confirmed. The ratio of width to length and of depth to length throughout the series showed that in the development of the individual shell the width and length were connected by a linear function, whereas the depth and length, though related by a linear expression up to a certain size, were connected by a logarithmic function over the greater portion of the range covered by the specimens. The transition from the linear function to the logarithmic relationship was perfectly gradual and continuous.

DUBLIN.

Royal Dublin Society, November 25.—Mr. R. Ll. Praeger in the chair.—T. G. **Mason**: Electrolytes in the leaf-sap of *Syringa vulgaris*. Determination of the dissolved electrolytes of the cell by means of conductivity measurements is largely vitiated by the influence of the viscosity of the solvent. Correction by means of direct measurement of the relative viscosity of the sap is shown to be unsatisfactory. By introducing a known concentration of an electrolyte into the sap and by comparing its conductivity in the sap with that in water, it is possible to obtain a closer estimate of the amount of electrolytes in the sap corresponding with the observed conductivity of the sap. Fluctuations in the electrolyte content of the sap appear to be in the inverse sense of those of the soluble carbohydrates. It is suggested that the concentration of the dissolved electrolytes may be directly or indirectly controlled by the osmotic pressure of the sap.—L. B. **Smyth**: The Carboniferous coast section at Malahide. Between Malahide and Portmarnock, Co. Dublin, an outcrop of Carboniferous Limestone rocks occurs, extending for about a mile along the sea-shore, and having a general dip to the north. This exposure was mapped by the Geological Survey. One fault was shown, separating a smaller southern portion from the rest. This southern part was considered to be older than the remainder, and to have been brought *up* by the fault. It was assigned, chiefly on lithological grounds, to the Lower Limestone Shales. The author maintains, on both structural and faunal grounds, that it is really the youngest part of the section, and belongs to Vaughan's "C" zone, the part north of the fault being assigned to the "Z" zone and the base of "C." The throw of the fault was estimated to be at least 780 ft. Two other faults are pointed out. One, in the middle of the exposure, causes a repetition of "Z" beds, and has a downthrow of 330 ft. to the south. The other, to the north of this, throws in the opposite direction, and is probably slight. Three new species of corals are described of the genera Michelinia, Zaphrentis, and Endophyllum.—J. J. **Dowling**: An apparatus for the production of high electrostatic potentials. The apparatus is an influence machine which transforms a battery voltage of, say, four hundred to, say, five hundred volts. The ratio of transformation can be adjusted, and the high potentials are remarkably steady. An earthed disc is carried to and fro, being fixed to the end of a rod which is given a reciprocating motion by an eccentric device. A contact-maker is mounted on the eccentric shaft, and this alternately connects a fixed insulated disc, mounted opposite the earthed disc, alternately to the battery and to the apparatus which is to be maintained at the high potential. One pole of the battery is, of course, earthed.

BOOKS RECEIVED.

A Short History of Education. By Prof. J. W. Adamson. Pp. xi+371. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

Malleable Cast-Iron. By S. J. Parsons. Second edition. Pp. xi+175. (London: Constable and Co., Ltd.) 14*s*. net.

Les Grottes de Grimaldi (Baoussé-Roussé). By Prof. M. Boule. Tome i., Fasc. iv.: Géologie et Paléontologie (Fin). Pp. 237–362+plates. (Monaco.)

An Introduction to Social Psychology. By Dr. W. McDougall. New edition. Pp. xxiv+459. (London: Methuen and Co., Ltd.) 7*s*. 6*d*. net.

Nationality and Race: From an Anthropologist's Point of View. By Prof. A. Keith. Pp. 39. (London: Oxford University Press.) 2*s*. net.

Mesures Pratiques en Radioactivité. By Drs. W. Makower and H. Geiger. Traduit de l'Anglais par E. Philippi. Pp. vii+181. (Paris: Gauthier-Villars et Cie.) 8 francs.

Aircraft in Peace and the Law. By Dr. J. M. Spaight. Pp. viii+233. (London; Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

An Introduction to Anthropology. By Rev. E. O. James. Pp. ix+259. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

Psychology of the Normal and Subnormal. By Dr. H. H. Goddard. Pp. xxiv+349. (London: Kegan Paul and Co., Ltd.) 25*s*. net.

Lectures on Industrial Psychology. By B. Muscio. New edition. Pp. iv+300. (London: G. Routledge and Sons, Ltd.) 6*s*. 6*d*. net.

Fuel, Water, and Gas Analysis for Steam Users. By J. B. C. Kershaw. New edition. Pp. xii+201. (London: Constable and Co., Ltd.) 12*s*. 6*d*. net.

The Aviation Pocket-Book for 1919–20. By R. B. Matthews. Pp. xxiv+536. (London: Crosby Lockwood and Son.) 12*s*. 6*d*. net.

Outlines of the History of Botany. By Prof. R. J. Harvey-Gibson. Pp. x+274. (London: A. and C. Black, Ltd.) 10*s*. net.

The Preparation of Organic Compounds. By E. De Barry Barnett. New edition. Pp. xv+273. (London: J. and A. Churchill.) 10*s*. 6*d*. net.

A Treatise on Qualitative Analysis. By Prof. F. Clowes and J. B. Coleman. New edition. Pp. xvi+400. (London: J. and A. Churchill.) 12*s*. 6*d*.

Elementary Practical Chemistry. By Prof. F. Clowes and J. B. Coleman. New edition. Part i.: General Chemistry. Pp. xvi+241. (London: J. and A. Churchill.) 6*s*.

Modern Spiritism: Its Science and Religion. By Dr. A. T. Schofield. Pp. ix+259. (London: J. and A. Churchill.) 3*s*. 6*d*. net.

Die Stämme der Wirbeltiere. By Prof. O. Abel. Pp. xviii+914. (Berlin and Leipzig: W. de Gruyter and Co.) 56 marks.

DIARY OF SOCIETIES.

MONDAY, DECEMBER 29.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Mrs. Dickinson Berry: Serbia and Yugo-Slavia, Before the War and After (Christmas Lecture to Young People).

TUESDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound, I., What is Sound? (Christmas Lectures).

THURSDAY, JANUARY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound, II., Sound and Music (Christmas Lectures).

FRIDAY, JANUARY 2

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Miss Hilda Bowser: A Visit to the Diamond Mountain in Korea (Christmas Lecture to Young People).

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—A. P. Morris: Burmese Village Industries: Their Present State and Possible Development.

SATURDAY, JANUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound, III., Sounds of the Country (Christmas Lectures).

CONTENTS.

	PAGE
The Profession of Chemistry	409
Flowering Plants and Ferns	410
Our Bookshelf	411
Letters to the Editor:—	
Polarisation of Light Scattered by Helium Atoms.—**Right Hon. Lord Rayleigh, F.R.S.**	412
Gravitation and Light.—**Sir Joseph Larmor, M.P., F.R.S.**	412
Radio-activity and Gravitation.—**Sir E. Rutherford, F.R.S., and Dr. A. H. Compton**	412
Mortality among Snails and the Appearance of Bluebottle Flies.—**Dr. N. Annandale**	412
Remains of a Fossil Lion in Ipswich.—**Nina F. Layard**	413
Promotion of a Plumage Bill.—**H. J. Massingham.**	413
The Deflection of Light during a Solar Eclipse.—**Capt. C. J. P. Cave**	413
Industrial Resources of India	413
The Reform of the Calendar. By H. C. P.	415
Notes	416
Our Astronomical Column:—	
Barnard's Proper-Motion Star	420
The Great Solar Prominence of Last May	420
Atomic Disintegration and Heat Energy	420
The British Association at Bournemouth:—	
Section M—Agriculture—Opening Address (Abridged) by **Prof. W. Somerville, D.Sc., President of the Section**	421
University and Educational Intelligence	425
Societies and Academies	426
Books Received	428
Diary of Societies	428

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THURSDAY, JANUARY 1, 1920.

BRITISH IRON ORES.

Special Reports on the Mineral Resources of Great Britain. Vol. viii., *Iron Ores: Haematites of West Cumberland, Lancashire, and the Lake District.* By Bernard Smith. Vol. ix., *Iron Ores* (continued): *Sundry Unbedded Ores of Durham, East Cumberland, North Wales, Derbyshire, the Isle of Man, Bristol District and Somerset, Devon and Cornwall.* By T. C. Cantrill, Dr. R. L. Sherlock, and Henry Dewey. Vol. x., *Iron Ores* (continued): *The Haematites of the Forest of Dean and South Wales.* By Prof. T. Franklin Sibly. (Southampton: Ordnance Survey Office, 1919.) Prices: Vol. viii., 9*s*. net; vol. ix., 3*s*. 6*d*. net; vol. x., 4*s*. net.

AS is well known, one of the effects of the recent war has been to direct the attention of the British people to the wealth of the mineral resources of their own country, whereupon it soon became apparent that accurate official information as to the nature and extent of these resources was conspicuous only by its absence. Fortunately, the Director of the Geological Survey, Sir Aubrey Strahan, took immediate steps to rectify this deficiency, and a series of volumes on the mineral resources of Great Britain has been issued under his direction; the last three of these have just been published. These are the opening volumes of a set dealing with British iron ores, and Sir Aubrey Strahan has written a short preface to the first of them, in which he indicates the general scheme which it is proposed to follow. He divides the British ores into "three classes, namely, those products, mostly hæmatites, which occur as replacements, in lodes, etc.; the bedded ores of Mesozoic age; and the bedded ores of Palæozoic age."

This classification is a quite satisfactory one, though the use of the word "lodes" in the above description may well be objected to if it is intended to imply that replacements and lodes are equivalent terms. A typical replacement deposit is certainly not a typical lode; the latter term is identical in meaning with vein, and ought to be restricted definitely to mineral deposits filling fissures, which show for the most part well-defined walls, and have a fairly regular form, so much so that authorities like, *e.g.*, Sir Clement Le Neve Foster, have made them a subdivision of the tabular or sheet-like deposits. It is quite true that the walls of a lode generally show more or less alteration due to the same causes that brought about the filling of the lode itself, and that this alteration may take the form of impregnation or of more or less complete replacement of the country rock, but this fact does not justify calling the lode a replacement deposit. The typical replacement deposit, on the other hand, is, as a rule, quite irregular in outline, and if it does at times assume a tabular form, this is due to accidental conditions, and is certainly not a genetic characteristic.

The three volumes now issued cover the first of Sir Aubrey Strahan's classes, and form geologically the most interesting, but economically the least important, of the three; in fact, it is only the ores described in vol. viii. that possess any economic importance whatever. As regards the economic aspect, it may be considered unfortunate that the authors of the three volumes have put forward statements as to what they consider the probable ore reserves contained in the mineral fields that they have investigated. In the case of irregular deposits, such as are here dealt with, this is a problem of exceptional difficulty, seeing that the data for its solution do not exist, and sound estimates of quantity are impossible; the best that can be done is to make a more or less intelligent guess, and under these conditions the best possible guess is likely to be very wide of the mark. Such speculations are somewhat out of place in an authoritative Government publication, and it is greatly to be feared that heavy money losses may be incurred by adventurers who do not discriminate between the geologist's idea of the quantity of ore that may be supposed to exist and the miner's view of the amount that can be economically extracted.

Apart from his attempt at estimating the probable ore reserves, Mr. Bernard Smith's volume on the West Coast hæmatites is in every respect a very satisfactory one; here the difficulty of forming any opinion as to quantity is peculiarly striking. Owing to the soft nature of the ore and to its highly irregular mode of occurrence, ore reserves cannot be blocked out for any length of time in advance, and there is rarely, if ever, any "ore in sight" in the accepted sense of that phrase, although mines have continued for many years, and will doubtlessly continue in the future, to produce considerable quantities of ore by the hand-to-mouth methods of exploitation which the nature of the deposits renders necessary in the great majority of cases. The volume gives a short but sufficient and very clear description of the geology of the district, and the mode of formation of the ore bodies is described in very convincing terms. It seems impossible to doubt that the ore was deposited metasomatically, as Mr. Smith asserts; he has, however, avoided the more difficult question, namely, whether the ore was first deposited as a carbonate or as a hydrate, and afterwards metamorphosed to red hæmatite, or whether it was deposited in practically the same form as we now find it. He concurs in the generally received opinion that the iron-bearing solutions were introduced from above, but says nothing as to the theory strongly held by many that these solutions were the result of the leaching out of iron from the New Red Sandstone, which may be presumed at one time to have overlain the whole of the iron-bearing region. The greater part of the book is taken up with a careful, detailed description of the mines, the area being, for the sake of convenience, divided into the Egremont and Whitehaven districts of Cumberland, the Furness district of Lancashire, and the far less important occurrences in the Lake district. Existing mines are fully described under the heads of geological occurrence and mining details, whilst information as to the old and abandoned mines has also been collected. The volume forms a very valuable and welcome addition to our knowledge of this important mineral area.

Vol. x., by Prof. Sibly, is geologically the most important of the three, as it has involved a careful geological study of the Forest of Dean coalfield, with which the iron ores of the Forest are necessarily closely connected. Much new matter has thus been brought to light, and as a result of his work Prof. Sibly has succeeded in proving two important geological facts—one that the Millstone Grit of the Geological Survey is in fact a sandy facies of the dolomitised upper portion of the Carboniferous Limestone, and the other that there is an important unconformity between the Coal Measures and the underlying rocks; it need scarcely be said that there is a close connection between these two facts. This is the first time that a systematic study of the iron ores of the Forest of Dean has been attempted, and Prof. Sibly deserves the highest praise for the manner in which he has unravelled the complex problems that the geology of the district presents. Unfortunately, this field cannot pretend to any economic importance commensurate with its geological interest. The ores, as Prof. Sibly shows, are of relatively shallow occurrence, and have been practically worked out; it is indeed fortunate that the study of this field has not been deferred much longer, for in that case there would probably have been no mines open for the geologist to consider. Prof. Sibly guesses the total amount of ore reserves still existing at about a million tons, but it is very doubtful whether anything approaching this figure will be produced here, and his conclusion "that the Forest of Dean is not far from exhaustion as a source of iron ore" is fully warranted by the facts. The second part of the volume is taken up with a description of a small group of iron-ore mines in the Carboniferous Limestone that forms the south-eastern margin of the South Wales coalfield, extending between Taffs' Well and Llanharry; out of the five mines that have been active in this area, only one, the Llanharry mine, is now at work, producing 50,000 to 60,000 tons yearly; this mineral occurrence is fully described, and particulars are given of the abandoned mines also. In a concluding chapter Prof. Sibly discusses the genesis of all the ores dealt with, and in agreement with most other authorities he looks upon them as undoubtedly of metasomatic origin, due to descending iron-bearing waters; he seems inclined to seek the source of the iron in the Triassic rocks that once probably covered the Forest of Dean area and in the Conglomerates and Red Marls of the Keuper in the South Wales district. The volume contains a mass of interesting information upon the area studied, and as regards the Forest of Dean must rank high as a piece of first-class geological research.

Vol. ix. includes a number of miscellaneous occurrences in different parts of the country, of very various character. It is greatly to be regretted that it falls very far below the high standard to which the other two volumes have attained. It is not improbable that the time allotted to the investigation of each deposit was insufficient, but, whatever be the cause, there are no signs of the painstaking thoroughness which characterises the work already discussed. This volume leaves the impression that the authors merely accepted what they were told in each case, and did little actual field work, or, at the best, only looked at what was shown them. They have thus in many cases arrived at a wholly exaggerated opinion of the importance of the deposits they describe. For instance, in describing the Sharkham iron-ore mine, the authors state that "the amount of ore in sight is considered to be large," whereas as a matter of fact there is very little ore in sight, and they seem never to have heard of the deep adit driven in below the deposits, which runs wholly in barren limestone, and shows that the occurrence is strictly limited in depth. It would serve no useful purpose to multiply examples of such oversights; it is, however, fortunate that none of the occurrences described in vol. ix. have any real economic importance.

The Geologial Survey and the country may both fairly be congratulated on the continuation of Sir

Aubrey Strahan's special reports, and it need scarcely be said that the further volumes dealing with the other two classes of iron-ore occurrences will be eagerly awaited by the large body of workers interested in British iron ores.

H. LOUIS.

ALCOHOL.

Alcohol: Its Production, Properties, Chemistry, and Industrial Applications. With Chapters on Methyl Alcohol, Fusel Oil, and Spirituous Beverages. By Charles Simmonds. Pp. xx+574. (London: Macmillan and Co., Ltd., 1919.) Price 21*s.* net.

MR. SIMMONDS, one of the senior analysts in the Government Laboratory, is well qualified by his position to undertake the compilation of this book, since his duties have rendered him familiar with his subject in all its aspects—its production and industrial applications, its chemistry, and its special relations to the revenue.

The work treats of the early history of alcohol; its origin and composition; its production by fermentation and by synthetic processes; the nature of the materials employed; the biochemical agents involved; and the general operations of distillation and rectification. The author devotes a chapter to the general chemistry of the homologues with which ordinary or ethyl alcohol is associated, either as a product of fermentation, or in industry as methylated spirit. He is, by virtue of his office, naturally concerned with the analytical chemistry of these alcohols, especially of ethyl and methyl alcohol, and with the subject of alcoholometry, in this country and abroad, and he writes with special knowledge and authority. He gives a sufficiently full account of the fiscal relations of ethyl and methyl alcohol and of the different forms of "denatured" alcohol, as used in industry; treats of various spirituous beverages, their origin, nature, and chemical examination, and concludes with a concise statement of what is definitely known concerning the physiological properties of alcohol. It will be seen from this short summary that the book constitutes a comprehensive treatise in which practically everything relating to alcohol finds a place. It is, of course, essentially a compilation from numerous sources, the range and extent of which may be inferred from the excellent bibliography appended to the work. But the compilation was well worth making, and has resulted in a complete and well-arranged monograph; it is eminently readable, and the information is sound, accurate, and up to date.

Although the practical brewer and distiller will find much in it that will be of use to them at times, the book is not primarily intended for use in the brewery or the distillery. Technical details, such as are to be found in standard treatises on brewing and distilling, and which are the subjects of the trade journals, would be out of place in a work of this kind, where alcohol, as such, is the main consideration.

For the commercial production of alcohol from wood by Classen's process, or some modification of it, there is apparently no future in this country, and it would seem to be doubtful whether any permanent success will be possible even in countries where wood-waste is more plentiful than with us. Alcohol from sulphite-waste liquor in the manufacture of wood-pulp is, however, being produced in considerable quantities in Sweden and elsewhere, and bids fair to become an important industry. Synthetic alcohol from acetylene, derived from calcium carbide, has been made in Germany by methods which were largely developed during the war, mainly in consequence of the shortage of potatoes. It remains to be seen whether the manufacture will become permanently established. The synthetic production of alcohol, if greatly extended, would be certain to produce considerable economic disturbance in Germany, and would also occasion much perturbation in agrarian circles. The danger was foreseen by the late Government, which, by the Spirit Monopoly Act of 1918, placed the manufacture of synthetic alcohol under the control of the State.

In describing the properties of methyl alcohol, the author rightly lays stress on its toxic character. It is far more dangerous than is generally known. It is alleged that the shortage of whisky during the past four years has led to a great increase in the drinking of methylated spirit. Ordinary mineralised methylated spirit, which is the only form to which the public has ready access, contains wood naphtha and a certain amount of mineral naphtha, in addition to ketones and other substances, and is a very noxious beverage; its habitual consumption quickly results in blindness, paralysis, and death. The detection of the presence of methyl alcohol in mixtures containing ethyl alcohol has naturally received much attention in the book. The matter is of fiscal importance, in view of possible illicit attempts to use "denatured" alcohol instead of duty-paid spirit. It has given rise to an abundant literature, a critical synopsis of which is given by the author, to whom the problem has a special professional interest. Many of the methods described are highly sensitive and characteristic, and there is no practical difficulty nowadays in recognising the presence of methyl alcohol in alcoholic mixtures or in ascertaining its amount.

The author deals with the question of alcohol as a fuel, especially in the internal-combustion engine, and gives details of the results of special investigations which have been made in America and in Australia to elucidate its relative advantages as compared with other forms of motor spirit. Lastly, his chapter on the physiological effects of alcohol gives a careful summary of our present knowledge of its action on the human organism, mainly based upon the report (published in 1918) of the Committee appointed by the Central Board (Liquor Traffic) of the United Kingdom. It is a well-balanced and impartial account of established fact concerning a most important subject, intimately related to the national welfare.

The book is well illustrated; indeed, this, perhaps, constitutes its only demerit; the necessity to use so-called "art" paper throughout in order to reproduce the large number of "process" figures adds greatly to its weight, and thus detracts from its general utility. We would willingly have dispensed with many of the pictures, some of which add little or nothing to the attractiveness or usefulness of the book. Its convenience in handling, and as a work of reference, would thereby have been increased.

A GREAT ARTIST OF NATURE.

A Naturalist's Sketch Book. By Archibald Thorburn. Pp. viii+72+60 plates. (London: Longmans, Green, and Co., 1919.) Price 6 guineas net.

ALL artists are more or less influenced by the work of some previous craftsman whose technique they admire, and it is no detriment to the achievements of so superb an artist as Archibald Thorburn to say that on him has fallen the mantle and style of Joseph Wolf, the greatest artist of bird and mammalian life the world has ever seen. Thorburn himself admits this influence, and renders an adequate tribute to the bygone master. Yet, whilst the care and delicate handling of birds, mammals, landscape, and natural features bear some similarity in their rendition to Wolf in treatment of form and sense of beauty, Thorburn's style is all his own and distinctly original. In one respect, at least, and that a most important one, he excels even Wolf for the beauty, accuracy, and strength of his colour. This has never been surpassed by any artist of ancient or modern times in water colour.

In the work before us we are presented with a series of finished sketches, mostly in colour, and drawn direct from life. Having for his models the most restive and elusive of all sitters, the average artist is content to draw roughly in pencil characteristic poses, and then has to rely for colouring in his details of feather and fur on such skins or stuffed specimens as he is able to procure. Thorburn, it is true, uses only such aids *afterwards* to correct the coloured sketches he makes direct from Nature, and thus he obtains the proper lighting and the real effect of fur and plumage as it is in Nature. Thus he gives us a perfectly satisfactory representation of the creature depicted, and with all the effect of true colour without ultimate studio work, which is always liable to inaccuracy. No one, unless he is an artist himself in this difficult line, has any idea of the rapidity, skill, and accuracy of observation that are required to be *always* successful, and whilst it may be said that even Thorburn occasionally fails slightly in his drawing, 99 per cent. of his work is beyond criticism, and perfectly successful.

In no family of birds is Thorburn more complete in his knowledge than in the case of the game birds and raptorials. His eagles, falcons, grouse, partridges, and black game are drawn from life with a dexterity that is amazing. He puts a wealth of colour and a "bloom" on his plumage that we who know these birds best are left in wonder at his skill. There are just the right softness and rotundity all done with a few unlaboured washes. Details of the plumage in the form of primaries, secondaries, scapulars, and tail are, in the case of each species, rendered with exactly the right number of feathers. No point that is characteristic of any species is lost. A golden eagle in repose shows just the one fluffy feather on the flank, and in flight the striking whites of the under-feathers, which show only when the bird is in movement. We do not need to be told that the series of sketches of game birds, hawks, owls, and smaller perching birds are drawn direct from life, because here, in this beautiful volume, we who are naturalists see them as they really are in all the beauty of life and movement. Perhaps Thorburn is more successful with creatures in repose than in intense action, but this may be due to the fact that the public prefers birds and mammals in their quieter moods, and he likes to render them so.

Probably the artist's work is most successful because he takes such infinite care with all his details before attacking his finished pictures. If he has to do a plate for some work, one or two coloured figures from life are not sufficient. He draws carefully all the "soft" parts, such as feet, bills, and eyes, directly from some dead or living specimen, and thus gains a first-hand knowledge of the whole creature before commencing his final essay.

The text which the artist supplies of how and when he made his sketches, supplemented with original observations of the habits of birds and mammals, is both adequate and interesting. At the end of the volume are some beautiful studies of landscape and plant life, notably the exquisite sketch of a thistle (plate 60), snow-covered furze and pines (plate 58), the eagle's hunting-ground (plate 57)—a perfect handling of the high tops—and pheasant covert (plate 56).

The volume will do much to enhance the reputation of Archibald Thorburn as an artist, and those possessed of the necessary wealth have the opportunity of purchasing something that will live as long as the taste for Nature, high art, and beauty continues—and that remains for ever.

It is an unfortunate truism that few men, least of all artists, are recognised as supreme craftsmen during their lives. The day is coming shortly—if it has not already arrived—when the public, and even art critics, will awake to the fact that this century has produced two great artists of Nature—namely, Joseph Wolf and Archibald Thorburn—and those who possess a complete set of the work of these two masters will be very fortunate.

In the volume under review we notice only two slight errors. We have never seen a white-tailed eagle (plate 4) so dark as the specimen figured, nor have we observed a green cormorant (plate 36) with a "bushy" crest of the shape depicted.

J. G. M.

SUBMARINES AND SEA POWER.

Submarines and Sea Power. By Charles Domville-Fife. Pp. viii + 250. (London: G. Bell and Sons, Ltd., 1919.) Price 10*s.* 6*d.* net.

The author has already written several books dealing with the development of submarines and also with their exploits on actual service under war conditions. In the present volume an attempt is made to discuss the influence of the submarine, now an important weapon in naval warfare, "on national life in time of war in order to awaken those who administer the empires of to-day and to-morrow to the need of provision against a new and growing menace which has changed the older theories of sea power."

Much of the matter in this book has already been covered in the author's previous publications, particularly that in the chapters on the evolution of the submarine. The difficulties of navigating the submarine, the restrictions imposed by limited depth of water and other hydrographical features, the conditions for favourably attacking an enemy and for escape from one, and other factors dealing with the employment of submarines, are dealt with in some detail, particularly in so far as they affect the use of naval power. The immediate effect of the German submarine menace upon our "sea power" during the Great War is discussed, and the author makes some suggestions based on our recent unpleasant experience for the guidance of future administrators.

So long as details of construction and of working the submarines are under review, the author is on safe ground, but in developing general arguments, in stating his premises, in the marshalling of his facts, and in selecting his language, he is not so happy. A plaintive appeal is made in the preface that the book may be read to the end before any definite opinion is formed. The appeal is necessary.

The author has not considered his subject on broad lines. When one has defined a submarine as a mobile ambush which can be set not only on this side of an enemy, so that he will have to encounter it in his advance, but also well within the enemy lines without incurring any serious risks, and with a considerable degree of protection by reason of its power of submergence, whilst retaining its powers of observation, the serious restrictions it imposes upon the movements of a surface fleet become almost obvious. The submarine affects enormously the tactics of a surface fleet, but the experience of the war has not shown that the submarine has appreciably altered the application of naval strategy. It will alter types of ships.

A picture is drawn or suggested of what might have happened to our sea-borne commerce had Germany possessed at the outbreak of war 1000 high-powered submarines. Such a picture is not instructive in any way in regard to the future aspect of the submarine question. The success of the German submarine—for it was undoubtedly a most successful weapon for harassing our sea power—as a matter of fact lay in its surprise application contrary to the Hague Convention. Had Germany possessed 1000 submarines Britain would have had in all probability 10,000 partial antidotes. Fortunately, such favourable conditions for surprise by submarine cannot occur again. A measure of the success of submarine activities is obtained from the book, in which it is stated that 600 merchant ships and fifty warships were destroyed, and that 1500 patrol ships, with guns and ammunition and depth-charges, and 2000 minesweepers had to be built or used in combating submarines.

The chapters at the end of the book dealing with sea power and some economic and international problems should be read. Attention is directed to the necessity for the revision of international law and to its enforcement in regard to matters affecting the mercantile marine. International law as developed from previous war experience must of necessity be inapplicable to wars such as that just concluded, in which, instead of small navies and armies, we had nations in arms when every import is almost certain to be contraband.

The title given to the book brings disappointment, for the author does not give a general treatment of the effect of the submarine upon sea power in the future. He pictures many trees, some of the soil, much undergrowth, but one never seems to see the forest. A. B. T.

OUR BOOKSHELF.

Studies in the Construction of Dams: Earthen and Masonry. Arranged on the Principle of Question and Answer for Engineering Students and Others. By Prof. E. R. Matthews. Pp. v+43. (London: Charles Griffin and Co., Ltd., 1919.) Price 4*s.* 6*d.* net.

We gather from the preface that this little book is intended to be of assistance to students preparing for the examinations of the Institution of Civil Engineers, the B.Sc. (Engineering) of our universities, or other similar examinations. The text is arranged in the form of "question and answer," and includes references to some of the more important dams constructed in different parts of the world. Students who are pursuing systematic courses in the principles of engineering will find a good many statements open to criticism. Thus, at the foot of p. 1, we read: "In a low dam BC may be taken as being equal to AB." ABC is the pressure diagram, and surely this statement regarding BC is not independent of the scale of pressure employed. Again, on p. 1: "The centre of pressure passes through the centre of gravity of this triangle"; and on p. 9: "The centre of pressure acting at a point H/3 above base." On p. 3, r^bH^2 should read rbH^2, and there are several other misprints. On p. 4 the reader is told that the weight of the wall will act through the centre of gravity of the section, but receives no directions as to how to find this point, although space is wasted on p. 25 in answering the questions how to find the centre of gravity of a triangle and parallelogram. We hope that questions such as No. 7, p. 15, do not occur often in professional or university examinations: "What are the suggestions made by Molesworth relative to the thickness of high and low masonry dams?" On p. 16 we read some curious statements, and quote a typical one: "g=specific gravity of the masonry=for light masonry 130 lbs. per square foot=2·08." It is not possible in the limits of a short notice to deal with every point which might be criticised, but probably enough has been said to justify the conclusion that it would be well to give the book a thorough revision.

Immune Sera: A Concise Exposition of our Present Knowledge of Infection and Immunity. By Dr. C. F. Bolduan and J. Koopman. Fifth edition, thoroughly revised. Pp. viii+206. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 7*s.* net.

The present edition of this book has been revised throughout, and fresh details have been inserted where necessary. It gives an excellent and, on the whole, a simple account of the salient facts connected with infection and immunity, antitoxins and other sera, cytotoxins, opsonins, vaccines, and other reactions of immunity, and the practitioner will find it a trustworthy guide to modern views on these subjects. We suggest that the details of the partial saturation method and of "toxin spectra" in connection with antitoxins are somewhat beyond the general scope of the work, and that the space devoted to them might be better employed in extending the more directly practical subject of agglutination. The technique of the Wassermann test for syphilis has been included in this edition in response to many requests for information concerning it. Here, again, we think that the description is too technical for the average reader, and might be simplified with advantage. These, however, are minor faults, if faults they be, and do not in any way detract from the general excellence of the book. Several figures serve to visualise the descriptions given in the text, and the book is very readable.

R. T. H.

Handbook of Mineralogy, Blowpipe Analysis, and Geometrical Crystallography. By Prof. G. Montague Butler. Pp. ix+311+v+80+viii+155. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 16*s.* 6*d.* net.

This book is in three parts, which are separately paged. They are also on sale separately. The first part consists of concise, clearly printed descriptions of the different mineral species, and should prove useful for their recognition by the student or prospector. This will be facilitated by the use of the folding tables of the physical characters of the different minerals, which are a special feature of the work. The second part deals with the blowpipe analysis of minerals. Here also the results are set out in a convenient tabular form. The third part, which is devoted to crystallography, is not so satisfactory. The author has a system peculiar to himself of describing crystal symmetry which is by no means clear. He is also exceptional at the present time in retaining the Weiss system of notation of crystal faces.

J. W. E.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Atomic Energy.

REFERRING to the notice of my recent Trueman Wood lecture on p. 420 of NATURE of December 25 last, let me explain that I admitted that we could not at present tap or utilise intra-atomic energy except what is given us spontaneously. But we may claim to be utilising intra-atomic properties, since without some kind of disintegration the right kind of projectiles would not be available. I say clearly in the lecture "it is atomic properties rather than atomic energy that are at present being utilised" in wireless telephony.

Furthermore, although the excitation of healthy retinal nerves is primarily dependent on the energy of incident light, yet the action is as if the atoms of a retinal substance acted as accumulators, storing up an æther disturbance of quite unphysiological frequency until a quantum has been collected, when a stimulating projectile is liberated. If anything like this happens, the energy actually utilised is atomic energy; for if that had no existence, the light-waves would be powerless. There may be pathological cases where optic-nerve stimulus is independent of received luminous energy, but that is a highly undesirable state of affairs.

OLIVER J. LODGE.

Metamorphosis of Axolotl caused by Thyroid-feeding.

THE fact that a diet of mammalian thyroid will induce frog-tadpoles to metamorphose precociously into the adult form is now well established. It is of some interest to find that this diet produces a similar effect in a form which usually does not metamorphose—the Axolotl. This is the larva of a salamander known as Amblystoma, but is remarkable in being neotenic, *i.e.* it normally fails to metamorphose, and attains full size and sexual maturity while keeping its larval characters. Chief among these are the external gills and the fin along the back and both borders of the tail, but the adult also differs from the larva in colour, in shape of head, in the development of eyes and eyelids, in the rounded form of the tail, and, of course, in the use of its limbs for progression on land.

Marie von Chauvin in Germany (*Zeitschr. f. Wiss. Zool.*, vol. xxvii., 1877, and vol. xli., 1885) and E. G. Boulenger in this country (Proc. Zool. Soc., 1913 (2)) have succeeded in getting Axolotls to assume the adult form by forcing them to breathe air, either by keeping them in damp moss or in a gradually diminishing quantity of shallow water.

In conjunction with Mr. D. F. Leney, I have been trying the effect of thyroid diet on Axolotls. Two young specimens, 11·5 cm. and 12·7 cm. long, and therefore presumably between six and twelve months old, were kept in a tank at an average temperature of 15°–16° C. in a depth of water (more than 2 in.) considerably greater than that needed to induce air-breathing. They were fed on ox thyroid, at first three times, and later twice, a week.

The thyroid diet began on November 30 last. On December 15 distinct alterations were visible in colour and in resorption of gills and fin, and on December 17 the stage which is critical in metamorphosis induced by air-breathing (see Boulenger's paper) had been passed, the animals being in Boulenger's stage 6, with only vestiges of gills and fin. On December 19 the next or penultimate stage, with scarcely a trace of larval characters, was reached. The larger specimen, the metamorphosis of which was slightly more advanced, had climbed out of the water up a platform provided for the purpose, and its skin was as dry as an ordinary salamander's. When placed on the table they both walked well, thus differing markedly from the larva, which cannot use its legs efficiently if placed on land. Curiously enough, on the succeeding day the larger animal had returned to the water, where it remained until December 23. It then again left the water of its own accord, and up to the time of writing (December 24) has remained in air. Two other specimens of similar size, fed on worms and kept in shallow water, according to Boulenger's method, have so far shown only minimal changes.

Two points are of special interest. First, the time of metamorphosis—just over three weeks—is much shorter than any previously recorded. Boulenger's larvæ took from twelve to sixteen weeks, Marie von Chauvin's from seven to forty weeks. Secondly, the "critical stage" in the metamorphosis was reached apparently without the animals breathing air at all; *i.e.* two entirely different causes, forced air-breathing and a thyroid diet, can produce the same result—metamorphosis. It was not until December 19 that they were observed to come to the surface for air; and even after that, although possessing no functional gills, they spent much time at the bottom of the water, only occasionally rising to float suspended close below the surface with limbs outspread, after the fashion of newts.

Many interesting problems present themselves, which it is hoped to work out as opportunity offers. Meanwhile, this note is published in the hope that others who possess Axolotls will repeat and develop experiments along these lines. I should be glad to enter into correspondence with anyone intending to work on the subject, with the view of preventing useless overlapping in the working out of the problems that arise; and, further, I should be very grateful if anyone possessing Axolotls, whether young or old, would give me the opportunity of purchasing some, as they are at present very difficult to obtain in the market.

JULIAN S. HUXLEY.

New College, Oxford, December 24.

The Hibernation of the House-fly.

M. DE SEGUY'S discovery of larvæ of *Musca domestica* in the bodies of snails, Dr. J. C. Gahan's observations thereon in the *Times*, and the note in NATURE of December 18 last are very interesting to biologists, but it is most improbable that a winter crusade against the Helicidæ would have any appreciable effect in diminishing the summer swarms of flies.

I am led to this conclusion by circumstances under my immediate observation. Round my house is a large flower-garden in which I work constantly at all seasons, desperately worried in summer by legions of house-flies. In the course of forty years I have never come across one of the larger Helicidæ in this garden; and my head gardener, a very intelligent man and a good observer, assures me that in thirty years he has never seen one in the kitchen-garden, which is distant half a mile from the flower-garden. Slugs abound in both, but the only one of the Helicidæ that is found is a very small species with a thin, flattened shell (? *Helix cellaria*, Müller) and a body too small to accommodate the larva of a house-fly. It is also the reverse of abundant. There must, therefore, be other kinds of *nidus* to harbour the larvæ of *Musca domestica* through the winter.

Monreith. HERBERT MAXWELL.

The Magnetic Storm of August 11–12, 1919.

THE Kodaikanal Observatory magnetographs recorded the "sudden commencement" of this storm on August 11 at 6h. 58m. G.M.T., horizontal force showing an instantaneous rise of 149 γ and vertical force about 35 γ, while the declination magnet was deflected about 1′ towards west. I have measured the three traces, and, after making due allowance for the errors affecting the hour-marks, the following values were obtained:—

	h.	m.
Horizontal force	6	58·0
Vertical force	6	58·7
Declination	6	57·9

Greater weight may be given to the declination result because of the more sharply defined hour-marks in this trace.

It is of interest to compare this result with the times recorded in England in view of the fact that at Kodaikanal the sun at 6h. 58m. G.M.T. was barely three minutes past meridian passage and only 5° north of the zenith. In other words, this observatory was almost at the centre of the earth's disc as seen from the sun, and it might be supposed that the disturbance would have been recorded here earlier than at other places if it is directly due to emanations from the sun.

Apparently the sudden commencement was recorded at Kew "at about 7h. G.M.T.," and at Stonyhurst at 6h. 50m., while at Eskdalemuir the time is given definitely as 6h. 58m., in exact agreement with my result (NATURE, vol. ciii., pp. 483, 505 and 506).

It seems probable that the impulse is simultaneous over the earth to within a fraction of a minute, but it would be interesting to know the limits of error to which the above times are subject, and particularly whether allowance has been made for the rather large error which may be produced by the mechanism for cutting off the light from the sensitive paper at each hour. J. EVERSHED.

Kodaikanal, S. India, November 25.

Deflection of Light during a Solar Eclipse.

DURING a total eclipse of the sun there will be, as I suppose, an increase of density of the air at the central portion of the shadow. If we imagine the normal atmosphere removed, we are left with a residual atmosphere the refraction effects of which will be changes in the normal refraction effects. The whole point is whether, on reasonable suppositions, this residual atmosphere can produce refraction effects of the order of the observed effects that have been attributed to the gravitational field of the sun.

Let us suppose with Prof. Eddington that the portion of this residual atmosphere concerned corresponding to a star near the edge of the sun's disc has a radius of about 150 yards, and let the index of refraction of the residual atmosphere at the central part be μ_2, and that at the circumference μ_1. Then, as I have shown, the displacement will be accounted for if

$$\mu_2=\mu_1\left(1+\frac{7}{10^8}\right).$$

Assuming that the change of density depends only on change of temperature, we have

$$\frac{\rho_2}{\rho_1}=\frac{\theta_2}{\theta_1}=\frac{\mu_2-1}{\mu_1-1},$$

where ρ_2, ρ_1, θ_2, θ_1 are the increases of density and falls of temperature at the centre and circumference.

Thus we have, approximately,

$$\frac{\theta_2-\theta_1}{\theta_2}=\frac{7}{10^8(\mu_2-1)};\quad \frac{\theta_2-\theta_1}{\theta_1}=\frac{7}{10^8(\mu_1-1)}.$$

We must now make some assumption as to the gradient of temperature, and this is a very important point. It would not, I think, be right to make it uniform or approximately uniform throughout a distance of 150 miles. We will assume that in a distance of 150 yards the increase of temperature is 1/100th part of θ_2. This does not seem to be unreasonable.

We then have $\mu_2=1{\cdot}000007$ for the index of refraction of the residual atmosphere at the centre, corresponding to a lowering of temperature of 6·28° C. at the centre and of 6·22° C. at a distance of 150 yards. If we assume that the increase of temperature at a distance of 150 yards is 1/10th of θ_2, we get the fall at the centre 0·63° C. and that at 150 yards' distance 0·57° C. It will be seen that the greater $\frac{\theta_2-\theta_1}{\theta_2}$, the smaller is the necessary fall of temperature at the centre. ALEXR. ANDERSON.

University College, Galway, December 28.

Entente Scientific Literature in Central Europe during the War.

I WAS much interested in reading Prof. Brauner's letter from Prague in NATURE of December 11. Like Prof. Brauner, I was unable to obtain NATURE during the first two years of the war, and I fully appreciate his joy on obtaining your invaluable journal again, after an interval of more than five years.

Prof. Brauner states that from July 30, 1914, "the Austrian Government prohibited for more than four years the circulation of anything printed in England as a punishment for the regard which, especially during the war, we [the Czechs] have always had for your country."

This statement is misleading, for "enemy" periodicals were withheld from the whole of the Austrian Empire, and not from the Bohemians alone. Prof. Brauner is apparently unaware of the fact that, from 1916 onwards, it was possible for institutes of the Austrian universities and technical high schools to obtain scientific periodicals and publications from Entente countries. The enactment which made this possible did not appear to be generally known, but I am aware of two institutions at least, which made application for, and obtained from the Austrian Foreign Office, the necessary permission; and in neither instance was any difficulty experienced.

The Radium Institute of Vienna was one of the institutions concerned, although at that time several Poles (one of them a Russian subject) and the writer of this letter were working there. What is more, the Austrian Foreign Office was not unaware of this "quasi-international" character of the Radium Institute!

Books were also obtainable, and I know of several men of science of Vienna, Budapest, and even of Prague, who were granted permission and obtained books from France and England through neutral countries.

A few months before the armistice I remember sitting in a Viennese restaurant at the same table as a gentleman, who was voraciously devouring the contents of the *Sketch* and the *Illustrated London News*. To judge from his frequent unsuppressed laughter, one would have thought he was scanning the pages of *Punch*. Not having seen these periodicals for nearly five years, my interest and curiosity were aroused, and I asked this gentleman's permission to see them. His reply was very emphatic: "Das ist ja ganz unmöglich!" I gathered from his further conversation that he belonged to the Intelligence Bureau of the Austrian Foreign Office, and that his work consisted in reading such journals. I envied him, but could not suppress my feelings of astonishment at his reading such "ganz geheimen Dokumente" in a public restaurant.

It may be mentioned in conclusion that Germany was much more liberal than Austria about the circulation of Entente publications. At least until the later months of the war, it was possible to go into any of the larger *cafés* of the German cities and enjoy a cup of coffee-substitute over a copy of the *Times, Le Temps, Secolo,* and various other newspapers of the Allied countries.

ROBERT W. LAWSON.

The University, Sheffield, December 17.

Royal Meteorological Society's Phenological Returns.

WITH 1920 the phenological returns complete the thirty years, which period is a recognised critical epoch in meteorological records.

In consequence of the war, our observing stations fell to 110 in 1918, against the high-water mark of 132 in 1914. We are most anxious now to recover lost ground, and would in this respect like to make 1920 preparatory to the years to follow.

A reasonable total would include at least 220 stations, an average of twenty only for the eleven Meteorological Office districts. At present we are short of this in all but South-east England and the Midlands. The six districts forming Scotland, Ireland, and North-east England average only 3½ each. Wales has two stations only, both in the south-west.

The observations asked for refer to the blooming of thirteen common flowers and the appearances of six birds and six insects. Other migrant records and notes are also invited, but these are of secondary importance.

A copy of the observing form and of a recent report will be sent with pleasure (the reports so far as they are available) to any readers of NATURE who would be interested to help.

We especially suggest the value for all interested in Nature-study and regional survey classes.

Inquiries should be addressed to one of us, or to the Assistant Secretary, Royal Meteorological Society, 70 Victoria Street, S.W.1.

H. B. ADAMES,
33 Holcombe Road,
Ilford, Essex.
J. EDMUND CLARK,
"Asgarth," Purley,
Surrey.

Einstein's Theory and a Map Analogue.

I AM grateful to the Director-General of the Ordnance Survey for directing my attention to an inaccuracy in my article in NATURE of December 11, p. 375. It was there stated that it is not possible to strain a map of the earth's surface so that all great circles become straight lines.

This is clearly contrary to the known fact of the central projection. As a matter of fact, the sphere is one of the limited class of surfaces for which it is possible to strain all geodesics into straight lines. For an arbitrary surface this is not true. The difference between the properties of the sphere and of the general surface gives a fair indication of the geometrical notions at the back of Einstein's theory.

E. CUNNINGHAM.

THE SUN DANCE OF THE TETON SIOUX.

AS man advances in the scale of culture he loses his dependence on Nature. The dweller in a modern city relies chiefly on artificial means for his pleasure and comfort, but the American Indian realised that his whole success depended on his co-operation with natural forces. He studied his surroundings and evolved a system of reasoning by which he attempted to explain them. A thoughtful Sioux Indian said to the writer: "When we see the changes of day and night, the sun, moon, and stars in the sky, and the changing seasons upon the earth, with their ripening fruits, anyone must realise that it is the work of someone more powerful than man. Greatest of all is the sun, without which we could not live. The birds and the beasts, the trees and the rocks, are the work of some great power."[1] Having recognised a creative power with the sun as its most important manifestation, it was a natural step in native logic to regard the sun with a reverence that is best expressed by the word "worship."

While the worship of the sun, in various forms, was widespread among the Indians of North America, the sun dance was a ceremony the observance of which was limited to certain plains tribes. The sun dance among the Santee Sioux differed in some respects from that of the Teton Sioux, which is herewith presented, but the underlying idea is the same. The sun dance was "the first and only religion of the Sioux," and even at the present time it is considered too sacred a subject for ordinary conversation. At the opening of the writer's study a member of the tribe said: "If we were to talk of the sun dance there should be at least twelve persons present, so that no disrespect would be shown, and no young people should be allowed to come from curiosity."

The purpose of the sun dance was the public offering to Wakaŋ'taŋka (Great Mystery) of what was strongest in the nature and training of the Indian—namely, his ability to endure physical pain. He did this in fulfilment of a vow made in time of great anxiety or danger, usually when on the warpath. The time of the sun dance was the full moon of midsummer, "when all Nature and even man is rejoicing." Into this joy and beauty, as though to give a greater contrast, the Indian projected his personal suffering. For a month before the sun dance it was customary for the medicine men to "pray for fair weather," singing their songs of magic power, burning sweet grass, and offering their pipes to the sky, the earth, and the cardinal points as they made their petitions. It is said that the oldest men cannot remember the falling of rain during a sun dance.

From long distances the people came and made their camp in a great circle. The dance enclosure was in the centre of this circle, and was about 50 ft. in diameter. Around it was erected a shelter

1 "Teton Sioux Music." By Frances Densmore. Bulletin 61, Bureau of American Ethnology, Smithsonian Institution, Washington, D.C., p. 96. Other direct quotations, as well as the facts herein presented, are from the same work. The Bureau of American Ethnology has kindly given permission to reproduce the illustrations used in this article.

for those who witnessed the ceremony. The sun-dance pole was placed in the centre of the dance enclosure, and near its entrance, which was toward the east, a large drum was placed, the singers being seated around this drum. About 15 ft. west of the pole a square of exposed and finely pulverised earth was located. This was called the "sacred place," and its preparation, as well as the securing and erection of the sun-dance pole, were accompanied by ceremonial songs and action.

The tree for the sun-dance pole was sought as men seek an enemy. It could be cut only by a virgin selected carefully from the tribe, and the song while it was being felled was a song of war. The branches were cut off, and in a triumphal manner the pole was carried to the camp, where it was painted in vertical red stripes by the leader of the ceremony. The people watched the painting and erection of the pole with deep reverence, and listened while the leader sang the sacred songs that had come down to him through many generations—the songs of Dreamer-of-the-Sun. In one of these songs the pole speaks, saying: "Sacred (made holy) I stand"; and after the pole was in position the words of the song were: "Grandfather, at the places of the four winds may you be reverenced. You made me wear something sacred. The tribe sitting in reverence, they wish to live." The "sacred place" was then prepared, the earth being finely pulverised and two intersecting lines drawn in it, forming a cross. In these lines tobacco was placed, then covered with vermilion paint-powder, and over this was spread powdered gypsum, shining white in colour. At the intersection and ends of the lines were placed bunches of downy white eagle feathers. West of this was spread a bed of fresh sage, on which a buffalo skull would be laid during the ceremony, and between the two was a "pipe-rack" to support the stem of the ceremonial pipe. The people watched this also in silence, and the leader sang the following song: "Four times to the earth I prayed. A place I will prepare, O tribe, behold."

The sun-dance pipe (Fig. 1) was decorated in a prescribed manner by one of the most skilful women of the tribe. This pipe was carried by the leader of the dancers. Those who took part in the dance wore their hair loose after the custom of men who had recently killed an enemy. Each man wore a deer-skin apron that extended to his knees back and front. An eagle-bone whistle was hung around his neck, and on this whistle he blew as he danced.

FIG. 1.—Sun-dance pipe.

FIG. 2.—Knife used in inflicting sun-dance torture.

The torture of the sun dance was inflicted by the insertion of a short stick or skewer through the flesh of the chest or back, and placing a strain upon this until the flesh tore, releasing the man. While the word "flesh" is commonly used as suggesting the severity of the ordeal, the Indians said that "the stick was put through the skin." It probably penetrated also the subcutaneous fascia. A knife used in making the incisions is shown in Fig. 2, together with the shield covering the point of the knife when not in use. A man accustomed to the work lifted a small portion of the man's flesh (or "skin") between his thumb and finger, thrust the knife through it, following this with the pointed stick. The strain on the stick was secured by tying to it the ends of thongs that hung from the cross-bar of the sun-dance pole, the length of these being such that the man was only relieved from the strain by rising on his toes. He was, however, expected to dance until the flesh gave way. Others dragged buffalo skulls attached to their backs, and a man might request that the stick be tied to his horse. Another form of torture consisted in the cutting of gashes in arms and body. A man when making his vow designated the manner of its fulfilment, and those who witnessed the vow were expected to see that it was carried out.

After a man released himself it was customary to apply a powdered herb to the wound, which healed in a short time; it is said that even a swelling of the wound was unknown among the Sioux. The man then resumed dancing with eyes steadily fixed upon the sun, and continued dancing without food or water during that day and the following night. As the sun rose on the second day it was greeted by the leader with this song: "Here am I, behold me. I am the sun, behold me."

The scene of a sun dance, while the men are still dancing, is shown in Fig. 3, a drawing by a man who had taken part in the dance. The suspension from the pole and the carrying of buffalo skulls are seen, though the buffalo skulls were usually allowed to drag on the ground. The pole is decorated with streamers, and from the cross-bar are hung two effigies cut from raw hide, one representing a man (an enemy), and the other a buffalo. The drum is seen at the right with two singers beside it, and in the upper left-hand corner two women are carrying kettles of food. Feasts were often given in honour of young men taking part in the sun dance for the first time, and in the camp there were various events taking place during the dances.

Fig. 3.—Native drawing of sun-dance.

During the second day the men fell from exhaustion, and after being carried into the shade they gradually regained consciousness. The evening of that day saw the sun-dance ground deserted, as it was the custom that all the people take their departure before sunset of that day.

While the element of pain forces itself on our thought, it is interesting to note the unselfishness underlying it. As the men were dancing they "prayed for all in the tribe, especially the sick and the old," believing that "an act performed publicly is more effective than the same thing done in private." The men who had taken part in the sun dance were men of fine character. White-buffalo-walking (Fig. 4) was one of those who fulfilled a vow in the last sun dance ever held by the Teton Sioux, that splendid tribe of the rapidly vanishing race.

FIG. 4.—White-buffalo-walking, who took part in a sun-dance.

FRANCES DENSMORE.

THE INTERNATIONAL HYDROGRAPHIC CONFERENCE.

THE International Hydrographic Conference, which was held in London between June 24 and July 16, will, it is believed, mark a new era in hydrography. The revival of trade, with the consequent increased traffic on the high seas which will accompany it, makes the present time most opportune for the discussion of the methods of charting the seas and the publication of information to ensure safe navigation. Thanks to the initiative of the Admiralty, it was found possible to bring together most of the chief hydrographic experts of the world, and the decisions they have arrived at in the conference, and the general interchange of ideas which took place, will be fraught with good to the seamen of the world. Twenty-three countries were represented at the conference, amongst the representatives of which were the Hydrographers of Denmark, France, Great Britain, Greece, Holland, Norway, Sweden, and the United States of America.

The subjects to which the conference devoted its attention were "Charts," "Sailing Directions," "Light Lists," "Notices to Mariners," "Time Signals, Distance Tables, and Other Miscellaneous Hydrographic Publications," "Tide Tables," "Instruments Used for Surveying on Shore and at Sea," "Time-measuring Instruments," "The Interchange of Publications," and "The Establishment of an International Hydrographic Bureau."

The subjects, it will be seen, practically covered the whole field of hydrography, and the main object of the conference was to compare the practices of all countries, with a view to the adoption by all of the best methods, and so more or less to standardise the hydrographic publications of the world. All seamen will appreciate the benefit which must accrue from the adoption of common methods of producing all information required for their use to ensure safe navigation. The conference therefore divided itself into committees on the various subjects, and from day to day these committees pursued their investigations, finally reporting to the conference the agreements at which they had arrived. The conference, after discussing the committees' reports, recorded its decisions in a series of resolutions, to which the hydrographic authorities of each country will, it is hoped, give effect without delay. The result will be practically to standardise all published hydrographic works, and will amply justify the holding of the conference.

It is not possible in this brief account to enumerate all the decisions of the conference, and only a few of the most important can be noted.

Under the head of "Charts," agreement as to the use of a common set of signs and abbreviations which denote the various features on a chart was arrived at. The adoption of the metric system of measurement for depths and heights was discussed at length, but whilst the conference unanimously expressed the opinion that all nations should, as soon as convenient, adopt it in their charts and publications, it was recognised that it was not possible for the countries not using it in their charts to do so until the metre had been adopted as the general standard of measurement in their respective countries, and it was therefore agreed that those countries not using the metre should insert on their charts tables for the conversion of the measurements used to the equivalent measurements of the metric system, and that in their sailing directions, light lists, etc., the metric measurements should follow the national measurements. The transcription of names received attention, and it was agreed that generally the literal, and not the phonetic, transcription was desirable.

Under the head of "Sailing Directions," the general arrangement of these important addenda to the charts was discussed, and the necessity for the publication of an annual supplement to each volume to bring it up to date was recognised. An improved method of describing tidal streams and currents was adopted. Bearings, it was agreed, should be given as "true" only, and from 0° to 360° measured clockwise.

The arrangement of the British "Notice to Mariners" met with universal approval, and its form was adopted as the standard for all countries.

With regard to the "Light Lists," the principal alterations and additions agreed to were the inclusion in the lists of "light buoys," "wireless direction-finding stations," and "sound-ranging signal stations." The desirability of finding a satisfactory formula for describing visibility as limited by the intensity of light was recognised, and it was agreed that each nation should make observations and collect data in order that the matter might be dealt with by the International Hydrographic Bureau if ultimately established.

The subject of "Tides" was carefully considered, and the necessity recognised for the adoption of a uniform zero from which heights should be measured, which should also be the datum for soundings on the charts, and of uniform methods of publishing tidal information. A rule for determining a "universal datum plane," to be called "international low water," was suggested for the further consideration of hydrographers, and decisions were reached regarding information to be published in tide tables, and on charts at places where the semi-diurnal tide predominates, but it was unfortunately found that modern tidal knowledge was insufficient for any recommendation to be made as to information which should be given on charts at places where the semi-diurnal is not the predominating tide-wave; this question was therefore left for further investigation.

Interchange of publications, a most important matter to all countries, as each country freely copies the publications of the others, received consideration, and steps were taken to put the matter on a more satisfactory footing.

A number of instruments used by various countries in hydrographic surveying were exhibited, and useful comparisons made and information exchanged.

The adoption by all countries of a system of "time zones" to regulate the time kept at sea, such as have already been adopted by France, Great Britain, and Italy, was recommended.

The last item on the programme of the conference was the establishment of an "International Hydrographic Bureau," and as the work of the conference progressed, the necessity for such an institution became more and more evident. Questions arose upon which an agreement in principle was arrived at, but time would not permit of the necessary details to give effect to the decisions being worked out by the conference, nor was such a large body as the latter found to be a suitable medium for doing so. On the necessity for the establishment of a bureau, which should be a purely advisory body with no executive powers, and of the existence of sufficient work to employ it, there was unanimous agreement. Such a body, it was felt, was urgently required to consider and make proposals for the co-ordination of the work of the whole of the Hydrographic Offices, to study the numerous questions not fully solved by the conference, to act as an authority to which questions could be submitted for advice, to take steps as required to obtain the assistance and co-operation of Governments and Hydrographic Offices when required for the execution of any particular work or research desirable in the common interests of all countries, and generally to watch over and advance the science of hydrography. As a result of its deliberations the conference decided to appoint a committee consisting of Rear-Admiral Sir J. F. Parry, K.C.B. (then Hydrographer of the British Navy), Monsieur J. Renaud, the French Hydrographer, and Rear-Admiral E. Simpson, the Hydrographer of the United States Navy, to prepare for presentation to the various Governments the case for the establishment of a bureau, and to take the necessary steps for its formation when the various countries should have signified their approval of its institution.

With this final act the conference concluded its labours, which, from a hydrographical point of view, cannot be over-estimated, and the results of which will, it is hoped, speedily be apparent in the publications of the various Hydrographic Offices.

A SHAKESPEAREAN GARDEN.

WE learn with interest that the trustees and guardians of Shakespeare's birthplace are laying out the "Great Garden" attached to his house, "New Place," as an Elizabethan garden. The trustees are naturally anxious to plant the garden with those old-fashioned flowers which were grown in English gardens in Shakespeare's day, and they appeal to lovers of Shakespeare and of gardens to help them by contributing the flowers needed to restore the garden, so far as possible, to its original aspect.

Such a garden of old-fashioned flowers is much to be desired in these days, when so many of the old-fashioned, beautiful, sweet-scented flowers are almost lost to cultivation in gardens, owing to their being ousted by the modern creations of florists. No doubt present-day flowers are larger and more brilliant, but we have to a great extent lost the charm, scent, and elegance of the old garden flowers as a result of what may be termed the vulgarity of present-day tastes.

The desire for masses of colour and for magnificence of form no doubt accounts for the lack of interest in the old-fashioned plants, many of which are now scarcely known. Among the plants which the trustees desire to obtain are "sweet musk roses," "roses damask'd red and white," the "crimson rose" and "milk-white rose," all alluded to by Shakespeare. Crown imperials, "lilies of all kinds"—but those known in Shakespeare's time were only a tithe of what are now found in gardens; daffodils—again only a few—and "fleur-de-luce" are all referred to by Shakespeare, and may be sent. Of shrubs, rosemary, lavender, lavender cotton, box, woodbine, and many others should be planted.

The trustees, in their circular, refer to several early gardening books which give accounts of the plants in cultivation in the latter part of the sixteenth century, but they omit to mention the excellent book by the late Canon Ellacombe, a keen student of Shakespeare, whose "Plant-lore and Garden Craft of Shakespeare" is a mine of useful information on the plants in cultivation in Shakespeare's day. The list of plants grown in the garden at Bitton vicarage in 1831, reprinted in the recently published memoir of Canon Ellacombe, might also well represent what would have been found in a garden three hundred years ago, and should be referred to by those anxious to assist in the good work.

Fortunately, there are still collections of the old roses from which it may be possible to supply plants for the "Great Garden." Anyone having any of the old-fashioned plants suitable for the garden should send them to Mr. Frederick C. Wellstood, secretary to the trust, Shakespeare's Great Garden, New Place, Stratford-on-Avon, by whom they will be gratefully acknowledged. The names of the donors will be preserved at Nash's House, adjoining New Place, which was once the property of Thomas Nash, the husband of Shakespeare's granddaughter Elizabeth.

There are probably many people who would wish to take part in this interesting tribute to Shakespeare's memory, but have no flowers to send; contributions in money from such will be equally acceptable, and should be sent to the secretary to the trust.

A RESEARCH INSTITUTE FOR NEW ZEALAND.

UNDER the will of the late Thomas Cawthorn, of Nelson, New Zealand, the sum of 240,000*l.* was left for the founding of a technical institute. The trustees were unanimous in desiring that the Cawthorn Institute should be a research institution, and appointed a private commission of scientific men to advise as to the best method of procedure. The commission consisted of Sir J. C. Wilson, President of the N.Z. Board of Agriculture, Profs. Benham, Easterfield, Marshall, and Worley, and Dr. Leonard Cockayne. At the request of the trustees, the commissioners have consented to become an honorary advisory board. The main recommendations of the commission have been adopted by the trustees. The chief work of the institute is to be "instruction in and performance of scientific research; such research to be definitely related to the industries of Nelson and of the Dominion."

A beautiful, well-wooded site overlooking Tasman Bay has been secured, the area being approximately 20 acres and the distance from Nelson about three miles. It is expected that the buildings will be commenced at an early date. At the last meeting of the trustees it was decided, with the approval of the advisory board, to offer the position of director to Prof. T. H. Easterfield, professor of chemistry at Victoria College (University of New Zealand), Wellington, who has accepted the position. Mr. T. Rigg, of the Cambridge School of Agriculture, a New Zealand 1851 Exhibitioner, has been appointed agricultural chemist; other staff appointments will be made shortly.

A liberal scheme of scholarships and fellowships is arranged, so that university graduates may be attracted to carry out investigations under the guidance of members of the staff.

An annual "Cawthorn Lecture" has been established. The 1917 lecture was delivered by Prof. Easterfield on "The Aims and Ideals of the Cawthorn Institute"; the next lecturer was Prof. Benham, and the lecturer in 1919 was Dr. L. Cockayne.

Questions having been raised as to the legal right of the trustees to establish a research institute, an originating summons was taken out under the Declaratory Judgments Act. The decision of Mr. Justice Chapman was to the effect that the scheme set out in the report of the commissioners falls, in its main features, within the terms of the testator's intentions. It is proposed to introduce a Bill embodying the chief points of the judgment in the New Zealand Parliament next session.

Though it is intended that the work of the institute is to have a distinct economic bearing, it has been made clear that the trustees recognise that no sharp line can be drawn between technical and scientific research, and that the term "technical" will be understood in a broad and liberal sense.

DR. CYRIL G. HOPKINS.

STUDENTS of agricultural science in all countries will learn with regret of the death on October 6 of Dr. Cyril G. Hopkins, the distinguished head of the department of agronomy in the University of Illinois. Dr. Hopkins had for the past twelve months been studying the exhausted soils of Greece under the auspices of the American Red Cross. He had written his report, seen it translated into Greek, and received a decoration from the King of the Hellenes. He was on his way home, but when three days out from Gibraltar was suddenly struck down with congestion of the brain, with malarial complications.

Dr. Hopkins's chief service to agriculture was his urgent and persistent advocacy of the need for the honest and adequate use of fertilisers. His region of operations was the State of Illinois, of which he had a very extensive knowledge. It was the present writer's privilege to accompany him on an agricultural tour through this State in 1912, and to learn at first hand some of his interesting agricultural deductions and conclusions. Dr. Hopkins's critical scientific outlook was manifested in his lectures and writings. Besides being popular with his students, he had a great faculty for getting on well with farmers, and was obviously a welcome guest in their homes. English agricultural students will remember with pride his high opinion of the work of the Rothamsted Experimental Station, with which he was unusually well acquainted. The Rothamsted data were constantly used by him in lectures and writings, and he maintained his personal interest in the work right up to the time of starting for Greece.

Two of Dr. Hopkins's books are well known in this country. One—"The Story of the Soil"—was written in the main during his long railway journeys in the States; it is an attempt to introduce scientific facts about the soil into the dialogue of a novel. It is not less attractive than other novels written with a purpose, and it is light reading. His more serious book is entitled "Soil-Fertility and Permanent Agriculture"; it contains valuable summaries of the results of the more important field experiments, and an interesting and illuminating discussion. His own view was narrower than would be usually accepted by the younger generation of workers in America or in this country; he considered soil fertility to be essentially a matter of nitrogen, phosphate, and potash, and to be expressible in the terms of the actual weights of these substances in the soil. There are cases where this view would suffice, and many appear to have come within Dr. Hopkins's experience. These, however, would now be regarded as limiting rather than as normal cases, and more generally fertility would be considered to be the outcome of many factors, some chemical, some physical, others, again, biological. But Dr. Hopkins did much good work, training a splendid body of students, and developing a department which has added lustre to the great University of Illinois.

E. J. Russell.

NOTES.

We announce with deepest regret the death on Monday, December 29, at seventy years of age, of Sir William Osler, Bart., F.R.S., Regius professor of medicine in the University of Oxford.

Mr. R. Nathan, late Indian Civil Service and author of works on the history of plague in India and the progress of education in India, has been promoted by the King to the rank of K.C.S.I.; and Mr. G. S. Sankey, Inspector-General of Forests to the Government of India, has been given the honour of K.B.E.

Dr. F. Broili has been appointed professor of geology and palæontology in the University of Munich in succession to the late Prof. A. Rothpletz. Dr. Broili was a pupil of the late Prof. K. A. von Zittel, and is well known for his numerous contributions to vertebrate palæontology.

We learn from Dr. Tolmatcheff, a Custos of the Russian Academy of Sciences, who is now in London, that when he left Petrograd early last summer the collections and libraries of the Academy, the School of Mines, and the Geological Survey were intact, and scientific men were being sympathetically treated by the Bolshevik Government. The most important specimens of the Permian reptiles collected by the late Prof. Amalitsky in northern Russia had been removed from Warsaw to the museum of the Academy of Sciences at Petrograd.

The death is announced, in his sixtieth year, of Dr. Louis Valentine Pirsson, who had been professor of physical geology since 1897 at the Sheffield Scientific School at Yale, where for several years previously he had held various minor posts. Prof. Pirsson was a geologist on the staff of the U.S. Geological Survey and an associate editor of the *American Journal of Science*. He was the author of numerous scientific memoirs, text-books, and papers on geological and mineralogical subjects.

The Photographic Arts and Crafts Exhibition, which was held annually until the war intervened, is to be resumed in the coming spring. It is renamed the Photographic Fair, and will be held at the Horticultural Hall, Westminster, on April 16 to 24. As usual, the Professional Photographers' Association will hold a congress at the same time in connection with the exhibition, while the Photographic Dealers' Association will, for the first time, organise a congress of photographic dealers. It is intended to afford dealers special facilities for examining the exhibits. The organising secretary of the fair is Mr. Arthur C. Brookes, Sicilian House, Southampton Row, W.C.1.

The death of Mr. J. Hartley Wicksteed on December 16, at seventy-seven years of age, is announced. *Engineering* for December 19 gives some particulars of his career. Probably his inventions which have had most bearing on engineering progress are his vertical single-lever testing machine and his horizontal universal testing machine. Mr. Wicksteed was connected with the Institution of Mechanical Engineers for more than fifty years, and was president in 1903–4. He was one of the first members of council of the Yorkshire College, Leeds, afterwards becoming a life governor of the University; and through this and other local activities he exercised a wide influence. He became a member of the Institution of Civil Engineers in 1889.

By the death of Dr. Harold Cecil Greenwood a few weeks ago, at thirty-two years of age, British engineering chemistry has lost one of its most promising younger members. Dr. Greenwood was always a careful and accurate worker, and applied that characteristic to even the smallest detail in every problem which he took up. As a result his work was exact; his data on the boiling points of metals, published in 1909, are generally accepted as the most accurate existing upon the subject. During the last three years of his life Dr. Greenwood was engaged on behalf of the Government on an extremely laborious undertaking: the construction of an experimental synthetic ammonia plant for the preparation of ammonia from its elements. In this work his training with Prof. Haber at Karlsruhe stood him in good stead, but it was no easy matter to translate laboratory experimental work to the semi-technical working-plant model producing 1 kg. per hour of ammonia, desired by the authorities. It was at this stage that his industrial experience with Messrs. Hutton at Sheffield aided him both in the choice of suitable materials and in the proper design of apparatus. No member of Dr. Greenwood's staff had had previous experience with the operation of gases under very high pressures or with the design of suitable plant, yet he not only brought his work to a successful issue, but he also effected the training of the staff in such a way that they could operate the extremely complicated plant unaided. This in itself is a tribute to his technical and executive abilities; and his work on "Industrial Gases," published since his death, is a worthy record of his knowledge of an important department of applied chemistry.

The loss of that keen geologist, Prof. Joseph Barrell, of Yale, who died at the comparatively early age of fifty on May 4 of last year, will be felt far beyond those who met him and appreciated at first hand his mental energy and accuracy of perception. A sympathetic memorial of Prof. Barrell's work, with a portrait and bibliography, appears in the issue of the *American Journal of Science* for October last, and it is followed by two important papers by him on the theory of isostasy. An obituary notice of Barrell by Prof. Schuchert appears in *Science* (vol. xlix., p. 605, 1919). It is here pointed out that his reasoning powers were applied to the relations of climate to organic evolution, as well as to those problems of earth-structure that he made peculiarly his own.

The Government of India has appointed a Committee, consisting of European and Indian experts, to inquire into the conditions and prospects of the sugar industry. At present most of the sugar produced is locally consumed in the crude form of "jaggery," but there seems little doubt that if capital and modern methods of manufacture could be introduced India might become one of the great sugar-producing areas in the world. The annual consumption of sugar in India, as elsewhere, has rapidly increased. India until recent years stood first of all the countries in the world in its area under sugar-cane and its estimated yield of cane-sugar, and even now ranks second only to Cuba. Yet it is notorious that the yield both of cane and raw sugar per acre and the available sugar extracted from the cane are undesirably low. In view of the conservative habits of the Indian peasant, the Government, in inducing him to adopt improved methods, has a difficult task to encounter.

At a conversazione of the Eton College Scientific Society, held on December 15, a presentation from past and present members was made to the retiring president, Mr. W. D. Eggar, who, in returning thanks, referred to the losses which the society had suffered since the last conversazione in 1914, and in particular mentioned the names of W. S. Stewart, A. G. Parsons, and H. G. J. Moseley. Henry Moseley was "in college" with a brilliant band of classical scholars. He obtained his scholarship at Trinity, Oxford, in chemistry and physics, but the only paper which he contributed to the society was on deep-sea fishes. At the 1905 conversazione he demonstrated the simpler properties of those X-rays which afterwards he investigated to such purpose that his name, like that of Robert Boyle, links Eton with a law of Nature. After attending the British Association meeting in Australia, Moseley hurried back to join the Army, and fell in Gallipoli on August 10, 1915. Dr. Leonard Hill, who demonstrated in an amusing and instructive lecture the advantages of oxygen for athletes, deplored the loss to science in Moseley's death. Dr. R. Whytlaw Gray is the new president of the society.

The council of the Scottish Meteorological Society proposes to hold a series of meetings, mainly in Edinburgh, at which lectures on popular lines will be given or discussions opened on questions of meteorological interest. The first of these lectures has, indeed, already been given in Glasgow by Capt. Franklin, who opened the winter session of the Royal Philosophical Society of Glasgow by an address on "The Study of Meteorology in Schools and Universities." The report of the council, adopted at the annual business meeting on December 19, refers to climatological stations maintained by voluntary observers, and says it has become evident that the country should no longer depend so largely on voluntary effort for a record of important economic factors. It is felt that those who may be in charge of any scheme of reconstruction should regard it as a vital matter that there should be a sufficient skeleton network of stations the permanence of which is guaranteed by some local authority or by some Government Department the interests of which are directly concerned. The president of the society for the ensuing year is Dr. C. G. Knott; vice-presidents, Prof. T. Hudson Beare and Mr. D. A. Stevenson; and hon. secretary, Dr. E. M. Wedderburn.

The executive committee of the National Union of Scientific Workers has appointed Major A. Church to be whole-time secretary of the union, the appointment to date from January 1, 1920.

A new era of prosperity for the Zoological Society of London seems to have dawned. At the last monthly general meeting, held on December 17, it was announced that the number of visitors to the gardens from January 1 to November 30 showed an increase of 653,187 as compared with the previous year, while the money received for admission in the gardens during the same period showed an increase of 22,977*l*. as compared with the corresponding period in 1918.

We are glad to note that vigorous measures are to be taken to suppress the practice of bird-liming in Lower Egypt. The Ministry of Public Works, Egypt, has just issued a report by Mr. J. Lewis Bonhote setting forth the hideousness of this traffic and the grave results to agriculture which must follow unless it is speedily stopped, for the victims are almost exclusively small, insectivorous birds. In an introduction to the report Major Stanley Flower, Director of the Zoological Service, remarks that in the past, in every normal year, practically the whole surface of the country was flooded, so that both the insect and rat population was swept away and drowned, with the exception of such comparatively small numbers as could survive by taking refuge in villages, in the tops of banks and trees, and on the desert fringes. The conditions within the last century have changed, and are becoming increasingly favourable for the spread of pests of agriculture. But there are serious difficulties to be overcome in certain districts in enforcing the law, as at Damietta, Fuwa, and Rosetta, owing to the "unpatriotic and uncivilised behaviour" of the local authorities.

MR. T. SHEPPARD has reprinted from the Transactions of the East Riding Antiquarian Society (vol. xxii.) a paper on Danes' Dyke, the remarkable earthwork stretching across the triangular Flamborough headland from north to south. It is certainly much more ancient than the Danish period. Its shape and mode of construction demonstrate that it is not Roman. But in the same area, and associated with the earthwork, are numerous barrows, the implements, weapons, and ornaments found in them belonging to the Bronze age, though they also contain many fine stone implements, the use of which continued into the Bronze age. The results of some excavations made by Major-Gen. Pitt Rivers in October, 1879, are published in the Journal of the Anthropological Institute for 1880.

SIR W. RIDGEWAY describes in the November issue of *Man* a remarkable Irish decorated and socketed bronze axe, of which the provenance is doubtful, but it probably came from Co. Westmeath. The axe, 60 mm. ($2\frac{2}{5}$ in.) long, is remarkable because the maker made a careful scheme of ornamentation for the whole of its surface, dividing it into four compartments by means of four fine curved lines in relief, and adding the main feature, a band or frieze of chevrons, in refined and delicate relief running along the top of each side immediately under the delicate line running below the mouth of the socket. There is no similar specimen in the Irish National Museum or in the British Museum collections, now enriched by that of the late Canon Greenwell, nor does Sir John Evans describe any such in his "Bronze Implements." But Canon Greenwell possessed an Irish socketed axe with elaborate and refined decoration. This agrees fairly well with Sir W. Ridgeway's specimen, which is said to have come from Rathowen, Co. Westmeath, and there is at least some probability that the Ridgeway axe may have been made in that area.

THE progress of boundary delimitation in Europe is the subject of a short article and a useful sketch-map by Mr. A. R. Hinks in the *Geographical Journal* for December (vol. liv., No. 6). The Treaty of Versailles delimited the boundaries of Germany, subject, of course, to the result of the plebiscites in Schleswig, East Prussia, Silesia, and, in fifteen years' time, in the Sarre basin. The Treaty of Saint-Germain-en-Laye delimited the boundaries of Austria subject to the result of the Klagenfurt plebiscite. The new frontier of Italy is not yet fixed in the north-east; the frontier of Hungary is fixed only in the west. Czecho-Slovakia's and Poland's frontiers are incompletely delimited. In Eastern Europe the frontiers are still vague. It is proposed to revise the sketch-map and reissue it from time to time in the *Geographical Journal*.

THE Ordnance Survey decided in 1911 to undertake the levelling of an entirely new network in the British Isles to form the basis for a new series of bench marks and heights shown on the map. Experience has shown that many of the bench marks have altered their heights, either from subsidence or actual displacement; others have disappeared. The instruments and methods decided on for this work were described in a paper on "Precise Levelling" by Major E. O. Henrici read at the Institution of Civil Engineers on December 17. The new lines are laid out so that it is possible to erect special "fundamental" bench marks at intervals of about twenty-five miles. The marks of these will be fixed on solid rock or on concrete founded on rock. These marks have three reference points, one consisting of a metal bolt let into the top of a granite pillar, for general use, and two lower marks which are buried, and are for the use of the Survey only; they will serve in time to come to check the height of the upper mark. The probable error of the difference of height between any two consecutive "fundamental" marks may be about 0·01 ft. Intermediate bench marks take the form of gun-metal plates let into the surface of walls.

IN his new pamphlet ("The Stanton Drew Stones," Bristol, 1s.) Mr. E. Sibree returns to the theme of his former publication ("Stanton Drew: A Calendar in Stone"), treating it in greater detail and with an abundant wealth of literary scholarship and interesting folk-lore. The circles of 30, 12, and 8 stones respectively are referred to the days of the month, the months of the year, and the years of the Venus cycle of intercalation. Eight years of 12 months, each of 30 days, contain 2880 days; if to these are added 12+30 days we get 2922 days, very nearly eight solar years. Mr. Sibree shows that the same number is obtained from the Carnac stone calendar in Brittany. He draws the conclusion that the Stanton Drew calendar was erected by Romans or by Romanised Britons in about the fifth century. Some confirmation is afforded by the fact that the diameters of the circles are 375, 150, and 100 Roman feet respectively, proportional to the numbers of stones in the circles, and by the presence of the Guild of Calendaries at Bristol in about A.D. 700. Much of the lore of Merlin and of the Welsh mythology is invoked to support this conclusion. It must be urged, however, that the lateness of the author's date is surprising. The geometrical interpretation of the construction of the circles is very artificial and too complicated to be accepted as the intention of the erectors; in any case, it is really irrelevant to the main theme of Mr. Sibree's pamphlet.

MR. A. L. SHEATHER describes a malaria-like parasite found in the blood of an Indian buffalo. The animal suffered from irregular attacks of fever and anæmia, and eventually died. The parasites occurred in considerable numbers and in three forms—small, large, and dividing (Agricultural Research Institute, Pusa, Bulletin No. 90). Malaria-like parasites in the blood of ruminants seem to have been recorded only by Bruce, who found two antelopes infected in Nyasaland in 1913.

IN the recently issued fascicle iv. of "Contributions à la faune des Indes néerlandaises" (vol. i.), published by the Instituts scientifiques de Buitenzorg, Dr. Paul van Oye gives an account of the Chætognatha found in fifty-one samples of plankton taken off the north coast of Java. He describes five new species of Sagitta and one of Krohnitta, and founds a new genus Zahonya. Details are given of the horizontal distribution of the various species. Dr. A. L. J. Sunier has examined the collection of Stomatopoda in the fishery station and in the museum at Buitenzorg. The specimens prove to belong to known species of Squilla, Pseudosquilla, Odontodactylus, and Gonodactylus. Notes are given on seventeen species, the known geographical range of several of which is considerably extended.

IN the paragraph in these columns on September 25 (p. 78) referring to a paper by Mr. E. W. Vredenburg on "Observations on the Shells of the Family Doliidæ," the statement that "it appears that the genus Dolium is not known in formations older than the Oligocene" is in need of correction. Mr. E. A. Martin writes to point out that a Cretaceous Dolium is mentioned in Mantell's "Medals of Creation" and in the same author's "Geology of Sussex" (1822, p. 196). This was described and figured as *Dolium nodosum* by Sowerby in 1825 ("Mineral Conchology," vol. v., p. 34, pls. 426, 427). The figures represent casts of a large species of this genus. An analogous, if not identical, species of Dolium is recorded by W. C. Williamson from the Cretaceous formation of Mount Gebeel Suneen, part of the Lebanon range, immediately above Beyrout (Proc. Geol. Soc. Lond., iii., 1840, p. 291).

DR. NATHAN MUTCH describes in the Journal of the Royal Microscopical Society (pt. 3, September, 1919, p. 221) a comparatively simple procedure for the isolation of a single bacterial cell. It consists essentially in making a very dilute emulsion of the culture and transferring a minute drop of this to a sterile cover-glass, which is quickly mounted on a cell so as to form a hanging-drop preparation. A ring of filter-paper moistened with saline solution is placed on the bottom of the cell, and serves both to prevent evaporation from, and addition of moisture to, the hanging drop, which thus maintains a constant size. The preparation is then examined microscopically, and if a single cell only is found to be present, a drop of melted sterile agar is added to the drop on the cover-glass, the preparation remounted on the cell, incubated, and a growth is thus obtained.

WE learn, from *California Fish and Game*, vol. v., No. 4, that in 1919, for the first time in several years, squid were caught in abundance at Montery, California. Three Chinese firms have dried, in the past season, about 1,772,000 lb. of this mollusc. Three tons of wet furnish one ton of dried squid. Practically the whole of the harvest was sent to China. But, apparently by way of experiment, a small percentage of the catch was canned, while some was put upon the market in a fresh state, and is, it would seem, slowly winning favour as a table delicacy. Squid tentacles are said to rival the oyster in flavour. The kelp industry, which was started during the war to furnish potash, seems, from this number, to have come to an end. But it is hoped that the plant will be re-started on a paying basis by the sale of certain by-products which are obtainable during the process of extracting the potash. No hint, however, is given as to the nature of these promising substances.

THE *Journal of Agricultural Research* for October 15 contains two interesting contributions to the study of plant nutrition. By determining the composition of barley at successive stages of its growth in soil, Mr. J. S. Burd demonstrated considerable losses of potassium and nitrogen from the plant at the beginning of ear-formation, at which period the water-extract of the soil has a minimum concentration. The author considers that the most important condition of the soil solution for a high yield is an adequate supply of nutrient elements during the first half of the growth-period; subsequent high concentration is unnecessary, and may be undesirable. Similar results were obtained by Mr. D. R. Hoagland in carefully controlled sand and water cultures. Marked absorption of all nutritive elements occurred throughout growth if suitable concentrations of the medium were continuously maintained, but the absorption in the later stages of growth led to no important increase in yield. Attention is directed to the necessity of clearly distinguishing between the concentration and the total supply of essential elements in the nutrient solution, since rapid absorption by the plant may produce considerable alterations in the composition of the solutions.

A REPORT of the Meteorological Committee for the year ended March 31, 1919, has recently been issued. This is the first report since the Armistice, and much interesting information is given in it. Immense strides have been made in meteorology, and the Meteorological Office has expanded accordingly, dependent on the necessities of the war. Whereas the sum available, including many costs for the Services, in the year 1913–14 was 29,380*l*., in 1918–19 it was 66,371*l*. A much greater demand was made on the office for meteorological instruments, and for forecasts of all descriptions, including the upper air. The marine division, on the other hand, which is dependent for its information on the Royal Navy and mercantile marine, experienced a great falling off in the number of documents received from observers at sea, the documents numbering 2738 in the year 1913–14 and only 43 in 1918–19. Throughout the war there was great activity in the supply of data to the Army, Navy, and Air Service, and the work commonly undertaken in times of peace was greatly augmented, although most of the information was considered private and was withheld from the general public. The restrictions upon the circulation of meteorological information were removed after the signing of the Armistice.

Reports for the several branches of the office show the variety and extended work now undertaken. Any future report will presumably be made through the Air Ministry, to which the Meteorological Office is now responsible.

EXPERIMENTS have been carried out by Prof. Garelli, of Turin, on behalf of the Italian Government, with the view of extracting nitrate of ammonia from surplus stocks of explosives. According to *La Nature* of November 29 last, the explosive mixture is placed in special receptacles, a fixed quantity of water added, and the whole allowed to stand. A dense solution of nitrate of ammonia is then formed, which is separated by decantation. Powdered peat is then added to this solution, and after mixing and drying the product thus obtained it becomes a species of manure which is called "nitric peat." This material, which has the appearance of a blackish powder, has the following composition:—Water, 17·8 per cent.; ash, 18·8 per cent.; nitrate of ammonia, 42·8 per cent.; and organic matter, 20·6 per cent. Tests for ascertaining its value as a fertiliser have been carried out in the Alba district of Italy, and the results show that the action of this fertiliser is nearly equal to that of nitrate of soda.

DR. A. E. H. TUTTON has recently published in the Proceedings of the Royal Society (A, vol. xcvi., pp. 156–84) the results of an exhaustive study of the crystallographic properties of the monoclinic double selenates of the cobalt group, $R_2Co(SeO_4)_2,6H_2O$, where R stands for potassium, rubidium, cæsium, and ammonium successively. Only the potassium and ammonium salts of the group had previously been studied. The results fulfilled expectation, and fully accorded with those obtained for the zinc, magnesium, nickel, and iron groups, and for the eight known groups of the analogous double sulphates. The dominating facts brought out are, first, the progressive character of all the crystallographic and physical properties following the alkali metals concerned, potassium, rubidium, and cæsium; and, secondly, the almost perfect isostructure of the crystals of the ammonium and rubidium salts of the group.

THE Australian Institute of Science and Industry has published at Melbourne a pamphlet on "Engineering Standardisation," by Mr. Gerald Lightfoot. The objects of standardisation in cheapening manufacture and reducing maintenance charges and stocks, and in securing interchangeability of parts, are discussed. The British Standards Association is described, and under its influence other similar bodies are being formed in various countries. It is argued that if Australia neglects to take action, it will be impracticable to develop her engineering industries at the same level as in other countries. The institute desires to carry out research work on lines similar to those in the case of the U.S. Bureau of Standards and the National Physical Laboratory. The outline of a scheme for the formation of a Commonwealth Engineering Standards Association is given. It is mentioned that there is a multiplicity of voltages in electrical supply in Australia, and that merchants have to stock lamps for about twenty different voltages.

VOL. XIII. of the Transactions of the Rochdale Literary and Scientific Society contains the papers that have been read before the society during the years 1917–19. These papers, some fifteen in number, are entirely devoted to local subjects, and are mainly concerned with the history of the town and its institutions. There is a short article by Mr. E. L. Taylor on the Rochdale Grammar School (an old foundation dating back to 1564), two papers on the old Rochdale roads by Dr. Ashworth and Mr. A. P. Wadsworth, an annotated list of Querns found in the Rochdale district by Mr. J. L. Maxim, and a topical contribution by Mr. G. E. Leach on the connection of Rochdale with Peterloo in 1819. Of immediate interest to scientific readers we may note the interesting presidential address by Dr. Ashworth, in which he gives a brief but clear statement of the great and important part which Lancashire men and institutions have played in the striking advances which have taken place in electrical science during the last hundred years. The Rev. T. A. Jefferies contributes a short but suggestive paper on the natural transformations in the vegetation of Blackstone Edge, in which he traces the life-cycle of its plant associations. Dr. Ashworth's paper on atmospheric pollution in Rochdale provides the local authorities with a valuable mass of facts on which to base legislative action to mitigate the evils of smoke, unfortunately inevitable in large industrial areas. Altogether, the volume is an excellent example of the kind of research work, both historical and scientific, which it is the peculiar province of local societies to undertake.

A VOLUME devoted to the "Life and Letters of Silvanus Phillips Thompson" has been prepared by his wife and his daughter, Miss Helen G. Thompson, and will be published by Mr. T. Fisher Unwin in the spring. Many of the letters relate experiences on journeys abroad, some record adventures of the antiquarian in pursuit of early scientific literature, while others tell of battles for truth in some field or other. A few chapters deal solely with Thompson's scientific and public work, and contain appreciations of his books and original papers. Throughout the work there are many indirect testimonies to the warmth of personal regard which the frank geniality of his nature won for him and to the influences he exerted on the lives of those he met.

Messrs. George Bell and Sons, Ltd., will publish almost immediately "The Year-book of the Universities of the Empire" for 1920, edited by W. H. Dawson. The latest list of the *Cambridge University Press* includes:—The late Prof. J. H. Poynting's "Collected Scientific Papers," edited by Dr. G. A. Shakespear and G. Barlow, with biographical and critical notices by Sir Oliver Lodge, Sir Joseph Larmor, Sir J. J. Thomson, and Dr. G. A. Shakespear; "An Introduction to the Study of Cytology: An Outline of the Main Facts of Cytology for Advanced Students," Prof. L. Doncaster; "The Foundations of Einstein's Theory of Gravitation," E. Freundlich, translated by H. L. Brose; "A History of English Philosophy," Dr. W. R. Sorley; "Discovery in Greek Lands," F. H. Marshall; and "Life and Labour in the 19th Century," C. R. Fay. *Messrs. Constable and Co., Ltd.*, announce "Montessori Experiments," Miss Blackburn. Prof. Patrick Geddes has written a volume, which *Messrs. Longmans and Co.* will issue shortly, on the life and work of Sir Jagadis Chandra Bose, the founder of the Bose Research Institute in Calcutta.

OUR ASTRONOMICAL COLUMN.

FIREBALL ON DECEMBER 25.—A brilliant fireball was visible on Christmas night at 10h. 21m. at Bristol. It must have very much exceeded Venus in lustre, for it gave a flash which illumined the whole sky, and in that section of its flight where the greatest outburst occurred it left a streak about 3° long for 40 seconds. The apparent path was from 115°+34° to 105½°+1°. The motion was rather swift, the course of about 35° being traversed in 2 seconds. The radiant point is doubtful; it may have been at 165°+73°, 219°+75°, 245°+72°, or 261°+62°. If the second is the correct position, the meteor may quite possibly be considered to have been a fragment of Mechain-Tuttle's comet, which has a period of about 13½ years. Further observations of the object would be valuable, and should be sent to Mr. W. F. Denning, 44 Egerton Road, Bristol.

COMETS.—The following continuation of the ephemeris of Finlay's comet is for Greenwich midnight, from the elements in Lick Bull. 325:—

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Jan. 2 ...	3 3 35	21 47	0·1703	9·8160
6 ...	3 12 57	22 24	0·1806	9·8510
10 ...	3 22 24	22 58	0·1911	9·8849
14 ...	3 31 21	23 27	0·2013	9·9173
18 ...	3 40 9	23 55	0·2114	9·9485

The comet will traverse the Pleiades on January 18.

It is calculated that Holmes's comet passed perihelion about November 30, and a search ephemeris was published. The comet is probably too faint to give much hope of its recovery. It has not been seen for two revolutions.

RADIATION PRESSURE.—The *Astrophysical Journal* for October last contains an article by Mr. Megh Nad Saha in which the opinion is expressed that the quantum theory of light will explain the repulsion of particles much more minute than those the dimensions of which are of the order of a wave-length. In the undulatory theory the repulsion is a maximum for particles of that order of magnitude, and becomes practically zero for those of the dimensions of molecules. Mr. Saha quotes the results of spectrum analysis of comets' tails, and some laboratory experiments by Lebedew (*Ann. der Physik*, 1910), for the fact that gaseous molecules actually do suffer repulsion by radiation pressure, which he considers an argument in favour of the quantum theory.

Assuming that a pulse of light gives all its momentum to a hydrogen atom, the velocity imparted to the latter by each "kick" would be 60 cm./sec. Some calculations are given, from which the author deduces that by repeated "kicks" the atom might acquire a velocity of 6×10^7 cm./sec., which has sometimes been observed in the solar prominences.

THE ORION NEBULA.—We lately noted Dr. Bergstrand's estimate of the parallax of this object, 0·0078″. Prof. W. H. Pickering (Pubns. Ast. Soc. Pac., April, 1919) contends for the value 0·0020″. This is deduced from assumptions of the absolute magnitudes of a number of faint stars which appear to be associated with the nebula. By comparing their photographic with their visual magnitudes, he concludes that their spectral type is A or B, whence their absolute magnitude is unlikely to be very low. But this involves the conclusion that the brighter stars in Orion are super-giants. Rigel in particular would have 87,000 times the luminosity of the sun. But perhaps it is nearly as easy to accept this as the value 5000 times the sun, which results from Dr. Bergstrand's parallax. Prof. Pickering estimates for the masses of the faint B7 stars in the nebula only four times that of Jupiter, using his parallax. With Kapteyn's parallax 0·0054″, the mass would be one-twentieth of this. Either value seems far too small for a body to attain the temperature necessary to shine as a B star.

SPHERICAL SHELL CRYSTALS IN ALLOYS.

AT the autumn meeting of the Institute of Metals recently held in Sheffield, Dr. J. E. Stead presented an account of his investigations on some ternary alloys of tin, antimony, and arsenic, one of which was noticed by him to crystallise in a most unusual and remarkable way.

Having found that the alloys of antimony and tin crystallise in what appear to be cubic crystals, and those of tin and arsenic in rhombohedral flat plates, he made trials with the object of finding how the metals would arrange themselves when the three elements were fused together and the melt allowed to cool. The results obtained were astonishing, for the crystals found in the matrix had the form of incomplete spherical shells, the radii of which were small or great, according to the time allowed for development. With rapid freezing the radii were less than half a millimetre; when it was protracted for one hour they were 5 mm. or more. The most perfect structural arrangement of the crystals was obtained in an alloy containing from 70–85 per cent. of tin, 25–15 per cent. of antimony, and 4–5 per cent. of arsenic. Whether cooled slowly or quickly, the polished surface of the alloys, after dissolving away the matrix, is very suitable for printing blocks, since the hard crystals stand out in bold relief (see Fig. 1). The alloys are very brittle, and the fracture was found to travel midway along the shell walls. An alloy containing tin 70 per cent., antimony 25 per cent., and arsenic 5 per cent. gave the following arrests on cooling:—

(1) First separation of crystals ... 440° C.
(2) Retardation in cooling between 325° and 320° C.
(3) Solidification of the eutectic ... 244·9° C.

The last-named temperature agrees closely with that of the eutectic of the tin-antimony alloys. The conclusion is, therefore, warranted that the eutectic cannot contain more than a trace of arsenic, an inference confirmed by experiment. It was afterwards shown by analysis that the primary crystals contain a maximum amount of arsenic, and that, as crystallisation proceeds, the deposits contain less and less of this metal.

A large number of ternary alloys were prepared. It was found that, while it required 2·5 per cent. of arsenic in the presence of 25 per cent. of antimony to produce slightly curved crystals, 0·5 per cent. of arsenic in the presence of 3·75 per cent. of antimony yielded curved segments in the upper layers. In an alloy containing 1·65 per cent. of arsenic, 14·35 per cent. of antimony, and 85 per cent. of tin, spherical crystals were found in the top layers, below these smaller segments, under the latter cuboidal crystals, while the lowest stratum consisted of the eutectic. It was evident that the compound richest in arsenic was the first to freeze and floated upwards to the surface. As yet the analyses have given no decisive results as to the composition of these shells. Further details have been promised by Dr. Stead, and will be published in due course.

FIG. 1 (Nature-prin).

In the instance just quoted, four distinct stages of crystal growth can be observed. When, however, the proportion of antimony is between 20 and 25 per cent. and that of arsenic about 5 per cent., the primary crystals are distributed evenly through the whole alloy and there is no stratification.

That the primary crystals which form in such alloys are spherical shell crystals was shown by chilling

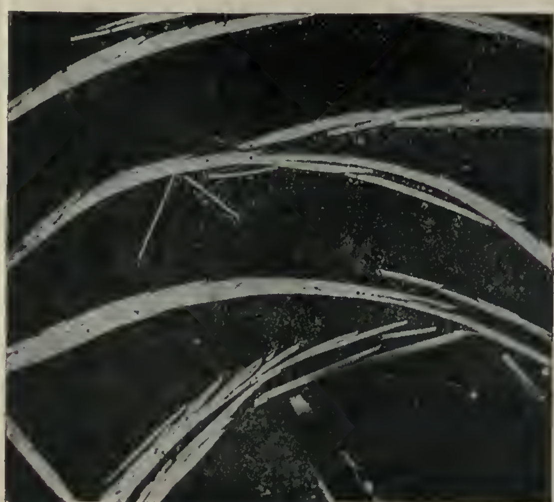

FIG. 2 (Photograph).

them just below the first thermal arrest. Fig. 2 depicts the structure after this operation. Sections of the shells are visible which are smooth on the concave, but slightly broken on the convex, side, due possibly to the stresses set up during quenching. With somewhat slower cooling, as shown in Fig. 3, both surfaces of the shells are seen to be smooth. That these are composite and contain a hard primary core was shown by grinding and polishing experiments.

In the latter part of his paper Dr. Stead quotes the opinion of Mr. L. J. Spencer, to whom specimens of the alloy containing spherical shells were submitted for his opinion, and who furnished Dr. Stead with important data regarding the curvature of crystals in minerals. Mr. Spencer's complete notes on the subject have been communicated to the Mineralogical Society. In them he refers to various instances of apparent curvature classified under these headings:—

(1) Curved crystallites; (2) capillary habit; (3) aggregations of crystals; (4) interfacial oscillations; (5) vicinal faces; (6) bent crystals; (7) twisted crystals; and (8) cylindrical and spherical crystals.

It would appear that, according to his view, the last-named constitutes the closest analogy to the alloy in question. "The mineral kylindrite is a sulphur salt of tin, lead, antimony, and iron. . . . It has the appearance of consisting of tightly wound rolls of foil with a smooth surface and a brilliant metallic lustre. The ore consists of large numbers of these rolls, with a more or less radial grouping. . . . The rolls have a diameter of a few millimetres up to one centimetre,

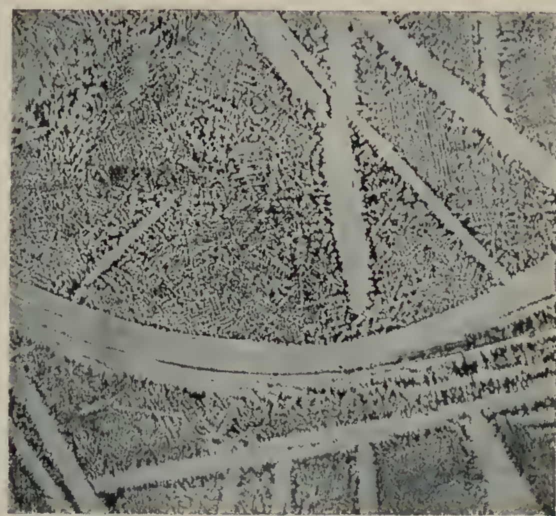

FIG. 3 (Photograph).

and reach a length of three to four centimetres. They flake off in concentric cylindrical shells with all the appearance of a perfect cleavage, very similar to that of the allied minerals, franckeite and teallite. These cylindrically curved cleavage flakes are perfectly bright and smooth and show no visible signs of being built up of smaller elements. Spherical aggregates of crystals possessing a perfect cleavage are, however, met with, but here a radial grouping is much more common than a concentric arrangement. Examples of radiating spherical aggregates of lamellar crystals with platy cleavages are pyrophyllite, zeophyllite, gyrolite, faröelite, tyrolite, etc."

With reference to the cases of curvature in mineral crystals thus referred to, Dr. Stead contends that none approach in character or form the spherical shell crystals obtained in his ternary alloys; that radial crystallisation round a nucleus is common in minerals, but the spherical form finally produced is an aggregation of many crystals, and not a single crystal; and that kylindrite consists of a number of cylindrical crystals which have formed round a central axis and are not independent cylinders. He states that no case is known to him in which the idiomorphic forms of the crystals are segments of spherical shells which have crystallised out of a liquid except in the ternary alloys referred to. The reason why idiomorphic shell crystals develop under such conditions and the laws which govern their formation await further research. Meantime, Prof. Bragg, to whom some of the separated crystals have been sent, has kindly promised to study them. H. C. H. C.

FORECASTING FROSTS.

In most countries during the spring, and to a lesser extent in the autumn, there are periods in which the meteorological conditions result in a frost. Leaving out of the question spells of cold weather, the prediction of which is the concern of a Meteorological Service, there remains the possibility of local frosts in isolated districts, occurring on clear, windless nights and lasting for a portion of the night and early morning. These frosts are capable of doing great damage to fruit-trees, etc., and the possibility of forecasting them in time for the fruit-growers to take precautions is of interest and importance.

It has long been recognised that local cooling of the soil can be largely prevented by a smoke pall produced by the burning of damp materials such as straw. Boussingault ("Economie Rurale," Paris, 1844) discusses this, and records an observation on the point by Pliny. In America definite systems of frost prediction have been in operation for some years, and practical methods have been evolved by which the grower can economically combat the danger to his crops. A study of these preventive measures is instructive in showing that several causes are concerned in producing a frost. The methods are varied. Leaving out those which attempt to delay the flowering-time until the danger period is past, they fall into four main classes:—(1) Increasing the water-content of the area (spraying or flooding); (2) "smudge" burning (damp smoke from wet straw, etc.); (3) temporary roofing; and (4) dry heating. The last method supplies additional heat mainly; the other three are largely indirect, and aim at reducing the rate of temperature fall either by increasing the heat capacity of the soil by the added water or by restricting the radiation from the soil.

Up to the present no complete correlation has been made of frost in any particular locality and its causes. For this purpose an examination by statistical methods of a series of continuous observations (of the automatic recording type) of meteorological factors is needed. The published papers deal usually with one factor, such as dew-point or air temperature, and the number of daily observations made is small. This is, no doubt, due to the necessity of keeping the cost of apparatus and working as low as possible for the sake of the growers. However, a general idea of the factors concerned can be obtained from a broad survey of the various papers.

The effect of an overcast sky on air temperatures near the ground has been studied by Hellman (*Preuss. Akad. Wiss.*, Berlin, 38, 1918, p. 806), who on clear nights found an exponential decrease of temperature with height, the average difference from ground-level to a height of 50 cm. being 3·7° C. An increase of cloudiness by 1° of scale (0=clear, 10=overcast) diminished this difference by at least ⅓° C. There was no temperature gradient when the sky was overcast, while windy and rainy weather resulted in a slight reversal of the gradient. Schubert (*Met. Ztsch.*, 32, 1915, p. 343) considers that during the last half of the night the fall of temperature is relatively greater with dry than with moist air, owing to the formation of dew, and frost from the latter resulting in latent heat being set free by the condensation. The presence of water-vapour in the atmosphere also retards the radiation cooling of the soil.

J. Warren Smith (*U.S. Monthly Weather Review*, 42, 1914, p. 573; 45, 1917, p. 402) has examined the accuracy of various methods of temperature prediction. The first, and simplest, is to subtract from the maximum temperature of the day the known average fall in temperature on clear, still afternoons and evenings for the appropriate period of the year. This temperature range varies in different months, but is remarkably uniform under similar topographical conditions and at similar seasons of the year. It has been used by Church (Nevada Station Report, 1915, p. 46).

The second method is due to Smith, and involves two temperature readings daily. Smith discovered that the daily temperature curves showed marked similarity in periods of calm, clear weather when a high-pressure system was centred over the district and conditions were favourable for strong insolation during the day and free radiation at night. For these curves the half-way point in the temperature fall from the maximum of one day to the minimum of the next morning (the "median") occurred at very nearly the same time. Hence a forecast of the probable minimum can be made by subtracting from the maximum the temperature shown at the time previously ascertained to be that of the median, and then subtracting this difference in turn from the observed median temperature. The values thus obtained agreed much more closely with the observed minima than those given by the original dew-point method, which is mentioned immediately below.

The third method, as developed by Smith, is an elaboration of the dew-point determination. This, as used by Hazen (Minn. Expt. Sta. Bull. 12, 1890), and by O'Gara (U.S. Farmers' Bull. No. 401, 1915), consists simply in determining the dew-point in the early evening (6–10 p.m.), and assumes the dew-point temperature will be the probable minimum temperature reached. Smith found that the prediction could be made much more accurately if the relative humidity of the atmosphere was also determined, and he used the correlation method to show that with high relative humidity the minimum temperature falls below the determined dew-point, while with low relative humidity the reverse is true. A satisfactory equation expressing this relation was obtained,

$$Y = 18{\cdot}314 - 0{\cdot}39R,$$

where R = relative humidity in the evening, and Y is departure of minimum temperature of the following morning from evening dew-point. A determination of R gives the value of Y, which added to (or subtracted from) the dew-point gives the probable minimum temperature to be expected. The numerical terms in the equation differ for different localities.

Recently T. B. Franklin (Proc. Roy. Soc. Edin., 39, 1919, p. 120) has published some observations on the cooling of the soil at night, with special reference to late spring frosts, and has arrived at a number of important conclusions, which will help considerably in developing methods for forecasting the minimum surface-soil temperature in this country. As a result of observations of temperatures in the air, on the soil, and at a depth of 4 in., Franklin concludes that a prediction of frost depends on assessing the value of:—(1) Average relative humidity during the night; (2) the temperature of a given depth (4 in.) at the time of surface minimum temperature; (3) the conductivity of the layer between the assigned depth and the surface; and (4) the difference between the surface-soil minimum and that of the air above it. These determinations are necessary because:—(i) The radiation from the soil on calm, clear nights is a function of the relative humidity (A. Angström, Smithsonian Misc. Coll., 65 No. 3); (ii) the radiation from the soil can be accounted for in balancing the upward conduction and the latent heat of freezing, the residue only cooling the soil; and (iii) the temperature of the surface soil rapidly falls sufficiently below the temperature of the 4-in. depth to make the conduction from this depth balance the radiation; after this the surface temperature falls no faster than that of the 4-in. depth.

Franklin has also noted rapid changes in underground temperature (6-in. depth) after heavy rain. This he attributes to the receding water drawing hot or cold air into the soil, but it is scarcely possible that the volume of air thus drawn in could supply or abstract sufficient heat to account for the observed differences. These latter are in the direction which would be expected from the time of the day when the readings were taken; and while the re-aëration of the soil may have slightly increased the temperature changes, it is unlikely that it had a predominating influence.

B. A. KEEN.

LUBRICATION AND LUBRICANTS.

THE meeting of the Physical Society held on November 28 was devoted to a discussion on the subject of lubrication, suggested by a paper on "Oiliness and Lubrication" by Mr. R. M. Deeley, sent by the Committee on Lubrication. Other contributors included Dr. Stanton, Principal Skinner, Messrs. W. B. Hardy, Dorman, Southcombe, Martin, Archbutt, Edser, and Dr. H. S. Allen.

In the consideration of lubrication problems a clear distinction must be made between two prevailing conditions, viz.: (1) Those in which the solid surfaces are completely separated by a film of oil, as occurs in the lubrication of cylindrical journals and their bearings working under moderate pressures, revolving at high speed, and supplied with abundance of oil; and (2) those in which, owing to the shape or condition of the surfaces, the kind of motion, high bearing pressure, low speed, or an inadequate supply of oil, the oil-film cannot form completely, or becomes broken, and the solid surfaces come into contact. In (1) the friction is entirely due to the viscosity of the oil, as proved by Beauchamp Tower and Osborne Reynolds. Engineers have Reynolds's theory to guide them in the design of bearings so as to secure fluid friction, and it is possible by determining the viscosity and chemical characteristics of an oil to form a sound opinion as to its suitability to meet the required conditions. In (2) the circumstances are quite different. Lubricating value is then found to depend upon some property which is quite distinct from viscosity, and has been called "oiliness."

In opening the discussion Dr. Stanton referred to experiments recently made at the National Physical Laboratory for the Lubrication Committee with the Lanchester worm-gear testing machine, in which working pressures of several tons per square inch are developed, showing that in the case of all the mineral oils tested the lubrication at a certain temperature suddenly became imperfect, the friction irregular, and the efficiency of the gear fell off. With fixed oils no such "breaking-down" point was observed under the conditions of the tests, and it was found that by adding quite a small percentage of fatty oil to a mineral oil the breaking-down point, though not obliterated, occurred at a higher temperature.

Mr. Deeley described and exhibited a small hand-driven machine which he had invented for the purpose of measuring the oiliness of lubricants under conditions of metallic contact. Three flat-ended metal studs, each 5/32" in diameter, secured concentrically as feet to a metal disc, rested upon another metal disc which could be slowly rotated. The upper disc could be weighted as desired, and actuated a spindle to which a spiral spring and a recording finger were attached. The lower disc, when rotated, carried the studs and upper disc with it by friction until the stress in the spring caused the surfaces to slip, when the pointer gave the frictional resistance, oscillations being damped by gearing the spring and pointer to a train of wheels. Experiments made with this machine showed that the static friction depended upon the nature of the metal surfaces in contact as well as upon the oil, and the fatty oils which in practice are found to be the best lubricants gave lower static coefficients than the mineral oils. Mr. Deeley's view is that the oil, or some constituent of it, enters into physico-chemical union with the comparatively rigid metallic surface, forming a composite film having the yielding nature of velvet-pile, and that the best lubricants are those which produce the most easily sheared contact films.

Dr. Allen directed attention to the important work of Irving Langmuir on surface films, and suggested that the property of "oiliness" depends upon the chemical forces called into play between the active part of the oil molecule and the solid surface of the bearing, and not only on the nature of the lubricant, but also on that of the solid surfaces with which the liquid is brought into contact.

Mr. W. B. Hardy referred to the work carried on by his son and himself, and discussed by them in the *Philosophical Magazine* of July last. In the apparatus they used there was only one point of contact between the solid surfaces, which consisted at first of a curved watch-glass on a flat glass plate, and latterly of similarly shaped surfaces of bismuth. The force measured was that necessary to cause the curved surface to slide over the plate when lubricated by the films formed by individual chemical substances representative of various groups of chemical compounds. The authors concluded that the true function of a lubricant was to reduce the energy of the surface, and thereby to reduce the capacity for cohesion and the resistance to slip when two composite surfaces are applied one to the other. This, in the opinion of the present writer, is the conclusion to which all recent work leads, and the problem before the chemist is to determine in what manner the molecular structure of the chemical compounds in lubricants determines their "oiliness."

The practical side of the problem cannot, however, be neglected, and it is necessary to experiment with commercial lubricants acting between such dissimilar metal surfaces as are used in the construction of machines, in order to obtain the information which engineers require to guide them in the lubrication of machinery. Mr. Southcombe's observation that the interfacial tension between oil and water and oil and mercury is much higher with mineral oils than with fatty oils, and that the addition of a very little free oleic acid to a mineral oil greatly lowers the surface tension, is of great importance. It appears that by adding 1 per cent. of free fatty acid to a mineral oil the lubricating power is increased as much as by adding a very much larger percentage of fatty oil. The emulsifying properties can also be materially modified by the addition of fatty acids.

L. A.

ADULT EDUCATION.

THE Final Report of the Adult Education Committee of the Ministry of Reconstruction (Cd. 321, 1s. 9d.), appointed in July, 1917, as a Sub-Committee of the Reconstruction Committee, over which the Prime Minister presided, but afterwards, on the establishment of the Ministry of Reconstruction, as a Committee of the Department, has been issued and presented to the Prime Minister, in the absence of a Minister of Reconstruction to succeed Sir Auckland Geddes. It is a most informing and suggestive document, and has been preceded by three interim reports dealing respectively with industrial and social conditions in relation to adult education, and suggesting drastic reforms, both industrial and social; education in the Army; and libraries and museums, in which it is insisted that a much closer relationship and co-operation should be arranged with other branches of educational work, even to the extent of the transfer of their administration to the local education authorities.

The Committee was presided over by the Master of Balliol, who has prefaced the Report by a most illuminating covering letter addressed to the Prime Minister. The Committee comprised scholars, employers, trade unionists, and representatives of the Workers' Educational Association, and included men and women fully conversant with the needs of working people and others, and familiar with the work of the various educational organisations, both public and private. Its terms of reference were:—"To consider the provision for, and possibilities of, adult education (other than technical or vocational) in Great Britain, and to make recommendations." The scope of the inquiry necessarily covers a wide field, but it has been fully considered in its various aspects, and comprises a history and general review of adult education since 1800; standards and methods in adult education and its weaknesses and possibilities; the relation of the State and local authorities and of the higher institutions of learning to adult education; the supply of teachers; the development of adult education in rural areas; the relation of technical to humane studies; the organisation and finance of adult education; and concludes with certain valuable recommendations for its effective establishment.

The Report covers 178 pages, and, as is the case with the interim reports, is unanimous. It is followed by four important appendices, the first of which reviews respectively and at great length the present provision of the means and facilities of adult education; the part played therein by the local authorities; the universities in respect of lecture extension courses, and especially of tutorial classes; voluntary agencies such as the Workers' Educational Association; the colleges for working people, including the London Working Men's College and the Ruskin and Labour Colleges at Oxford; the educational work of residential settlements like Toynbee Hall and the Passmore Edwards Settlements, and of non-residential such as Swarthmore, Leeds; the Gilchrist Trust, the National Home Reading Union, the co-operative movement, and other activities of literary and scientific societies; war-time developments; and, finally, adult education abroad. The further appendices deal with university education in London and in Wales, the report of the Committee on the position of natural science and that of modern languages in our educational system. The appendices, which are replete with statistics and fertile in suggestion, cover 200 pages of the Final Report.

The Report lays down as an absolute condition of future civilised progress that education, taken in its true sense, is the basis and postulate of all urgent problems of reform, whether they refer to domestic questions such as those of nationalisation, the claims of Labour to better conditions of life, the position of woman, the subject of a Second Chamber, and social matters such as those of drink and prostitution, or to political questions dealing with the Imperial position in relation to the self-governing Dominions or to India and Egypt, or to the international problems involved in the redrawing of the map of Europe on sound lines of nationality with due regard to the claims of racial and religious minorities.

These serious and urgent problems will not find a speedy and wise solution until we have an educated and enlightened public. There is abundant evidence, in the opinion of the Committee, of the demand of the adult members of the public for the means of a humane and liberal education, which shall include literature, modern languages, local and general history, economics, art, and the natural sciences. There is latent in the mass of the people a capacity, far from being recognised as it should be, to rise to the fundamental conceptions of great issues and to face the difficulties incident to their realisation.

The Committee has based its main conclusions on the following propositions:—The main purpose of education is to fit a man or woman for life as a member of a civilised community, and so the education of the adult must proceed on the lines of successive periods in his education: the family, the school, the trade union or the profession, and the locality, which are all successive stages, and reach their fullness in the life of the community; and whilst each part of the process must be related to its appropriate stage, the goal of all education must be citizenship, viewed in relation to both rights and duties on the part of the individual as a member of the community. This is the *raison d'être* of the need for facilities for education and training

Adult education must not be regarded as a luxury for a few exceptional persons, or as a thing which concerns a short span of early manhood, but as an object of permanent national necessity, as an inseparable aspect of citizenship, and be therefore universal and lifelong, spread systematically and uniformly over the whole community in its own interest and as a duty to its members. All possible encouragement should be given to voluntary organisation, so that there may be freedom of experiment and that their work may find its appropriate place and opportunity of development in the national educational system.

The tutorial class methods of instruction are unreservedly praised in the Report, and, in order that the higher institutions of learning shall be enabled to take their full share in their development, the demand is made that the State and the local authorities shall place more abundant resources at their disposal, so that their staffs of teachers may be largely increased. In the present crisis of the nation's affairs is found the chief and abiding reason for the speedy adoption of the Committee's recommendations.

AN OBSCURE DISEASE, ENCEPHALITIS LETHARGICA.[1]

ABOUT two years ago reports began to appear concerning a "new" acute general disease associated with a condition of apathy and drowsiness which passed into lethargy. Other striking features were progressive muscular weakness and paralysis of various cranial nerves, leading especially to squint. The prevailing abnormal conditions of life and living

[1] Report of an Inquiry into an Obscure Disease, *Encephalitis lethargica*. Local Government Board Reports (New Series, No. 121), 1918.

caused suspicion at first to fall on articles of diet. Thus some observers were struck by a similarity to cases of botulism, a disease due to the poisons of a bacillus which can flourish in foodstuffs kept out of contact with air, as when meat or vegetables are immersed in a weak pickle. Others suggested that some essential accessory factor had been lacking in the diet, so leading to a "deficiency" disease, perhaps analogous to beri-beri, in which nervous symptoms are prominent from affection of the peripheral nerves. But the wide area over which cases were distributed, and the rarity with which more than a single member was attacked in any one family, almost excluded such theories of causation.

Further clinical investigation, and especially pathological examination, established the close resemblance between the new disease and the well-known condition, acute poliomyelitis or infantile paralysis. In both diseases the essential pathological feature consists in microscopic areas of inflammation, with cellular infiltration, consisting largely of round cells, in the perivascular lymphatic sheaths and in the grey matter. In *Encephalitis lethargica* these changes were most noticeable in the upper part of the pons and in the basal nuclei. In the affected areas the nerve-cells showed the usual changes indicative of degeneration. In addition, Marinesco found degeneration of the Purkinje cells of the cerebellum in the two cases examined by him; such changes are similar to those observed by Mott in shell-shock, and previously studied by Crile, who considered them an expression of cellular exhaustion.

Thus the nervous lesions did not at all resemble those originally investigated by Marinesco in botulism. On the other hand, there are certain well-marked differences from infantile paralysis as regards the localisation of paralysis, which in the new disease mainly affects the cranial centres, while the spinal cord is commonly the site of lesions in infantile paralysis; also there is a practically equal incidence of the disease at all ages, whereas infantile paralysis affects mainly children and young adults. But such differences are possibly within the limit of variations which may occur in a clinical "entity" or "syndrome," since modern investigation of infective diseases in general has taught that the number of "typical" cases of any condition may constitute a variable, and sometimes relatively small, proportion of the total number.

The experimental results are of greatest importance, however, as tending to show that the two diseases are distinct in their causation. It has been well established by various observers in different parts of the world that in cases of infantile paralysis the central nervous system especially harbours the virus, and that the disease can be transmitted to monkeys by intracerebral inoculation with glycerinated emulsions of brain or spinal cord. On the other hand, McIntosh consistently failed to transmit the new disease to monkeys by injecting emulsions of nervous tissue from cases under similar conditions to those which are successful in poliomyelitis.

The disease, after obtruding itself in the spring and early summer of 1918, has again relapsed into obscurity for the time being. The valuable work in this report has outlined the natural history of the manifestations, but the failure to reproduce the disease experimentally or to identify any micro-organism as constantly associated with it has prevented the elaboration of a basis for dealing with a future outbreak. It may be presumed that, like infantile paralysis, it is a disease to which the majority of individuals are relatively resistant, and that healthy carriers, who harbour the virus in the nose and pharynx without themselves suffering from ill-effects, probably play a large part in dissemination. The practically simultaneous occurrence of *Encephalitis lethargica* in this country, France, and Austria is another of the unaccountable manifestations of the disease.

C. H. B.

EXPLORATION OF NORTHERN GREENLAND.

THE second Thule Expedition to northern Greenland in 1916 to 1918, under the leadership of Mr. Knud Rasmussen, is the subject of articles in the *Geographical Review* for August and September (vol. viii., Nos. 2 and 3). With Thule on Melville Bay as a base, the main party of the expedition left on a long sledge journey to explore the northern coast of Greenland between Robson Channel and Peary Land. This coast had been only roughly sketched by Peary on one of his northern journeys. Mr. Rasmussen's party charted it in detail between St. George's Fjord and De Long Fjord. It was found that Nordenskjöld Inlet, at one time supposed to be the end of the so-called Peary Channel, but disproved in 1907 by Mylius Erichsen, is a short fjord ending in a glacier. The distribution of ice-free land was found to be the opposite of what was before believed to be the case, the land round St. George's Fjord being ice-free, and that round Nordenskjöld Inlet ice-covered. Mr. Rasmussen failed to find any ruins of Eskimo houses in that district, or any signs that Eskimo had ever migrated round the north coast of Greenland. This was previously supposed to be the route by which Eskimo at one time reached the east coast, where traces of camps and villages are numerous. Musk-oxen may have migrated in small herds round the north, but the general conditions of hunting are so poor that Eskimo are unlikely to have been attracted to the route. The ice-free areas are not large enough to furnish sufficient game for a wandering tribe, and the conditions of the pack-ice along the north-west coast make hunting on the sea impossible. Mr. Rasmussen believes that the east coast natives travelled from the west by Cape Farewell, and that reconnoitring parties of hunters went so far north as Independence Fjord. The botanical work of Dr. Thorild Wulff, who died from starvation, was important, and Mr. Lauge Koch obtained valuable geological results. The new map of the coast, of which a sketch is added to the article, was carefully prepared, forty observations of latitude and forty determinations of longitude being taken.

AQUATIC FAUNA OF SEISTAN.

UNDER the auspices of the Indian Medical Research Fund, Dr. N. Annandale and Mr. S. W. Kemp undertook in November, December, and January, 1918–19, an expedition to Seistan and Baluchistan with the object of discovering whether the disease Bilharziasis (or Schistosomiasis) occurred in Seistan, and, in particular, whether any of the known molluscan hosts of the parasite were to be found in that region. So far as the medical part of the inquiry was concerned the results were negative, but the opportunity was taken to make a collection of the limited aquatic fauna of the country. The zoological results of the expedition are now in course of publication as a special volume of the "Records of the Indian Museum" under the title of "Report on the Aquatic Fauna of Seistan." In an introductory essay Dr. Annandale describes the physiographical conditions of the Hamun-i-Helmand, the basin into which the

Helmand River flows, and which is occupied, according to season, by a large lake or by a series of lakes of variable area. Owing to the fact that in flood-time the Hamun overflows, by the Shelagh River, into the Gaud-i-Zirreh, "the Dead Sea of the Helmand system," its waters do not reach a high degree of salinity, and it sustains a fauna, impoverished indeed, but rich in comparison with that of true salt lakes. Dr. Annandale points out that although the Hamun occupies part of an ancient lake-bed, "there has been no biological continuity between the old lake and the recent one." The present lake may even have originated within historic times by a shifting of the course of the Helmand River. Dr. Annandale describes the Cyprinid fishes of the genus Discognathus found in the region and, in collaboration with Dr. B. Prashad, the Mollusca. In the case of the latter it is pointed out that the fauna shows a mingling of Palæarctic and Oriental types and a noteworthy absence of Western Asiatic elements. The fauna, however, "is a starved one, in which only species of great adaptability can survive."

PHYSICS AT THE BRITISH ASSOCIATION.

ONE day of Section A was devoted almost entirely to matters relating to wireless telegraphy. Prof. Eccles opened a discussion on thermionic valves, giving a general description of the history and development of the three-electrode valve, explaining its rectifying property, the method of heterodyne reception, and the arrangements necessary to produce continuous waves. Experiments were shown illustrating these uses of the valve, and the way was thus prepared for the discussion of special points by subsequent speakers. Prof. Fortescue directed attention to the functions and properties of the various parts of the valve in some detail. The hot filament is the source of the electrons upon which the action of the valve fundamentally depends; with tungsten filaments as at present used only 4½ per cent. of the energy heating the filament is usefully employed as electron emission. This efficiency might be improved by using oxide-coated filaments or higher temperatures, but at present neither of these methods has been entirely successful in practice. The construction of the grid and the question of freeing the anode and containing vessel from occluded gas during pumping were also discussed, and the importance of investigating the methods of removing the last traces of gas and examining their nature was emphasised. Dr. Whiddington directed attention to the possibility of using valves and oscillating circuits for making many standard physical measurements. Thus, for example, the coefficient of mutual induction can be determined by observing the degree of coupling at which oscillations are just started and maintained. He also alluded to Prof. Eccles's example of the extreme sensitiveness of heterodyne reception as illustrated by the effect of passing coal-gas between the plates of a condenser in an oscillating circuit. The temperature coefficient of resistance, the conductivity of flames, the permeability of liquids, and other quantities could also be measured by this delicate method.

In a paper entitled "A Wireless Method of Measuring e/m" Dr. Whiddington showed how oscillations may be set up in valve-circuits, not including capacities and inductances. The oscillations are produced by bursts of electrons from hot spots on the filament of a soft valve and the periodic return of positive ions from the space between the grid and anode. In the special experiments described it was shown from the value of e/m obtained that the ions consisted of mercury.

The report of the committee on wireless telegraphy was of special interest on account of the observations made on the strength of signals during the recent solar eclipse. It was, however, too early to give any very definite conclusions, although it was stated that Malta and Paris had received signals of increased intensity during the eclipse. Bearing on the same point, Prof. G. N. Watson gave a *résumé* of his recent work on the diffraction of electric waves, in which, starting from the Heaviside-Eccles hypothesis of conduction in the upper regions of the atmosphere, Austin's formula can be obtained as a result of certain simple assumptions.

Papers were read by Prof. Horton and Miss A. G. Davies and by Prof. Horton and Miss D. Bailey respectively on the ionisation by electron collisions in argon and helium and on the luminosity produced in the latter gas. It appears that there are two critical velocities of the electrons at which radiation from the atoms and ionisation occur respectively. In argon these two phenomena occur at 11·5 and 15·1 volts, and in helium at 20·4 and 25·6 volts. The results are of great interest, but, as Dr. Goucher pointed out, their interpretation seems still open to question.

The phenomena of novæ were dealt with in two papers by Mr. Stratton and Father Cortie. In the former paper the types of spectra occurring in the course of the history of Nova Geminorum were described. The observed displacements of the spectral lines correspond with velocities reaching 2×10^8 cm./sec., which are so large that electrical causes are suggested to explain them. Similar velocities were deduced from the observations on Nova Aquilæ, and, after sketching the sequence of progressive changes occurring in the star, Father Cortie concluded that a solar eruption in a giant star situated in a dark nebula would square with the observed spectral changes.

In an interesting communication on the theory of vision Sir Oliver Lodge put forward the suggestion that the retina may be found to contain atoms in such a condition of instability that impulses of the correct luminous frequency can excite them and cause the expulsion of electrons. A difficult but highly interesting experiment was suggested of trying to find in the retina chemical substances capable of emitting high-speed electrons when subjected to light.

Prof. Eddington gave an account of the observations which had been made at Principe during the solar eclipse. The main object in view was to observe the displacement (if any) of stars the light from which passed through the gravitational field of the sun. To establish the existence of such an effect and the determination of its magnitude gives, as is well known, a crucial test of the theory of gravitation enunciated by Einstein. Prof. Eddington explained that the observations had been partially vitiated by the presence of clouds, but the plates already measured indicated the existence of a deflection intermediate between the two theoretically possible values 0·87″ and 1·75″. He hoped that when the measurements were completed the latter figure would prove to be verified. Incidentally, Prof. Eddington pointed out that the presence of clouds had resulted in a solar prominence being photographed and its history followed in some detail. Some very striking photographs were shown.

Following on this account Prof. Eddington opened the discussion on relativity, and referred again to the bending of the wave-front of light to be expected from Einstein's new law when the light passes near a heavy body. It should be possible to test experimentally this law, which demands that the speed of light varies as $1-2\Omega$, where Ω is the gravitational potential. He showed that, whether Einstein's solution of the problem be correct or not, it has, at any rate, given a new orientation to our ideas of space and time. Sir Oliver Lodge regarded the relativity theory of 1905 as a supplement to Newtonian dynamics by the adoption of the factor $(1-v^2/c^2)$ and its powers necessitated by experimental results; but he did not consider this dependence of mass and length on velocity as entailing any revolutionary changes of our ideas of space and time, or as rendering necessary the further complexities of 1915. He compared the difficulties involved with the case of measuring temperature, defined in terms of a perfect gas, and made with gases which only approximate to this ideal state. Dr. Silberstein pointed out that Einstein's theory of gravitation predicts three verifiable phenomena, *i.e.* a shift of spectral lines, the bending of light round the sun, and the secular motion of the perihelion of a planet. In the neighbourhood of a radially symmetric mass such as our sun, the line-element ds is given by

$$ds^2=(1-2M/c^2r)c^2dt^2-(1-2M/c^2r)(dx^2+dy^2+dz^2).$$

The coefficient c^2dt^2 gives by itself a lengthening of the period of oscillation for a terrestrial observer in the ratio $(1+M/c^2r):1$, demanding a shift of spectral lines of about 0·01 Å.U. Secondly, the path of rays of light is obtained by putting $ds=0$, and the first and second coefficients give jointly a bending which for rays almost grazing the sun is 1·75″. Thirdly, Keplerian motion is predicted with a progressively moving perihelion, which in the case of Mercury turns out to be 43″ per century. He directed attention to the fact that St. John's results in 1917 showed no shift of the spectral lines, which in itself would overthrow the theory in question. Father Cortie pointed out that Campbell's photographs taken in 1918 and measured by Curtis gave no trace of any displacement of the images of forty-three stars distributed irregularly round the sun.

Amongst other papers read at the meeting may be mentioned an account by Sir Frederick Stupart of weather conditions in Alberta and a paper by Prof. Forsyth on Gauss's theorem.

CHEMISTRY AT THE BRITISH ASSOCIATION.

IT was perhaps only to be expected that the programme of the Chemical Section should be coloured by the four years of war through which we had just passed, but, though war chemistry took a prominent place, more academic subjects were not entirely relegated to the background.

Some excellent summaries of work in different branches of chemistry during the war were given by various speakers.

Sir William Pope spoke on the general subject of the position of chemistry in Germany and this country as a result of the war, and pointed out that while German chemical industries emerged from the war in a strengthened position, ours remained much as they were, and that we were faced with a great, immediate danger in a strong propagandist movement to rehabilitate the German chemist in the eyes of the world.

Brig.-Gen. Hartley described the development of chemical warfare and the measures taken to counteract its destructive effects by means of gas-masks, etc. This particular form of warfare is, perhaps, not so inhuman as it is often regarded to be; for if it be granted that human lives must be sacrificed and suffering endured to achieve military objectives, then such objectives can often be attained by the use of gas attacks, lachrymatory shells, etc., with less loss of life and permanent injury than by the employment of high explosives.

Col. C. D. Crozier reviewed the output and methods of manufacture of high explosives during the war, directing attention to the improvements in method and quality which took place as the exigencies of the military situation called for an ever-increasing output, and claimed that this result was due in no small part to the activities of the Inspection Department.

Prof. Desch gave an excellent *résumé* of the metallurgical position in this country and the Central Empires, and showed how metallurgical considerations entered into the Franco-German Peace of 1871, and largely influenced the war and the territorial readjustments of the Peace Treaties. The necessities of war, if without any striking metallurgical developments, have at any rate, so far as this Empire is concerned, done much to stimulate the working within the Empire of locally produced ores, while fresh industries have arisen to smelt ores of metals hitherto imported from enemy countries. In Germany, as might have been expected, the study and use of substitutes for such metals as copper, nickel, and manganese have received close attention.

A paper by Dr. M. W. Travers described the position of the glass trade after the war. Though much has been done to supply the demand for various kinds of glass in this country, Dr. Travers must undoubtedly be written down as an optimist when he declares we can now supply from home-made stock all requirements of laboratory glass and glass for scientific purposes. We fancy few universities and schools would endorse his view, as most of them have great difficulty in supplying the requirements of their students.

Prof. Boswell contributed a paper on some recent problems in geo-chemistry. The border-line of chemistry and geology presents problems of the greatest interest and value as regards the sources and supply of raw materials for chemical manufactures, and the necessity of finding fresh material or substitutes during the war has greatly stimulated geochemical research. Prof. Boswell reviewed the different problems created by war demands, and showed how geo-chemistry has developed our home supplies of materials formerly obtained from enemy countries.

A short but interesting paper by Major E. R. Thomas on the work of an ammunition chemist in the field concluded the papers directly dealing with the war. Major Thomas, with improvised appliances and some Chinese coolies for labour, recovered upwards of a ton daily of KNO_3 and pitch from condemned ammunition. Major Thomas deserves the warmest praise for setting an example of economy and showing that so-called waste is really valuable material.

Though not directly dealing with war chemistry, a paper by Drs. Lowry and Perman on the equilibrium in the system ammonium nitrate—sodium chloride—sodium nitrate—ammonium chloride gave the results of much work conducted for war purposes.

Several papers were contributed from H.M. Naval Cordite Factory at Holton Heath, dealing mainly with industrial bacteriological problems such as the preparation of acetone and industrial alcohol, though a few of them dealt with pure organic chemistry. Special mention must be made of the paper by Dr. A. C. Thaysen, which gave a capital review of different aspects of bacteriology outside medicine, and showed how large a field of investigation is open to bacteriologists in a technical rather than a microscopical sense.

A discussion took place on the report of the Fuel Economy Committee. At nearly every recent meeting of the association a somewhat similar discussion has taken place, and though fuel economy is far more imperative now than it has ever been, and is most unpleasantly brought home to all of us by our local Coal Controllers, it cannot be said that the discussions have been very constructive. They range over a wide field, they are disjointed, and while each speaker's communication is of value in itself, the discussion as a whole somehow seems unreal and almost futile. One wishes that the committee round the report of which the discussion centres were able to present definite propositions which, if approved after due discussion, could be sent through the council of the association to the Government Department, or whomever else they concerned. They would be received with more of the importance due to them if they came from the British Association as a whole. Fuel economy, however, is so vast a subject that probably the committee has scarcely had time yet to distil the essence from the great quantity of valuable material it is collecting.

Prof. E. C. C. Baly, Prof. A. Lapworth, and Prof. R. Robinson wound up the meeting with three papers on pure chemistry of great interest, since they all dealt with the mechanism of chemical reaction. In these papers the writers discussed the molecular and other aspects of chemical reactivity. It is refreshing to find that the great demands of war on the genius of chemists has not smothered the efforts of those who seek to probe deep into the very fundamentals of the science.

Mention must be made of a very enjoyable and interesting excursion to the Naval Cordite Factory at Holton Heath. By kind invitation of the superintendent, Capt. Desborough, eighty members of the Section were shown all over the factory, which in its completeness is second to none.

In conclusion, it should be stated that the meetings of the Section were very well attended, and more enthusiasm was shown than for many years past.

ZOOLOGY AT THE BRITISH ASSOCIATION.

SECTION D attracted a representative gathering of zoologists, and the papers were the subject of much interesting discussion. The following is a summary of the proceedings of the Section :—

Mr. E. S. Goodrich, in a paper on phagocytosis and protozoa, stated that phagocytosis of living protozoa had rarely been observed in vertebrates. Invertebrates deal more successfully with protozoal parasites; the leucocytes cling together, surround and finally smother a parasite. This power of aggregation appears to be due to the fact that the floating leucocytes are provided, not with outstanding pseudopodia, but with delicate films of protoplasm ready to spread over any foreign substance. It is the optical sections of these folded films which are usually figured as pseudopodia.

Mr. E. Heron-Allen, for Mr. Earland and himself, directed attention at a joint meeting of Sections D and K (Botany) to some hitherto unemphasised modifications of growth in the life-history of Foraminifera. He exhibited slides showing the modifications brought about by the cultivation of Foraminifera in hypertonic sea-water, the affinity of certain genera for gems as building material, and the power of selection of material exercised by certain species.

Dr. A. C. Coles exhibited photomicrographs of *Leptospira icterohaemorrhagiae*—the organism of infective jaundice in man—from the kidney of local rats.

Mr. A. T. Watson gave further details on the tube-building operations of the Polychæte worm, *Pectinaria koreni*.

Prof. E. W. MacBride described some further experiments on the artificial production of Echinus larvæ with a double hydrocœle. He stated that the optimum result was obtained when larvæ three days old were transferred from normal to hypertonic sea-water for a week or ten days and then put back into normal sea-water, and he offered a tentative explanation.

Prof. G. H. F. Nuttall gave a lecture on "Lice and their Relation to Disease." Commencing with the biology of *Pediculus humanus*, of which there are two races—*capitis*, the head-louse, and *corporis*, the body-louse—Prof. Nuttall described the mode of oviposition, the development, hatching, moulting, feeding, etc. The female lays 150 to 300 eggs, and under favourable conditions the life-cycle from egg to egg is completed in sixteen to seventeen days. Under experimental conditions dark or pale lice can be reared at will according as they are raised on dark or light backgrounds respectively. Hermaphrodites in large number have been obtained by crossing the two races *capitis* and *corporis*. After pointing out that lice transmit relapsing, typhus, and trench fevers, Prof. Nuttall described some of the methods of control on a large scale, *e.g.* hot-air disinfestors (Orr's huts) and railway vans into which steam from a locomotive was introduced under pressure.

Dr. E. Hindle traced the history of isolated pairs of body-lice and of their offspring raised through five generations. Out of sixty families, twenty-four were mixed (composed of males and females), nineteen were female, thirteen male, and four crosses were sterile. The lice were all fed on the same individual and under similar conditions, and no explanation of the occurrence of the three sorts of families could be discovered. The proportion of females to males in the total number of adults raised to maturity agreed almost exactly with that occurring in Nature—60 per cent. females and 40 per cent. males.

Dr. M. C. Grabham gave an account of the Argentine ant (*Iridomermyx humilis*) in Madeira. The ant was introduced twenty-seven years ago, but was only identified three years later, when it had become firmly established. Coffee cultivation has been ruined and every sort of fruit-tree—citrus especially—which would support coccus or aphis has been almost entirely destroyed. Sugar-cane and bananas still exist, though badly attacked, but sweet potatoes have disappeared in many districts. Attention was directed to the methods of the ant in searching for food, and to the harmony in working, there being a singular absence of fighting when separate communities meet. The ant has few enemies, *e.g.* spiders and Pholcus. A covering of powdered chalk on the basal part of the trunk of a tree is a deterrent to the ant, and banding the trees with rags soaked in corrosive sublimate has also been found effective. Dr. Grabham suggested that our Colonies should be warned as to the importance of this pest.

Prof. Dendy delivered a lecture on "Grain-pests and the Storage of Wheat," for the main points of which the reader is referred to NATURE for March 20 last, p. 55.

Before a joint meeting of Sections C (Geology) and D, Mr. C. Tate Regan spoke on the distribution of fresh-water fishes, with special reference to the past history of continents. He dealt particularly with the Ostariophysi—the dominant group of fresh-water fishes—and took the view that they originated in Gondwana Land in Cretaceous times, and that Australia and Madagascar became isolated before these fishes could reach them. The severance of Africa from South America and from southern Asia probably left Characiformes and Pimelodidæ in South America, Characiformes and Bagridæ in Africa, and Cypriniformes and Bagridæ in southern Asia. At the end of the Cretaceous new land connections may have enabled the ancestors of the Catostomidæ and Amiuridæ to reach North America through eastern Asia. Isolation of the continents during the Eocene helped the development of endemic types, and the union that followed in the Oligocene or Miocene probably gave Cyprinidæ to North America and a few Nearctic fishes to eastern Asia.

Prof. MacBride and Mr. Goodrich expressed some doubts as to the value of the evidence, on the zoological side, for the existence of Gondwana Land, but Dr. D. H. Scott regarded the evidence afforded by the Glossopteris flora as strongly in favour of the former existence of such a land area. Mr. D. M. S. Watson considered that the evidence from fossil plants, Pelecypoda, and vertebrates indicated a connection between Africa and America in Permian times, but whether this continued to the Cretaceous was doubtful.

Dr. J. W. Evans did not agree with those who dwelt on the incompleteness of the evidence for the existence of Gondwana Land. He was inclined to look with favour on the view that the land-masses had not always held their present relative positions, *e.g.* Africa and South America may have been nearer together. The Falkland Islands show closer geological relationship to Africa than to America.

Mr. Tate Regan, in replying, reaffirmed his belief in the former existence of Gondwana Land.

Before the same joint meeting Mr. D. M. S. Watson gave a paper on "Palæontology and the Evolution Theory," an account of which will be given in the article upon the proceedings of the Geological Section.

Dr. Marie Lebour summarised the results of her investigations, extending over three seasons at Plymouth, on the food of larval and post-larval fishes. Most of the fish examined were from 0·5 mm. to 15 mm. in length. The greater portion of their food consists of Entomostraca; diatoms seem to be little eaten by young fish except at a very early stage. Other unicellular organisms are rarely found in young fish, but the flounder up to about 10 mm. in length was found to be feeding exclusively on the flagellate Phæocystis, but at about 11 mm. it changes to a diet of copepods. Larval molluscs, though often abundant in the plankton, are much more seldom found than Crustacea in young fishes. The young fishes thus select their food to a great extent, but that which is selected is generally common, and there is no indication of any special migration on the part of the pelagic young in search of food.

Mr. L. P. W. Renouf gave an account of the development of the Bute Laboratory and Museum.

J. H. Ashworth.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The helpful paper, "On Lecturing with the Lantern," by Prof. G. A. J. Cole, which appeared in the *Journal of the Department of Agriculture and Technical Instruction for Ireland* (vol. xix., No. 1), has been reprinted with the permission of the Department, and is now published as a pamphlet by Mr. T. H. Mason, Dame Street, Dublin.

Applications for the Tyndall Mining Research Fund studentship are invited by the Royal Society. The studentship is for study and research on subjects relating to mining and the safety of miners, is of about 35*l*. in value, and open to any British subject. Applications must reach the Assistant Secretary of the Royal Society not later than January 15, give particulars of the kind of research it is proposed to carry out, and where, and be accompanied by not more than two testimonials or references.

Yale University is offering two Theresa Seessel research fellowships for the promotion of original research in biological studies. Each fellowship will be of the value of 200*l*., and preference will be given to candidates who have obtained their doctorate and demonstrated their fitness to carry out successfully original research work of a high order. Applications, accompanied by reprints of scientific publications, letters of recommendation, and particulars of the problem proposed by the candidate for investigation, must be made before May 1 next to the Dean of the Graduate School, New Haven, Conn., U.S.A.

The Association of Science Teachers has issued a list of science books which are suitable for use in schools. That a compilation of this sort is a matter of some difficulty is doubtless the reason for its being so rarely attempted. The association has done well to risk imperfection so as to supply an obvious need. The list, which contains the names both of text-books for the use of pupils and of books of reference for the library shelf, is attractively printed and reasonably classified. It is to be regretted that biology (as distinct from botany) and astronomy find no place in the main divisions, despite the fact that Dr. Sophie Bryant, in her excellent foreword, directs attention to the desirability of these subjects in the early stages of a child's training. The "Book List (1919)," which we hope will become a periodical publication, may be obtained for 1*s*. 1*d*. from Miss F. Storr, hon. secretary of the association, 12 Angell Park Gardens, S.W.9.

We are used to large private benefactions for education and science in the United States, but the announcement made in the *Times* of December 27 of a gift of 25,000,000*l*. for these purposes from Mr. John D. Rockefeller is really marvellous to those of us who know how little private generosity can be depended upon for like needs in our own country. The gift is divided into two equal parts of 12,500,000*l*. each to the General Education Board and to the Rockefeller Foundation. It is the largest sum of money ever given at one time to philanthropy, and it brings the total amount of Mr. Rockefeller's donations to 100,000,000*l*. The donation now announced is to be devoted to two purposes:—(1) To some plan of increasing the salaries of the teaching staffs of the colleges and universities of the United States; and (2) to the promotion of the objects of the Rockefeller Foundation, which are defined as the well-being of mankind throughout the world. The General Education Board was founded by Mr. Rockefeller in 1903, and the general purpose of the corporation is "the promotion of education within the United States of America, without distinction of race, sex, or creed." The principal funds of the board have been about 0,000,000*l*., and grants amounting to about 400,000*l*. have been made annually to various institutions. It was only a couple of months ago that Mr. Rockefeller added 2,500,000*l*. to his previous endowment of the Rockefeller Institute for Medical Research. This gift was to meet rapidly growing needs in the institute's many lines of research and also to make new knowledge available in the protection of the public health and in the improved treatment of disease and injury.

One of the notable features of the great struggle in which the nation has been engaged, and for which recruits were drawn from all classes of the United

Kingdom, was the effort made, in camps both at home and abroad, to continue, however imperfectly as to means and methods, the education already gained, having regard to the fact that sooner or later large numbers of men would return to civil occupations and duties, and that it would be desirable, so far as time and circumstances permitted, that military service should offer opportunities of continued study. It is gratifying to observe that the Army of Occupation on the Rhine, which numbers 250,000 men, is animated by the same spirit. The 222nd number of the *Cologne Post*, a daily paper printed and published at Cologne in English for the Army of Occupation, and the Christmas souvenir number of the same journal (price 9*d*., or 7 marks), both contain articles urging the vital importance of education, not only in its general and scientific aspects, but also as applied to the promotion of special phases of industry, of commerce, and of agriculture, with the view of fitting men for these several pursuits, and describes the means taken at Cologne and other Rhine towns for effective instruction and training in the various subjects by the institution of laboratories, workshops, and field allotments. At Siegfried there was held recently an exhibition in which was displayed a great deal of good work, the results of training men who had previously learned no trade to become wage-earners of the best possible type. The courses of study include educational facilities extending from the absolutely illiterate to the university graduate, but these articles are also remarkable for the point of view they express, namely, that the soldiers are urged on returning home to civilian life to insist that their children shall receive their due, and be trained to think and to appreciate the beauties of life.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, December 17.—Sir Napier Shaw, president, in the chair.—F. J. W. **Whipple**: The laws of approach to the geostrophic wind. The mode of transition from the winds near the surface of the earth to the general current at moderate heights has been discussed by various authors. In the present paper stress is laid on the geometrical aspect of the question. The term "relative wind velocity" being used for the velocity which must be combined with the geostrophic wind velocity by vector addition to give the actual wind velocity at any level, the laws of approach to the geostrophic wind are:—(1) The relative wind turns uniformly with increasing height; (2) the relative wind decreases with increasing height according to the exponential law; and (3) the actual wind at the surface and the relative wind there are inclined at 135°.—G. M. B. **Dobson**: Winds and temperature-gradients in the stratosphere. From the results of temperature observations by *ballon-sondes*, it can be shown that the horizontal pressure-gradient, and therefore the wind velocity, should decrease rapidly on passing from the troposphere to the stratosphere. Previously there had been little confirmation of this by actual observations. Seventy ascents recorded by the International Commission gave data for temperature, wind velocity, and wind direction to great heights. These showed that, almost without exception, winds of moderate or great velocity in the troposphere fall off very rapidly on entering the stratosphere, while the wind direction remained constant. On days with small pressure-gradients this effect was not usually found—a result which was to be expected, since the slope of the tropopause would then not necessarily be towards the low pressure. Horizontal pressure and temperature-gradients calculated for the observed winds on typical days with moderate or large pressure-gradients show that the pressure-gradient is suddenly reduced, and the temperature-gradient suddenly reversed, on entering the stratosphere. The temperature-gradients calculated from the observed wind velocities are in good agreement with those deduced by Mr. W. H. Dines from temperature and pressure observations.—Capt. C. J. P. **Cave**: Quotations from the Diary of Samuel Pepys on the weather. In this the author has collected together all references to the weather from the "Diary," using for this purpose Wheatley's edition. These amount to as many as 557 entries, and are arranged in chronological order. They form a brief comment on the general weather conditions prevailing from January, 1660, to May, 1669. In a preliminary essay the author summarises the principal weather events for each year. He points out that Pepys cannot claim to be considered as a meteorologist, and that his references to the weather are such as anyone might make in writing a diary or in correspondence. He also states that Pepys's memory for meteorological events was not always good, and his remarks on the worst or best weather he remembers must be taken with caution.

EDINBURGH.

Royal Society, November 3.—Prof. F. O. Bower, president, in the chair.—Capt. T. B. **Franklin**: The cooling of the soil at night, with special reference to late spring frosts. The aim of this investigation was to obtain data on which predictions might be formed as to the coming night temperature. Continuing a course of investigation, the author gives a formula whereby the minimum temperature on any calm, clear night may be known by about 5 p.m. on the previous afternoon. A comparison of his results with the observed minimum soil temperatures on twenty favourable nights between April and October, 1919, shows an average error of 0·3° C. only; it would thus appear that, under the weather conditions favourable to spring frosts, it is possible to forecast the occurrence of a frost with great exactness.—Sir Thomas **Muir**: Note on the determinant the matrix of which is the sum of two circulant matrices.—G. F. **Quilter**: Note on and exhibition of photographs of appearances of mirage at Ingatestone. These photographs showed apparent pools of water in the street in which pillars appeared reflected at a distance of about a hundred yards. The photographs were interesting as following up a previous paper by Mr. Alex. G. Ramage communicated to the society in 1918.

December 1.—Prof. F. O. Bower, president, in the chair.—Dr. R. **Kidston** and Prof. W. H. **Lang**: Old Red Sandstone plants showing structure from the Rhynie Chert bed, Aberdeenshire. Part iii.: *Asteroxylon Mackiei*, Kidston and Lang. The fourth vascular Cryptogam found in the silicified peat-bed at Rhynie, the age of which is not younger than the middle Old Red Sandstone of Scotland, was a larger and more complex plant than *Rhynia Gwynne-Vaughani*, *R. major*, and *Hornea Lignieri*, described in the earlier papers of this series. It has been named *Asteroxylon Mackiei* after Dr. Mackie, the original discoverer of the chert-bed. The remains of Asteroxylon are abundant, though fragmentary, and give, with more or less certainty, a fairly complete knowledge of the plant.

December 8 and 9.—Prof. W. Peddie, vice-president, in the chair.—Prof. R. A. **Sampson**: (1) Newton's views on gravitation and their subsequent history. (2) The theory of Einstein and its observational tests. In the second address, by the kindness of Sir Frank Dyson, the Greenwich photographs taken at the expedition to

Sobral, Brazil, were exhibited, and the method of measurement and agreement obtained were explained. It was pointed out that the first success of Einstein's theory was to explain completely a long-outstanding discrepancy in connection with the orbit of Mercury. Of the two other tests, which were in the form of predictions, one, that gravity would modify the solar spectrum, had not been verified, while the second, that light from a star passing near the sun would be deviated, had been verified. The general processes by which Einstein derived this formula carried no assurance that the results would describe Nature, and the theory must rest upon such tests as he himself has proposed for it. From this point of view, though it shows its changes only in minute remote phenomena, its claims are too vast to be settled in a short time.

PARIS.

Academy of Sciences, December 1, 1919.—M. Léon Guignard in the chair.—P. A. **Dangeard**: The distinction of the chondriome into vacuome, plastidome, and spherome.—The **Prince of Monaco**: The oceanographic study of the Mediterranean. An account of an international conference held at Madrid on November 17 last, at which France, Italy, Spain, Greece, Monaco, Egypt, and Tunis were represented.—G. A. **Boulenger**: The distribution in Africa of the barbel, sub-genus Labeobarbus.—G. **Bouligand**: The problem of Dirichlet for an infinite domain.—R. **Soreau**: Experimental laws of the variations of barometric pressure and of the specific gravity of air with altitude. From forty series of observations with sounding balloons, carried out in 1912 at Trappes, Uccle, Strasburg, Hamburg, Munich, Pavia, and Vienna at heights up to 23 km., formulæ are deduced giving the pressure and density as functions of the altitude.—H. **Godard**: Observation of Finlay's periodic comet (1919*e*) made at the Bordeaux Observatory with the 38-cm. equatorial. Position of comet and comparison star given for November 25.—M. **Auric**: The cycle of eclipses. The ratio l/d is expressed in continued fractions, the fifth of which, $\frac{242}{223}$, was known to the Chaldeans as the Saros cycle; its error is 0·036 day in 18 years. The fraction $\frac{4904}{4519}$ is in error by only 0·0003 day in 365·4 years.—G. **Sagnac**: The direct comparison of the two simultaneous mechanical systems of radiation. Method of showing the translation of the earth.—S. **Procopiu**: Layers of metal, of minimum thickness, measured by their electromotive force.—H. **Abraham**, E. **Bloch**, and L. **Bloch**: The ultra-rapid kinematograph. The film is moved continuously and the object illuminated by electric sparks. With the arrangement described and figured, upwards of twenty thousand photographs per second can be taken on the film.—G. A. **Hemsalech**: The spectra emitted by the red fringe and luminous vapour in the neighbourhood of a plate of incandescent graphite.—C. **Staehling**: The radio-activity of uranium. An account of some experiments undertaken in an attempt to split up uranium into uranium I. and uranium II. The attempt at separation was unsuccessful, but some of the phenomena described do not appear to be simply explained by the current theories of radio-activity.—G. **Claude**: The synthesis of ammonia at very high pressures. The results of a series of experiments on the formation of ammonia from its elements in presence of a catalyst at pressures varying between 200 and 1000 atmospheres and at temperatures between 536° C. and 740° C. are given graphically. At 1000 atmospheres and 536° C. the percentage of ammonia in the mixture amounts to 41 per cent. Having regard to the reaction velocity as well as yield, the zone of utilisable temperature is between 500° C. and 700° C. The yield per gram of catalyst per hour is much higher than that obtained in German works.—L. **Guillet**: The transformation undergone by certain aluminium alloys. It was shown about twenty years ago that certain alloys of aluminium with iron, manganese, and nickel rapidly fell to powder on exposure to air. This phenomenon has been further investigated, and it is found that the change in the aluminium-manganese alloy is due to an allotropic modification, whilst the aluminium-antimony alloy oxidises in moist air. The iron and nickel alloys did not change, and it is probable that some unknown impurity was the cause of the falling to powder observed in the earlier experiments.—P. **Dejean**: The critical points of self-tempering steels.—A. **Kling**, D. **Florentin**, A. **Lassieur**, and R. **Schmutz**: The preparation of chloromethylchloroformates. The existence of monochloromethyl- and dichloromethyl-chloroformates is proved and methods for their preparation are described.—L. **Moret**: The discovery of lacustral Eocene beds at the Roc de Chère (Lake of Annecy).—L. **Mercier** and C. **Lebailly**: Primitive cancer of the pancreas and giant cells in mice.—P. **Bugnon**: The use of commercial inks in plant histology. Some commercial inks of French manufacture can be employed with advantage as histological stains. Two formulæ for triple stains are given in which ink is one of the constituent dyes.—J. **Offner**: Phytogeographical remarks on the massifs of Vercors and Dévoluy.—M. **Baudouin**: The fibula of a newly born infant of the Polished Stone period, and consequences in anatomical philosophy. The faces of the bone are smooth and free from the grooving found in the Neolithic adult. The grooves are therefore acquired, being due to special muscular actions depending on the mode of walking of these prehistoric men.—MM. G. **Bertrand**, **Brocq-Rousseu**, and **Dassonville**: The influence of temperature and other physical agents on the insecticidal power of chloropicrin. When using chloropicrin against insects the intensity of the light and the hygrometric state of the air need not be taken into account; the temperature, however, is of importance; the higher the temperature, the more rapid is the destruction of the insects.—T. **Kabéshima**: Experimental researches on preventive vaccination against the dysentery bacillus of Shiga.

CALCUTTA.

Asiatic Society of Bengal, December 3, 1919.—Dr. N. **Annandale**: A loom used by the Gaodar herdsmen of Seistan. The loom, though of very simple structure, seems to be degenerate rather than primitive, its peculiarities depending not so much on lack of skill in its makers as on lack of proper materials, notably wood.—V. H. **Jackson** and A. T. **Mukerjee**: Improvements in measurements with quadrant electrometers. Part ii. Simplified arrangements for accurate and continuous work. During most months in the year accurate measurements with sensitive quadrant electrometers cannot be made in India without special precautions, owing to the high temperature and humidity. In continuation of earlier work the authors have now considerably simplified the arrangements for accurate and continuous work.—V. H. **Jackson** and A. T. **Mukerjee**: The utility of desiccants in electrostatic measurements. The authors have tested the relative efficiency of the various desiccants used in electrostatic measurements under strictly uniform conditions, using Dolezalek electrometers with the arrangements described in the previous paper. Calcium chloride has been found quite unsatisfactory, metallic sodium (extensively used in Germany) and phosphorus pentoxide worse than useless, and quicklime only temporary in its effect. Strong sulphuric acid is the only satisfactory desiccant for this purpose.

BOOKS RECEIVED.

Applied Chemistry. By Dr. C. K. Tinkler and H. Masters. Vol. i. Pp. xii+292. (London: Crosby Lockwood and Son.) 12s. 6d. net.

Wonders of Insect Life. By J. H. Crabtree. Pp. viii+211+32 plates. (London: G. Routledge and Sons, Ltd.) 6s. net.

The Natural Wealth of Britain. By S. J. Duly. Pp. x+319. (London: Hodder and Stoughton.) 6s. net.

Instincts of the Herd in Peace and War. By W. Trotter. Second edition. Pp. 264. (London: T. Fisher Unwin, Ltd.) 8s. 6d. net.

Popular Chemical Dictionary. By C. T. Kingzett. Pp. vi+368. (London: Baillière, Tindall, and Cox.) 15s. net.

Industrial Gases. By Dr. H. C. Greenwood. Pp. xvii+371. (London: Baillière, Tindall, and Cox.) 12s. 6d. net.

Fifty Years in the Royal Navy. By Admiral Sir Percy Scott. Pp. xviii+358. (London: John Murray.) 21s. net.

The Fungal Diseases of the Common Larch. By W. E. Hiley. Pp. xi+204. (Oxford: At the Clarendon Press.) 12s. 6d. net.

A Non-Euclidean Theory of Matter and Electricity. By P. A. Campbell. Pp. 44. (Cambridge, Mass.: G. H. Kent.) 35 cents.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound: Sound and Music (Christmas Lectures).

FRIDAY, JANUARY 2.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Miss Hilda Bowser: A Visit to the Diamond Mountain in Korea (Christmas Lecture to Young People).

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—A. P. Morris: Burmese Village Industries: Their Present State and Possible Development.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. V. Sims: Automatic Electric Weighing Machines, as used with Machine Packers.

SATURDAY, JANUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound: Sounds of the Country (Christmas Lectures).

MONDAY, JANUARY 5.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (in Mathematics Theatre, University College), at 2.30.—Dr. P. B. Ballard: The Development of Mental Tests.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—E. V. Evans: The Natural and Acquired Facilities Existing in the Occupied Area of Germany for the Manufacture of Chemical Products—the Outstanding Impressions resulting from an Inspection of Chemical Works in that Area, and a Consideration of the General Position in the Light of more Recent Developments in this Country.—Dr. G. S. Walpole: The Collective Effort of German Chemistry Industry.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Prof. J. W. Gregory: The African Rift Valleys.

TUESDAY, JANUARY 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg The World of Sound: Sounds of the Town (Christmas Lectures).

ROYAL PHOTOGRAPHIC SOCIETY (Technical Meeting), at 7.—Dr. G. H. Rodman: The X-Rays approached from the Popular Standpoint.

RÖNTGEN SOCIETY (at Medical Society of London), at 8.15.

WEDNESDAY, JANUARY 7.

ROYAL SOCIETY OF ARTS, at 3.—L. Pendred: Railways and Engines (Juvenile Lecture).

PHYSICAL SOCIETY OF LONDON (at Exhibition of Apparatus, in conjunction with the Optical Society, at the Imperial College of Science), at 4.—Prof. Rankine: The Use of Light in the Transmission and Reproduction of Speech; at 8.—Prof. F. J. Cheshire: Some Polarisation Experiments.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—S. S. Buckman: Jurassic Chronology: I. Lias. Supplement I. West England Strata.—F. J. North: Syringothyris, Winchell, and Certain Carboniferous Brachiopoda referred to Spiriferina.

ROYAL SOCIETY OF MEDICINE (Surgery, Subsection of Proctology), at 5.30.—Dr. W. M. Telling and Others: Diverticulitis.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Lt.-Col. D. J. Smith; Producer Gas for Motor Vehicles.

THURSDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound: Sounds of the Sea (Christmas Lectures).

PHYSICAL SOCIETY OF LONDON (at Exhibition of Apparatus, in conjunction with the Optical Society, at the Imperial College of Science), at 4.—Prof. F. J. Cheshire: Some Polarisation Experiments; at 8.—Prof. Rankine: The Use of Light in the Transmission and Reproduction of Speech.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—J. Shepherd: Failures of Turbo-Generators and Suggestions for Improvements.

OPTICAL SOCIETY, at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—T. Clarkson: Steam Vehicles.

FRIDAY, JANUARY 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.—Dr. S. S. Berry: A New Species of Mitra from California.—Dr. A. E. Boycott: Local Variation in Size of *Clausilia bidentata* and *Ena obscura*.—H. C. Fulton: Molluscan Notes, IV.

SATURDAY, JANUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound: Sound in War (Christmas Lectures).

CONTENTS.

	PAGE
British Iron Ores. By Prof. H. Louis	429
Alcohol	431
A Great Artist of Nature. By J. G. M.	432
Submarines and Sea Power. By A. B. T.	433
Our Bookshelf	434
Letters to the Editor:—	
Atomic Energy.—Sir Oliver J. Lodge, F.R.S.	435
Metamorphosis of Axolotl caused by Thyroid-feeding.—Julian S. Huxley	435
The Hibernation of the House-fly.—Right Hon. Sir Herbert Maxwell, Bart., F.R.S	435
The Magnetic Storm of August 11-12, 1919.—J. Evershed, F.R.S.	436
Deflection of Light during a Solar Eclipse.—Prof. Alexr. Anderson	436
Entente Scientific Literature in Central Europe during the War.—Robert W. Lawson	436
Royal Meteorological Society's Phenological Returns.—H. B. Adames and J. Edmund Clark	437
Einstein's Theory and a Map Analogue.—E. Cunningham	437
The Sun Dance of the Teton Sioux. (*Illustrated.*) By Frances Densmore	437
The International Hydrographic Conference	440
A Shakespearean Garden	441
A Research Institute for New Zealand	442
Dr. Cyril G. Hopkins. By Dr. E. J. Russell, F.R.S.	442
Notes	443
Our Astronomical Column:—	
Fireball on December 25	448
Comets	448
Radiation Pressure	448
The Orion Nebula	448
Spherical Shell Crystals in Alloys. (*Illustrated.*) By H. C. H. C.	448
Forecasting Frosts. By B. A. Keen	450
Lubrication and Lubricants. By L. A.	451
Adult Education	452
An Obscure Disease, *Encephalitis lethargica*. By C. H. B.	452
Exploration of Northern Greenland	453
Aquatic Fauna of Seistan	453
Physics at the British Association	454
Chemistry at the British Association	455
Zoology at the British Association. By Prof. J. H. Ashworth, F.R.S.	456
University and Educational Intelligence	457
Societies and Academies	458
Books Received	460
Diary of Societies	460

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THURSDAY, JANUARY 8, 1920.

WATER-POWER AND DARTMOOR.

THE proposal to develop electrical energy from water-power on Dartmoor has led to a strong protest against interference with the amenity of the moor as appreciated by the lovers of solitary places. Mr. Eden Phillpotts first directed attention to the matter by a letter in the *Times* of December 10, in which he called on the Duchy of Cornwall, the landlords of Dartmoor, to act quickly "and help to create a body of Parliamentary opinion; otherwise the destructive and ill-considered enterprise may receive sanction from an indifferent House of Commons next session." A Plymouth correspondent supplied to the *Times* of December 23 an account of the scope of the proposed scheme, and on later days other writers expressed their strong disapproval of the project from local, engineering, or æsthetic points of view. Unfortunately for a journal which desires to review the situation justly, the supporters of the scheme have not taken part in the newspaper discussion, and as we have not seen the Bill in question we can judge of its provisions only from the statements of its opponents, and must accordingly assume an attitude which may appear more critical of the upholders of the *status quo* than our sympathies would have dictated had we access to both sides of the question.

To many lovers of Nature, Dartmoor has already suffered disenchantment by the grim associations of the prison which has been established there for a century, and there may be some who object to the system of leats which for a still longer period has supplied water to the towns on its fringes. The correspondence referred to does touch unfavourably on the modern waterworks which supply Plymouth, Torquay, and Paignton, but these are accomplished facts, and serve merely to strengthen the opposition to new interference with the moor and its rivers.

The scheme of the Dartmoor and District Hydro-electric Supply Company is briefly to utilise the great rainfall and high altitude of Dartmoor in the generation of electricity at several power stations situated on different streams, to convey the current to the neighbouring towns and villages for ordinary municipal purposes, and possibly to erect industrial establishments where current might be used for electrolytic or power purposes. It is claimed that this work will furnish needed employment for the population of the district, provide a continuous and economical supply of electricity for lighting, traction, and heating, reduce the congestion of railway traffic by diminishing the demand for coal, and generally increase prosperity and confer public benefits more than sufficient to counterbalance any interference with agriculture, fishing rights, or the pleasure of visitors to the Moor.

The general, and especially the local, public is not qualified to weigh the rival claims, and as things now stand Parliament must proceed by the old, cumbrous, and very costly method of hearing eloquent advocates and technical experts on all the points raised.

No one is now likely to deny the general applicability of the rule that private convenience must give way to public advantage; but there is still a great deal of confusion as to the criteria by which the conflicting claims should be judged. It is in our opinion essential that all matters connected with the use of natural resources should be investigated by experts whose personal interests are not involved in the case. It is of equal importance that full and impartial information should be available before a decision is arrived at. In the present instance no one knows what the available rainfall on Dartmoor really is, but this can be ascertained if an average rainfall map is constructed from the data which are accessible and according to methods which have been established. The available fall between reservoirs and power-houses can be found by direct surveys guided by the existing Ordnance Survey maps.

The cost of the necessary engineering works is a more difficult and practically a more important question, as no one can foresee the price of materials or the value of the pound note during the years which must elapse before the works can be completed. The size of the dams required in forming reservoirs and the depth of their foundations, on which any estimate of cost must be based, can be ascertained only by detailed surveys and numerous borings, which experience of private Bill legislation has taught us are not always carried out before the Bill is deposited. The danger of underestimating the cost is less likely to be incurred by a company which depends on the scheme showing a profit when carried out than by a public authority which does not labour under that wholesome disability. In other aspects, however, the exploitation of natural resources by public authorities is more likely to be to the public interest, and certainly more likely to secure general confidence.

At present the whole question of the water resources, and especially of the water-power, of the British Isles is being investigated by a Committee of the Board of Trade, and on this account Parliament may be inclined to postpone the consideration of private Bills dealing with water, if not of special urgency, until the Committee has reported. There are few areas in England where an unused gathering-ground exists at an altitude allowing of the development of water-power, and it may well be considered inexpedient to allocate them finally before a hydrometric survey has been carried out to enable the available power and its cost to be calculated on a sure basis before work is commenced.

RADIO-COMMUNICATION AND THE THERMIONIC VALVE.

(1) *The Thermionic Valve and its Developments in Radiotelegraphy and Telephony.* By Prof. J. A. Fleming. Pp. xv+279. (London: The Wireless Press, Ltd., 1919.) Price 15*s*. net.

(2) *Text-book on Wireless Telegraphy.* By Prof. Rupert Stanley. New edition in two volumes. Vol. i.: *General Theory and Practice.* Pp. xiii+471. Vol. ii.: *Valves and Valve Apparatus.* Pp. ix+357. (London: Longmans, Green, and Co., 1919.) Price 15*s*. net per vol.

(1) SCIENTIFIC workers who desire to learn something about the latest developments in radio-communication generally find that books on the subject are either scientific but too technical, or not sufficiently scientific and so useless for their purpose. It is little use to have illustrations of the kenotron, the pliodynatron, the ultra-audion, and the tungar, with diagrams of their connections, unless we have also some reasoned account of their mode of action. The reader soon tires also of vague accounts of the electron theory, which is regarded by some authors as a kind of fetish which must never be criticised and the mere mention of which is supposed to explain everything.

In the first chapter Prof. Fleming gives an interesting and instructive historical introduction. So far back as 1883 he read a paper to the Physical Society describing the molecular radiation in incandescent lamps with horse-shoe filaments. He proved that the blackening of the bulb was due to the scattering in straight lines of carbon particles from the filaments, one leg of the horse-shoe filament protecting a long strip of the bulb from being blackened.

Later in the same year Edison discovered that a current would flow between the positive terminal of the filament and a metal plate sealed in the bulb. In those pre-electron days the phenomenon was considered by electricians hopelessly puzzling. In 1897 Sir J. J. Thomson first published an account of his demonstration that negative electricity is always associated with certain masses about 1800 times smaller than the mass of an atom of hydrogen, and that under certain conditions these electric corpuscles are emitted from hot bodies. It then became possible to give a scientific explanation of the Edison effect. It was not, however, until 1904 that Prof. Fleming published his master patent, which proved the utility of the Edison effect in radio-telegraphy.

The Fleming valve, which is the parent of all the thermionic valves, allows electricity to flow from a heated filament to a cylinder, both being enclosed in a vacuum bulb, provided the cylinder be at a higher potential than the filament. If the potential be lower than that of the filament, then practically no current flows. The device thus acts as a true valve, allowing current to flow in one direction, but not in the other. The high-frequency currents in the aerial can thus be rectified, and the consequent gushes of electricity in one direction can magnetise the electromagnet of the telephone and thus produce a sound.

In chap. iii. a description is given of several types of three-electrode valve and of the various ways they can be connected up. Special stress is laid on the historical side of the development of this valve. In chap. iv. we are told of the discovery that the three-electrode thermionic valve could in certain circumstances act as a generator of oscillations. It would be of interest to know who suggested to Meissner that he should try whether it was possible to make the thermionic relay into a generator. Whoever it was deserves great credit for his suggestion.

Prof. Fleming points out how analogous the action of the generator valve is to that of the "humming telephone," which has been known to electricians for the last twenty-five years, and also, but not so obviously, to that of the Duddell arc.

The great advantage of the thermionic valve as a detector in practical work is that it is not liable to be damaged by electric atmospheric discharges, which often cause endless trouble when coherers or crystal detectors are employed. In chap. v. the uses of the thermionic detector in radio-telephony are described, the complicated diagrams being quite easy to follow, partly because of the use of the excellent system of symbols standardised by radio-engineers. In chap. vi. descriptions are given of the methods of using thermionic devices in radio-telephony. We are pleased to note that due credit is given to H. J. Round, of the Marconi Co., for his numerous inventions.

In the concluding chapter an account is given of some recent improvements in thermionic devices mainly developed during the war. There are several suggestive methods of testing the efficiency of radio-apparatus described in the book, some of which are due to the author. There is also, perhaps naturally, a great deal about the law case between the Marconi Co. and the De Forest Radio Co., which ended so triumphantly for Prof. Fleming. We can heartily recommend the book to all scientific readers.

(2) The development of the art of radio-communication during the war has forced the author to expand his text-book into two volumes, the second volume being mainly devoted to vacuum valves and valve circuits. In writing the first volume Prof. Stanley had in view the needs of wireless operators and amateurs. He was impressed by the lack of a text-book on electricity and magnetism suitable for radio-students. We are told that the existing text-books do not discuss sufficiently fully induction, oscillatory currents, and the true significance of "magnetic or electric lines of strain in the all-pervading ether." In the author's opinion the electron theory will present fewer difficulties to the student than the "vague fluid theories which it has replaced." The reviewer read, therefore, his introductory chapters, giving an elementary *résumé* of the latest theories, with an open mind and with considerable interest.

The impression produced on him, however, was very disappointing. The student is at once introduced to electrons. He is told that there are 10^{23} free electrons in a centimetre cube of metal, that electricity is a constituent of all forms of matter, and that "a unit of negative charge is an electron, and a unit of positive charge, etc." He is told this before negative or positive charges are defined. On p. 13 he has to answer the question, "If the electron theory is taken as the correct one, what is electricity?" Potential (p. 23) is defined as follows: "The electric strain in the ether available for making an electric current flow through the medium is called the electric pressure, or potential, and is measured in units called 'Volts.'" This is certainly not the academic definition of potential, but it is getting perilously near the "vague fluid theories." We are told that "if two bodies of the same size are charged equally with 'positive or negative electrification' there is no difference of potential between them." This is misleading. It is true in free space, but if there are any other bodies in the neighbourhood it is probably not true.

Some of the definitions are carelessly given. The joule, for instance, is defined to be the work done by one ampere of current in flowing between two points, A and B, when the difference of potential between A and B is one volt. Similarly, in the definition of the erg (p. 42), the "per second" is left out. The dielectric constant is defined (p. 55) as "its effect when used as a dielectric as compared with an air dielectric." This is unintelligible. The formula for measuring the mutual inductance between two coils (p. 78) is wrong; it should be $M=(L_1-L_2)/4$. There is a misprint also in the formula for the time given on p. 82. The rest of the first volume is mainly concerned with ordinary radio-practice and is readable. Some of the diagrams are admirably clear.

In the second volume the author begins, very properly, with a recapitulatory chapter on "electrons." The theory of the thermionic valve is mainly concerned with the passage of electricity through gases, and the electron theory explains this admirably. As the author was chief wireless instructor with the B.E.F. in France he is thoroughly at home when describing the systems and apparatus used by the Allies in their wireless services. Radio-engineers will find the chapters on continuous wave (c.w.) transmission and on radio-telephony useful.

A. R.

CATALYSIS.

Catalysis in Theory and Practice. By Dr. Eric K. Rideal and Prof. Hugh S. Taylor. Pp. xv+496. (London: Macmillan and Co., Ltd., 1919.) Price 17*s*. net.

THE whole subject of catalysis stands in a peculiar position. For many years it has attracted investigators on the purely scientific side, who have added greatly to its scope in respect both of new material and of theoretical speculation. It is being actively pursued along both lines at the present time. There are also its vast technical applications, many of them already well known, to which addition is being constantly made, and wherein new fields are rapidly opening up, of which the modern chemist must take cognisance. Yet, in spite of all this, we should be hard put to it to distinguish clearly between a catalytic and a non-catalytic process. The so-called catalytic criteria are not really very helpful. Ultimately the term "catalysis" will probably vanish from chemical literature as our knowledge of the mechanism of chemical processes advances, though the term may remain for long as a convenient, though arbitrary, term of classification. But we are very far from this state of affairs at present, and there is the greatest possible need that the importance of the subject should be emphasised and its immense possibilities clearly indicated. We find this well brought out in the book before us. A brief enumeration of the contents will give an idea of what the authors have attempted.

After a short historical outline and a consideration of catalytic criteria, we are brought to the subject of promoters. There is a brief discussion of the possible mechanism of promoters, and it is pointed out that the beneficial effect of several promoters present simultaneously "may be due to the greater range of temperature over which at least one of the oxides is unstable or labile." In connection with induced or mutual effects, Liveing's views are given their just prominence.

Chap. iii. contains valuable information of a kind not usually met with in a text-book—*i.e.* such points as space-velocity and space-time yield—together with a short description of the authors' apparatus for the quantitative measurement of heterogeneous catalytic processes.

In the succeeding chapter oxidation processes are considered, viz. the manufacture of sulphuric acid, salt cake, the oxidation of ammonia to nitric acid, the manufacture of chlorine, the oxidation of sulphuretted hydrogen, the purification of illuminating gas and gaseous fuels, surface combustion, catalytic oxidation in the dye industry, the drying of oils, and other processes. Incidentally, the necessity of a sound knowledge of the thermodynamics of physico-chemical processes is made evident.

Chaps. v. and vi. deal with the manufacture of hydrogen and with processes of hydrogenation and dehydrogenation. These include some of the most recent and important developments of applied chemistry. The authors in these chapters, as elsewhere in the book, have added greatly to the interest and value of their work by useful suggestions regarding the directions along which further advances are likely to be made or are most urgently required. (As a minor point one might query the meaning of the data attributed to Rittman on p. 217.)

In chap. vii. we pass to a consideration of the all-important problem of the fixation of nitrogen, especially by the Haber process, which has attracted so much attention recently in the Allied countries, and upon which the authors write from first-hand knowledge, though too briefly.

After dealing with hydration and hydrolysis in chap. viii., in which such subjects as synthetic alcohol, the manufacture of glucose, and the Twitchell process are dealt with, the authors return in chap. ix. to reactions of the "Sabatier" type in their account of dehydration processes, consideration being given at the same time to dehydrations in homogeneous systems.

To a very large extent the preceding chapters are devoted to catalytic processes of technical importance—actual or potential. In chap. x. our attention is directed to a different aspect of the field, namely, the *rôle* of catalysis in organic synthesis, in which such topics as the Grignard reagent, the Friedel-Crafts reaction, halogenation, the aldol and benzoin condensations, dynamic isomerism, racemisation, and muta-rotation are discussed, on the whole, rather too briefly perhaps.

In chap. xi. ferment and enzyme action is taken up. Here we find catalysis the dominant characteristic, serving as the link between chemistry on one hand, and physiology and bacteriology on the other. This chapter is particularly good. The authors acknowledge their indebtedness to Prof. Bayliss for his criticism of the treatment given.

In the next chapter we are brought to the consideration of yet another field—namely, catalysis in electrochemistry, a subject in which catalysis plays an important but, on the whole, little recognised part. It is of the greatest value to have this aspect emphasised. The problems dealt with are: cathodic reduction, anodic oxidation, and passivity.

The concluding chapter is entitled "Catalysis in Analytical Chemistry." It is a familiar subject considered from a somewhat novel point of view. The treatment is comprehensive and sufficiently detailed to give the reader a true impression of the *rôle* of catalysis in this fundamental branch of chemical training and practice.

The book is excellent. It is indispensable, in fact, to everyone interested in chemical science whether on the academic or on the applied side.

W. C. McC. L.

THE NEGLECTED STUDY OF PROBABILITIES.

Calcolo delle Probabilità. By Prof. Guido Castelnuovo. Pp. xxiii + 373. (Milano-Roma-Napoli: Società Editrice Dante Alighieri di Albrighi, Segati e C., 1919.) Price 20 lire.

AMONG the sins of omission for which mathematicians and teachers of mathematics might be charged, there is probably none which has so vitally affected our national welfare as the neglect of the study of probabilities. Into every event of ordinary life considerations of probability enter in a greater or less degree, and for this reason every boy or girl who has learnt to use vulgar fractions ought to be taught to apply them to simple games of chance, and in this way to illustrate the rules for fractional addition, multiplication, and so forth. In default of this knowledge, millions of pounds are spent on postal orders in response to attractive offers of hundred-pound prizes the expectation value of which is not one-tenth of the price paid. Yet it was only recently that the Central Welsh Board excluded probabilities from an examination syllabus in algebra which was simply loaded up with questions on collections of letters and symbols that could convey no meaning to the victims of the examination system.

Other applications are to such problems as life assurance and statistics. In the former the calculations must, of course, be largely left to experts, but the public ought to acquire an intimate familiarity with the nature and meaning of probability and expectation and their numerical representation in order properly to appreciate the transactions. This elementary knowledge should come under arithmetic, not algebra. As for statistical applications, the systematic way in which parliamentary electors are misled for lack of understanding these things is evident. They have not realised that when wages go up prices also go up.

Now Prof. Castelnuovo's treatise strikes the reviewer as just the kind of book of which it would be worth while to publish an English translation. It is a long time since we had a standard work on the subject on similar lines, and in the interval our notions on teaching mathematics have certainly moved in a practical direction. Prof. Castelnuovo's book well meets the situation. Of course, the treatment is mathematical and the calculus is freely used, but the formulæ are introduced as statements of principles rather than as purely algebraic relations, and the whole treatment centres largely round practical applications. Any B.Sc. candidate would find the book quite easy reading, and the subject very useful in connection with physics, biology, philosophy, or, indeed, any branch of science, even including that all-embracing subject, aeronautics. A special feature on the more advanced side is the account given at the end of the discoveries of Tchebychef, who is quoted as having made the greatest contributions to the subject after Laplace.

Of course, the initial difficulty lies in the definition of probability, regarding which Prof. Castelnuovo's treatment both in the preface and at the beginning of the text is probably as good as the circumstances permit. There is no unique definition of probability, and in most cases no unique measure of its value. The old definition by an event which may happen in m ways and fail in n ways postulates a preconceived condition of "equal probability" for the m and n ways. There are, as Prof. Castelnuovo points out, many cases, in particular in games of chance, in which this postulate is admissible and the measure of probability has something like a unique value. But in most cases the estimated probability of an event depends on the extent of knowledge possessed by the person making the estimate, and, indeed, is a continually varying quantity depending on the progress of previous events. No two people would assign the same measure to the probability of a certain candidate passing an examination, and, indeed, the estimated chance varies continuously until the appearance of the list (sometimes even afterwards!). All that we can do in place of a definition is to substitute numerous examples in which the measure of probability is free from ambiguity. The nearest approach to a definition is given by the rules for compounding probabilities, of which the above-mentioned old definition is a particular case, with the additional convention that the probability always lies between 0 and 1, and that after an event has happened we must substitute 1 for the probability of its happening and 0 for the probability of its failing in our future estimates of the probabilities of dependent events. In fact, the theory of probability owes its existence to ignorance of future, and partial ignorance of past, events.

Attention has been frequently directed by the reviewer to energy running to waste among our mathematicians which could be utilised in connection with aeroplanes. In our universities a great deal of waste energy in the departments of pure mathematics could also be utilised by turning out graduates with a knowledge of probabilities and statistics which would filter down through the teachers to the elementary schools and thus to the citizens of the future. And for a start at the top of the ladder, Prof. Castelnuovo's book seems excellent.

G. H. BRYAN.

THE STUDY OF THE FAMILIAR.

A Source Book of Biological Nature-Study. By Elliot Rowland Downing. (The University of Chicago Nature-Study Series.) Pp. xxi+503. (Chicago, Illinois: The University of Chicago Press; London: The Cambridge University Press, 1919.) Price 3 dollars net.

IT is encouraging to read that never before has there been in America "so insistent a demand for a more thorough and more comprehensive system of instruction in practical science." To direct this demand, Mr. Downing is editing a Nature-study series, and has written a source book for the biological side. It aims at showing students in schools of education and teachers at work what materials are readily available and how these may be effectively used. "It undertakes to make significant some of the commonplace environment and to suggest ways in which living material may serve educational ends." Great prominence is given to material which has social and practical interest, but the danger of fostering a one-sided utilitarian outlook is guarded against. "The great contributions of science to the life of mankind are: its emphasis on the scientific mode of thinking or the problem-seeing, problem-solving attitude of mind; a mass of scientific knowledge that serves as the basis for desirable skills; and an interpretation of Nature productive of an inspiring appreciation, both intellectual and æsthetic, of her phenomena. Science instruction needs to assure these things to the individual pupil." These are clearly defined aims, and the book appears to us to be highly successful in all the three directions indicated—in setting problems and cultivating the curious spirit; in showing that Nature-study makes for efficiency as well as for understanding; and in cultivating a reasonable love of Nature. A note with fine resonance is struck when the author declares his ambition to treat his material so that "the everyday things may stand revealed as the wonders they really are."

The book deals with animals of pond and stream, insects and their allies, birds, gregarious animals, wayside flowers, common trees, seeds and seedlings, the garden, and spore-bearing plants. Each chapter has its list of references; there are practical hints as to material; the illustrations are abundant and interesting. They include some pupils' drawings. There is a genuine attempt throughout to get at the child's point of view and to use its judgment of values. "The teacher needs to take much of the foolishness of childhood along with her, and needs also to be persuaded that it is not altogether foolish." But there is no namby-pamby nonsense. We wonder a little, however, at some of the phrases which are unfamiliar to us, such as the chick's egg or the chicken's egg. Why not the hen's egg, and be done with it?

Of the many features which are admirable, we may give a few illustrations: (*a*) There is an embarrassment of living creatures in many country places. The author's plan is to make sure of the commonest—let us say, a score of the butterflies, birds, or trees. (*b*) There are many subjects which are so little understood that the cautious teacher is often inclined to leave them alone. The author's advice is rather to tackle them, to confess them as unsolved problems, and to leave them as seeds in the mind. We refer to such subjects as the migration of birds. (*c*) The author is not afraid of sounding the note of wonder. "To watch the germination of an inert seed, the development therefrom of the tiny plant, the growth of bursting bud and flower, is to cross the threshold of Nature's impenetrable mysteries." He quotes the sentence: "The love of a flower in the heart of a child is the highest thing that Nature-study can hope to develop." But the suggestion of this mood is not inconsistent with learning quite precisely how to graft or with understanding the work of Mendel or of Pasteur. We are sure that teachers of Nature-study will find Mr. Downing's book very profitable, and they ought also to know his almost perfect introduction to heredity, "The Third and Fourth Generation."

VACCINE-THERAPY.

Practical Vaccine Treatment for the General Practitioner. By Dr. R. W. Allen. Pp. xii+308. (London: H. K. Lewis and Co., Ltd., 1919.) Price 7*s*. 6*d*. net.

THE author of this little work is well known as an enthusiastic advocate of vaccine-therapy, on which subject he has already written widely. In the present volume he addresses himself more particularly to the general practitioner, for whose benefit and guidance he explains in lucid and forcible terms his methods and practice. The one theme which runs through the whole volume, and colours his frequent comments on the experience and teaching of other vaccinists, is his insistence on the necessity for adequate dosage capable of exciting focal or general reactions and its control by the closest observation of the patient's responses and clinical symptoms. He asks his readers to follow his methods and thereby assist vaccine-therapy "to take its rightful position as the most truly scientific therapeutic agent in the doctor's armamentarium." Unfortunately, however, the book contains scarcely one pessimistic note, and, again, the unbiassed reader, who otherwise wishes vaccine-therapy well, is left with the reflection that, so long as the results of vaccine-therapy continue to be assessed by the unscientifically accumulated personal impressions of vaccinists, so long will vaccine-therapy continue to hold no higher position than that of an empirical remedy, in spite of its undoubted scientific basis.

On this point the author, referring to vaccine treatment in respiratory diseases, remarks: "No physician has the right to play about with cases of pneumonia to satisfy statisticians or opponents of vaccine treatment. It thus becomes necessary to rely on the clinical impressions of reliable observers." Such impressions, we believe, carry less and less weight when we come to evaluate the results of specific therapy in its widest sense, and it is not unlikely that, as our knowledge of the non-specific as well as the specific therapeutic effects arising from the introduction into the animal body of a bacterial protein accumulates, many of the deductions so glibly drawn by ardent vaccinists may go by the board. None the less, as an exposition of the faith of an enthusiastic and somewhat over-confident vaccinist, the book is well worthy of perusal, and contains what, on the whole, appears to be sound advice.

The early chapters are devoted to general questions connected with the nature, preparation, and administration of vaccines, and are excellently written. For the chapter dealing with the best methods for securing material from various sources for culture and preparation of vaccine, the reviewer has nothing but praise, the laudable object being to secure "the right kind of material in the right kind of way." Chapters follow on the use of vaccines in prophylaxis and in the treatment of the carrier-state, but the greater part of the book is devoted to vaccines as therapeutic agents in practically every microbic disease. There would appear to be no microbic disease, whether of acute or chronic character, which is not amenable to vaccine-therapy when employed in the manner indicated by the author.

OUR BOOKSHELF.

The Stars Night by Night: Being the Journal of a Star Gazer. By J. H. Elgie. (First published as "Night Skies of a Year," 1910.) Pp. xiv+247. (London: C. Arthur Pearson, Ltd., 1919.) Price 1*s.* 6*d.* net.

There are many ways of being an astronomer, of which perhaps the easiest is to learn the stars and know them by position and name—and there are grades even in that. We do not imply that this defines Mr. Elgie's limitations, but he has written a very pleasant and useful book to help others to attain this degree of astronomical knowledge. Of such books there are many, but this is somewhat unusual. Written in a chatty manner on the model of White's "Selborne," it describes the author's experiences as a star-gazer or naked-eye observer throughout a year, with much quotation, anecdote, and general astronomical information intermingled. There are more than a hundred diagrams, showing the constellations as they appear with reference to the horizon at different dates. Naturally, the diagrams apply to any and all years, so the year when the observations were made is not given, except incidentally in the index, but the fact that the author saw Mira Ceti at maximum early in January, and that it was then as bright as γ Cygni, is fairly conclusive evidence that it was 1907.

The book is a cheap reprint of an earlier one published in 1910, "The Night Skies of the Year," which still remains as the page-heading, and it is not surprising that this reprint should have been considered advisable. It should command a large sale, for both the general reader and the astronomer of any category will find something of interest in its pages.

The Examination of Milk for Public Health Purposes. By Joseph Race. Pp. vi+224. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 8*s.* 6*d.* net.

This book gives a very useful summary of the chemistry and bacteriology of milk. The chemical portion includes the composition of milk and the chemistry of the various constituents, enzymes, immune bodies, mineral salts, etc., with details for their detection and estimation. Milk standards are considered, as well as preservatives. In the bacteriological portion a general account is given of the bacteria of milk and of methods for their enumeration. Chapters are devoted to excremental organisms and to streptococci, to the tubercle bacillus and other pathogenic organisms which may occur in milk, to cells, dirt, débris, etc. Chap. ix. deals with pasteurised milk and aciduric bacilli; and directions for the preparation of culture media and tables of specific gravity, for the conversion of cuprous oxide and copper to lactose, etc., are given in an appendix. The descriptions throughout are clear and concise, and the analytical methods are clearly set out. The book, which contains within its compass an extraordinary amount of information, is most useful, and can be strongly recommended as a laboratory handbook for the teacher and student.

R. T. H.

Insect Pests and Plant Diseases in the Vegetable and Fruit Garden. By F. Martin Duncan. Pp. 95+12 plates. (London: Constable and Co., Ltd., 1919.) Price 3*s.* 6*d.* net.

The object of this little volume is to provide gardeners and allotment-holders with a simple account of the commoner insect and fungoid pests. The descriptions of the various harmful species appear to be on the whole trustworthy, and some approved methods for eradicating them are recommended. But the book's value is diminished by want of revision in the light of modern work. For example, the author is content with Curtis's determination of the potato aphid, and states that the larva of *Anthomyia radicum* is a common pest on cabbage roots, which, despite the name of the fly, is not the case. The account of the infection of potato by Phytophthora and the denial of sexual reproduction in this fungus also require modification. The seven orders (including the comprehensive "Neuroptera" of old-time entomology) into which insects are said in the introduction to be "generally grouped" would not be accepted as an adequate systematic arrangement by any student of to-day. The illustrations include some good photographs and some indifferently executed drawings.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Deflection of Light during a Solar Eclipse.

IN discussing the effects of atmospheric refraction during solar eclipses Prof. Anderson disregards the shallowness of the effective layer of air as compared with the diameter of the moon's shadow. Unless the sun be very near the horizon, a line of sight drawn from the centre of the umbra to a point in the corona will remain within the umbra right through this layer. This consideration vitiates the method of solution adopted by Prof. Anderson, and consequently its results. On reading his first letter (NATURE, December 4, 1919) I was struck by the ingenuity of his explanation, more especially as I believe he undervalued the amount of the angular deviation arrived at on his theory through taking the sun's radius to be half, instead of a quarter of, a degree. In view of the importance of the subject, a fuller investigation seemed to be required. I hope soon to publish a note giving the complete solution of the problem, and may therefore confine myself here to a statement of the result, which is quite fatal to Prof. Anderson's explanation. I take the altitude of the sun to be 45° and the maximum fall of temperature 4°; the figures given may easily be modified to suit other conditions. I further assume the most favourable distribution of temperature, which is that adopted by Prof. Anderson, when the line of maximum fall of temperature is parallel to the edges of the moon's shadow and independent of altitude. Two stars at a distance of three solar diameters from each other might then show an increase in apparent distance owing to refraction amounting to the 240,000th part of a second of arc. If the diminution of the temperature effect with altitude be taken into account, this figure should be divided by 4.

ARTHUR SCHUSTER.

The Magnetic Storm of August 11–12, 1919.

THE principal question raised by Mr. Evershed in NATURE of January 1, viz. the simultaneity of S.C.s (sudden commencements of magnetic storms) at different parts of the globe, has already a considerable literature. It has been discussed by Prof. S. Chapman and myself in the Proceedings of the Physical Society (vol. xxx., p. 205; vol. xxvi., p. 137; and vol. xxiii., p. 49). It scarcely admits, perhaps, of a precise answer. S.C.s vary from one part of the earth to another, not merely in size, but also in type. In India, for instance, they are normally unidirectional, and much larger in H (horizontal force) than in the other elements. At Kew, and still more at Eskdalemuir, they are often oscillatory, the main movement, a rise in H, being preceded by a shorter and smaller fall. In the Antarctic (Scott's stations) they seem to be always oscillatory and of similar magnitude in the different elements. The time when a movement becomes visible depends on its size and the sensitiveness of the magnetograph. Magnetographs differ widely in sensitiveness and vary in type. An oscillatory movement that is very small or of very short period cannot be recorded by an ordinary magnetograph.

Whether the time of the S.C. is affected by the meridian position of the sun, *i.e.* by the local time, has been discussed by Prof. Chapman. Whether the results he got implied any real difference is a matter of opinion, but if any difference existed it was a question, not of minutes, but of seconds. If any difference existed in the times, one would expect it to be at least as conspicuous in the amplitudes. As I have lately shown, the *type* of the S.C. recorded in the Antarctic does seem to depend on the local time. Eleven S.C.s which occurred between 11h. 59m. and 17h. 20m. G.M.T. agreed in type; while six which occurred between 21h. 3m. and 23h. 25m. also agreed in type; but the two types were fundamentally different. The first class represent noon and the earlier afternoon at Eskdalemuir, but midnight or early morning in the Antarctic; while the second class represent hours near noon in the Antarctic. Complete measurements of the horizontal amplitudes of the S.C. movements exist for eight of the first and three of the second class. Dividing the sum of the Eskdalemuir movements by the corresponding Antarctic sum, we get 0·43 for the first class and 0·42 for the second, the mean from all the S.C.s of which I have complete records at both stations during 1911–12 being 0·42. The values of the ratio vary greatly for individual S.C.s, so that the coincidence in the above figures must be largely accidental. But, at all events, it seems incompatible with any conspicuous influence of local time on the amplitude.

As to the particular S.C. of August 11–12, 1919, when first measuring the Kew curves I made the time slightly before 7h. G.M.T., whether one or two minutes before I now forget. Remeasuring it now, with as little prejudice as possible, I make the time 6h. 58m., agreeing with the value got by Dr. Crichton Mitchell for Eskdalemuir. The time-breaks at Eskdalemuir occur on the curve itself, so the estimate there is free from the uncertainty to which, I presume, Mr. Evershed refers, which is usually known as "parallax" between the curve and time lines. This source of uncertainty is also practically non-existent at Kew, but the train and tram disturbances now experienced there make all measurements less certain than they used to be. The S.C. on August 11 was, however, so large, and the discontinuity in the H curve so conspicuous, that I think the uncertainty might fairly be put at ±0·5 minute. The uncertainty of the ordinary measurement at the average observatory, even for S.C.s, is certainly not less than this, and is probably a good deal larger.

C. CHREE.

Relativity and Radio-activity.

WITH regard to some of the postulates of relativity, it seems interesting to ask if radio-active instability might not be capable of providing a timekeeper which would retain its uniformity independently of motion relative to the æther.

As to how such a clock might be made practical or whether it must remain theoretical is beside the present question. So also is the degree of accuracy which might be attainable. Primarily, we might suppose the radio-active clocks rated one with another by a simple count of the α-rays emitted over a certain solid angle and during a certain time interval, the clocks being in the one locality. Thereafter these clocks would serve to define simultaneity in widely separated localities, the diminishing quantity of the radio-active substance notwithstanding.

As I say, the primary question is not so much one of practical application, but as to whether it would be theoretically possible in this way to observe motion relative to the æther.

Or is radio-activity also "in the conspiracy"?

J. JOLY.

Trinity College, Dublin.

British Botanic Gardens and Stations.

In the article on British botanic gardens and stations in the jubilee number of NATURE (p. 263) the statement is made that by the middle of the eighteenth century, when Kew and the Botanic Garden at St. Vincent were founded, "the purpose of botanical collections had become largely limited to the assemblage of plants interesting because of their rarity. Presently a healthy reaction against this rather narrow outlook arose . . .," and the example is quoted of the Calcutta Garden, founded in 1786 for the purpose, not of collecting rare plants as articles of curiosity, etc., "but for establishing a stock for disseminating such articles as may prove beneficial to the inhabitants, as well as to the natives of Great Britain, and which ultimately may tend to the extension of the national commerce and riches." Your contributor appears to have overlooked the fact that a very similar purpose underlay the founding of the St. Vincent Garden, as shown by the advertisement which appeared in the Transactions of the Society of Arts for 1762, offering a reward "to anyone who would cutivate a spot in the West Indies in which plants useful as medicine and profitable as articles of commerce might be propagated, and where nurseries of the valuable productions of Asia and other distant parts might be formed for the benefit of his Majesty's Colonies."

I am glad to add that the Royal Botanic Gardens, Trinidad, attained its centenary this year.

W. E. FREEMAN,
Director of Agriculture.
St. Clair Experiment Station, Port-of-Spain,
December 6.

I AM very grateful to Dr. Freeman for having directed attention to the existence of this interesting documentary evidence that West Indian public opinion in 1762 was a quarter of a century in advance of official opinion in the East Indies. This conclusion is pointed to by the circumstance that there was a demand in the West Indies for such sumptuous works as "The Natural History of Barbados," by Griffith Hughes, published in 1750; "The Natural History of Carolina, Florida, and the Bahamas," written by Mark Catesby, revised after Catesby's death by G. Edwards, and published in 1754; and "The Natural History of Jamaica," by Patrick Browne, published in 1756, of which a second edition was called for in 1780. It is important to have this conclusion definitely confirmed.

THE WRITER OF THE ARTICLE.

NATURAL HISTORY OF SOUTH AFRICA.[1]

MR. FITZSIMONS'S volumes are not strictly zoological treatises. They are intended to supply information about the ways and habits of the creatures of veld, forest, mountain, and stream. It sounds somewhat strange to hear mammals referred to as belonging to the "lower animal kingdom." The author speaks sometimes of "animals and birds"; in other places he alludes to "birds and mammals," while the bats are spoken of as "flying mammals." Since this work is addressed to school teachers, senior pupils, and the general public, it would have been better to explain what is meant by "mammals" and retain the term throughout. Mr. Fitzsimons holds the view that the leopards in wild countries uninhabited by man "are still fulfilling the mission for which the Creator evolved them" (i., p. 120), and that "it is essential that the old, decrepit, or malformed animals should not be allowed to live and breed, otherwise the great plan of the Creator in perfecting the various forms of life would be marred" (ii., p. 79).

[1] "The Natural History of South Africa." By F. W. Fitzsimons. "Mammals." In four volumes. Vol. i., pp xix+178; Vol. ii., pp. xi+195. (London: Longmans, Green, and Co., 1919.) Price 9s. each vol.

These and other views may not be acceptable to the modern zoologist, but there can be no doubt about the importance and interest of these two volumes to all lovers of natural history, and particularly to those who keep monkeys and other mammals as pets and to the guardians of our Zoological Gardens. A charm of style and a freedom from errors distinguish the volumes. The vivid descriptions of the habits of the blue ape and the Chacma baboon, as well as of those of

FIG. 1.—A baby Vervet monkey, born at the Port Elizabeth Museum. From "The Natural History of South Africa."

many other species, are fascinating to read. The author gives us further particulars of the wonderful story we heard long ago of "Jack," the Chacma which acted as signalman on a South African railway line. When his master, to whom he was devotedly attached, became incapacitated, owing to an injury, "Jack" took over his duties. He worked even the levers on the line by himself (i., pp. 61–67), and finally pushed his master home every night on a little railway truck. This marvellous story is fully substantiated by creditable witnesses.

Mr. Fitzsimons had a serval which was as tame as any domestic cat, and even when fullgrown it did not lose any of its playfulness, and nothing gave it keener joy than to be romped and played with. It had, however, to be kept in partial confinement on account of its fondness for poultry. The author makes some appropriate remarks on the subject of keeping animals in confinement.

Some people consider it distinctly cruel to deprive animals of their liberty, although they may be confined in large, roomy, comfortable cages and all their physical needs provided for. Such folk know little or nothing of the hardships which most animals in their native haunts are called upon to undergo in the shape of scarcity of food, inclement weather, and the necessity to be at all times on their guard against the many enemies by which they are surrounded. The feelings of the lower animals cannot be gauged by those of us who have the mental, moral, and spiritual faculties and an advanced condition of development. If the physical needs of the lower animals, and even the primitive races of man, are provided for, they are then in a condition of perfect happiness.

No one would imagine that lions could live on vegetables, and yet the late Dr. Livingstone pointed out that the lion of Central Africa frequently feeds on the desert water-melon. Mr. Fitzsimons is wrong in his statement that the lioness produces no more than five young at a birth (i., p. 123). On several occasions a lioness in the Dublin Zoological Gardens had a litter of six cubs.

There seems to be evidence to show that the African wild cat breeds freely with the domestic cat, and this would strengthen the view that the former is the ancestor of the European domestic cat.

The two volumes which have been issued contain a most valuable store of information on the habits of wild mammals. It is interesting to note that the aardwolf lives almost entirely on termites; that the Cape hunting dog will scour the country for days, doing perchance more than 100 miles a day, on a perfectly empty stomach; and that the Cape otter seems to be slowly abandoning its aquatic habits. Some mammals, like the ratel, exhibit an unusual amount of intelligence, if the reports can be credited that it follows the movements of a little bird known as the honey guide in its search for honey. "Of all the animals known to me," says the author, "the ratel has the most energy, endurance, and perseverance."

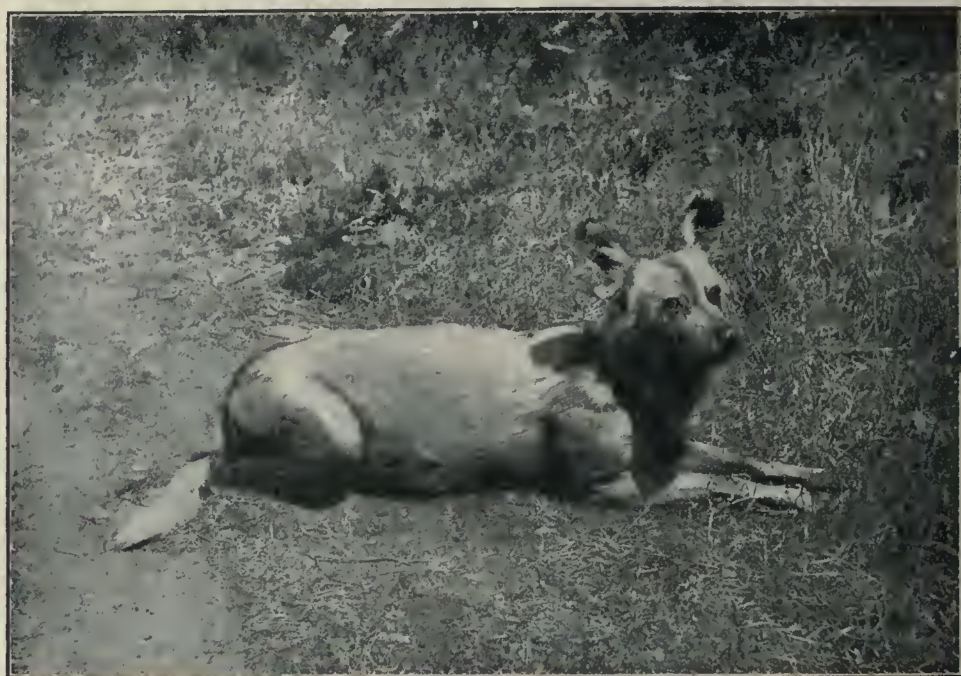

FIG. 2.—The Cape Hunting Dog, which is as big as a mastiff. From "The Natural History of South Africa."

Many of the illustrations are of a high standard, and add to the value of this welcome work.

INDUSTRIAL RESEARCH.[1]

DURING the past few years manufacturers have tended to lift the veil of secrecy behind which they were wont to hide their works processes and operations. Under the menace of war, and with the partial removal of ordinary intercompetitive conditions, rival manufacturers who were faced with problems incident to the fabrication of new war products turned to each other for mutual guidance and assistance, and a very considerable interchange of knowledge and experience resulted, to the benefit of all concerned. The tendency to secrecy, which prevented manufacturers from sharing their knowledge for the common benefit of the industry and for the better combating of foreign competition, was one of the

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1918–19. Pp. 94. (London: His Majesty's Stationery Office, 1919.) Price 6d. net.

greatest obstacles in the way of organising industrial research on a scale and of a character requisite for the needs of industry as a whole. It is therefore most interesting to note, from the recently published report of the Department of Scientific and Industrial Research, what success has attended the efforts to establish research associations. These associations are organised and supported by manufacturers in specific industries, and some financial aid is granted by the Department for a limited period of time, of an amount about equal to that contributed annually by the firms comprising the associations.

Through such means research bearing on problems of common interest in the several industries may effectively be carried out, and those channels for the interchange of knowledge and experience with which we have become familiar during the war, and which are so essential if the greatest benefits are to be obtained, will be maintained.

Already a number of the most important industries have established research associations, and most of the remainder are giving this matter earnest consideration. Some question might be raised on the soundness of the policy of conducting research in this manner, whereby each industry is more or less self-contained, so that difficulties arise in the ready interchange of special knowledge which, though acquired in the first instance by and for one special industry, would be, if readily available, of the very greatest interest and value in others. One might anticipate, however, that the present type of organisation will be only a step towards an ultimate goal, possibly a centralised scheme which will effectively provide for that interchange of thought and knowledge between research workers without which the whole benefit of their knowledge and discoveries cannot be secured.

The widespread variety of researches coming under the survey of the Department is worthy of note; of these, none is of greater importance than that relating to medical work. Jointly with the Medical Research Committee, the Industrial Fatigue Research Board has been established, in order to carry out investigations in industry concerned with output, timekeeping, labour, wastage, and such data as will serve as indices of fatigue. The enormous waste of human effort arising from inefficient application in almost every kind of mental and manual operation has long been recognised. Much of this inefficiency has been due to a lack of knowledge of the fundamental conditions governing fatigue, and at this time there is no investigation of greater importance than that which concerns the conservation of human effort, especially having regard to the far-reaching effects of fatigue, manifested in ill-health, increased risk of accidents, and loss of production. The results of researches falling within the scope of the Industrial Research Board may prove of outstanding value, not only as affording a scientific basis for the determination of the real working capacity of individuals, but also as indicating the laws underlying the most economical application of human effort, the observance of which will reduce to a minimum all the physiological and psychological reactions arising from fatigue, which are such potent factors in the cause of industrial discord and unrest.

It is gratifying to note the increased attention given by the Department to the financial assistance of those students who desire to qualify for research work. The lack of sufficient numbers of really sound research workers is acutely felt in industry, and money expended in bringing to maturity the powers of young men who exhibit an inherent capacity for scientific investigation will be wisely spent.

A further interesting feature of the report is the organisation of means for co-operating with the extensive scientific investigation that is being conducted by research organisations in the overseas Dominions. It is not sufficiently realised by consumers in this country that it is just as important for research to be conducted towards the efficient production of raw material as towards cheapening the more advanced processes of manufacture. In this connection every encouragement should be given to maintaining the closest possible relation with research in the Colonies.

A matter to which one would like to see greater attention given is a means for developing and maintaining an acute interest in scientific research on the part of the manual workers in industry and by the general public. As the report truly points out, a marked change is taking place in the attitude in industry towards scientific research, but this attitude has largely been the result of scientific achievement during the war, and unless efforts are made to stimulate and maintain it this interest is likely to suffer eclipse as other problems arise. Probably no better means could be devised for achieving this purpose than such displays as the admirably conducted British Scientific Products Exhibitions of the last two years, coupled with systematic propaganda in the daily and technical Press.

A. P. M. FLEMING.

SERICULTURE IN INDIA.[1]

FOR long past, the decline of the Indian silk industry has given rise to considerable anxiety. The main feature of the situation has been a serious falling off in the production of raw silk in Bengal (hitherto the principal silk-producing province of India) involving a restricted use of Bengal silk in India itself and a great decline in the overseas exports of raw silk. The place of these exports has in part been taken by the excellent silk now produced in Kashmir, but the quantity is small compared with the Bengal exports of former years. The unfortunate result has been a great advance in the import into India

[1] Report on an Inquiry into the Silk Industry in India. By H. Maxwell-Lefroy and E. C. Ansorge. Vol. i., "The Silk Industry." By H. Maxwell-Lefroy. (1916.) Pp. ii+211. Price Rs. 2, or 3*s*. Vol. ii., "Present Condition of the Silk Trade of India." By E. C. Ansorge. (1916.) Pp. vi+115. Price Rs. 1 As. 6, or 2*s*. Vol. iii., Appendices to Vol. i. By H. Maxwell-Lefroy. (1916.) Pp. 227. (Calcutta: Superintendent Government Printing, India, 1917.) Price Rs. 2 As. 12, or 4*s*. 2*d*.

of raw silk from foreign countries (especially Japan), and, more unfortunate still, a startling increase in the import of manufactured silk piece goods, also from Japan. When it is added that, with notable exceptions, the Indian raw silk is so defective as regards reeling and other characters as to hold but a low place in the estimation of manufacturers, it will be evident that the position of the Indian silk industry is indeed serious.

With the view of ascertaining whether, and by what methods, the revival of the industry is possible, the Government of India in 1915 decided upon a comprehensive survey of the whole question in both its sericultural and industrial aspects. Prof. Maxwell-Lefroy and Mr. C. E. Ansorge were appointed to conduct this inquiry, and their exhaustive reports are now available. Prof. Lefroy's inquiry was mainly concerned with sericultural and technical questions, while Mr. Ansorge's investigations have provided an admirable account of the industrial aspect of the industry.

India possesses great advantages as a silk-producing country. The enormous areas suited to the worms and their food-plants (in addition to the cultivated mulberry silk she has at least one promising "wild" silk), the abundance of cheap labour, the local market, and, not least, an experience extending over many centuries, should place India in the forefront of the silk countries of the world. Her present unfortunate position (resulting mainly from the decline in the Bengal production) is ascribed by Prof. Lefroy to four main causes, viz., (1) the increased production of silk in Japan, (2) disease among the worms, (3) increased value of other crops, (4) the inferiority of the Bengal worm. We suspect that (2) and (4) are the fundamental causes of the existing state of affairs. With expert organisation, the compulsory and exclusive use of disease-free seed and the improvement or replacement of inferior races of worm would unquestionably result in the relative rise in value of silk as a crop, and enable the competition of Japan to be more successfully met. Unmistakable object-lessons are afforded by the results of the scientific management of the industry in the native States of Kashmir and Patiala, both of which now produce an excellent mulberry silk.

These facts are recognised by Prof. Lefroy in making his recommendations. His principal suggestion is for the establishment of a central silk institute to investigate all branches of sericulture with a view to improvement; to study processes of weaving, dyeing, and finishing; and to afford expert advice on all phases of the industry, including the questions of trade and possible new markets.

It is possible that the results of Prof. Lefroy's investigations may not be regarded officially as indicating a clear case for a strong forward silk policy in India. The fact that the decline in silk is in part attributed to the increased value of the other crops will naturally result in hesitation to embark on a large development of sericulture absorbing an amount of energy which conceivably might be more profitably utilised in other directions. It must not be overlooked, however, that silk-raising can be successfully carried on only as a cottage industry, and that without deflecting a single worker from any other crop scientific organisation and control of the present sericultural industry would add enormously to the quantity and quality of the output of raw silk. The question is, however, admittedly difficult. Unfortunately, the fact is that for a large part of India's requirements the quality of the local silk is "good enough," and there may be a disposition to leave it at that. In doing so, exceptional opportunities —commercial, industrial, imperial—will be ignored. With the measures suggested by Prof. Lefroy (notably the establishment of a silk institute), India should be able to replace with locally-produced silk much of the raw material imported from Japan, and enable the growing import of silk fabrics to be reduced. As regards the overseas export of raw silk, India would find markets ready to take all the silk she could spare so long as it conformed to accepted standards of quality, reeling, and cleanliness. Within the last few years there has been a remarkable development in the world's consumption of silk (especially in America), and manufacturers would welcome with open arms new sources of supply of the raw material. The situation offers unique opportunities for India to establish her position as an Imperial source of merchantable raw silk; and before finally deciding as to the future silk policy of the country the authorities would be well advised to consider the changes that are taking place in the economic conditions of the world's silk trade.

SIR WILLIAM OSLER, BART., F.R.S.

ACLAND, Burdon Sanderson, Osler; and if to these we add—in a chair closely allied to theirs—George Rolleston, we look upon a procession of men of rare distinction of character and accomplishments; and each in his very distinction different from the others. Of such children Oxford may well be proud. For if Osler by birth was a Canadian, and in much of his life American, yet his temper and culture were also of the best Oxford could give; Oxford whose gifts are lavished abroad far beyond the narrow limits of her own walls. Thus Osler, "after a sleep and a forgetting," and "trailing clouds of glory" from the old West Country of his fathers, came to Oxford as to a spiritual home. And Oxford took him to her heart as her own; there, as one of her own, he rested; but bringing with him, as gifts from the New World, an openness and simplicity of mind and conversation, a frankness and generosity of temper, a freedom from the frost and weight of custom, and a pioneer's command of affairs which made him as delightful a fellow-worker as he was clear-sighted and effectual. Children loved him, for in him they found the best part of themselves. Osler happened to be visiting in Oxford with the present writer when Sanderson intimated his intention to retire from his chair; a few hours later, after some hints from his friends, Osler felt the call of the bounteous mother; and not the least of the warrants of his qualities was in this, that his friends in Oxford almost sprang upon him, as they realised that before them they had a man worthy to succeed his honoured predecessors.

And if Osler had not also to capture Great Britain, as he captured Oxford, it was because Great Britain was already his mistress. Indeed, there was not a school of medicine in the Old World where his presence was not almost as well known, and his friendship as precious, as in the New. It was characteristic of him that a few years later he obtained leave from Oxford to spend some months in Paris, during which period he regularly attended the clinics of the great hospitals, at 7.30 a.m., like an ordinary student.

Of Osler's contributions to knowledge it is as hard to make a list as it would be for Socrates. They were many, no doubt, but consisted even more in his insemination of other minds, in personal teaching and influence upon his disciples. His great text-book, for many years, and still, the guide of every English-speaking student, had many and almost singular merits. Although within its compass no particular subject could be dealt with at large—for every subject had to be kept in subordination to the whole—yet in the successive editions it was always helpful in any quest to turn to "Osler," because, if it were but in a word, or the turn of a sentence, one perceived that the latest and best researches, if not presented in detail, were known to the author. Thus the work was not a provider only, but also to the wise an indicator. The reader feels as he reads that both whole and parts were being continually re-adapted to the developing phases of knowledge. Perhaps the author's most original and valuable researches were in the field of the diseases of the spleen and blood; but he made eminent contributions also to the study of infections of the heart, of angina pectoris, of malaria, and of many minor maladies. But, the most modest of men, his conversation was always of the good work of others, silent on his own. It is to be hoped that some one of his pupils will prepare a bibliographical list of his essays and papers, and, furthermore, of his literary essays, such as are contained in the delightful volume entitled "Æquanimitas." It is said that a great part of the revision of the text-book for the new edition, on which he was at work, is written.

Osler's work for others was so incessant, and his hospitality so unbounded, that one always wondered when and where he amassed and made use of his learning; learning which, in particular, would discover itself, as it were, by accident, unless, indeed, his companions were expert enough to see it under the surface of his talk. Somehow or other he was not only in sympathy with various subjects of study other than medicine, especially with literary pursuits, but was able also to converse on something like equal terms with the masters of them. When in Cambridge, he found himself thus quite at home with Aldis Wright in the literature of the seventeenth century; and his proficiency in the history of medicine, well known to all students of the subject, gave breadth and living interest to all his teaching. His apprehension must have been as quick as his memory was tenacious and orderly and his power of expression felicitous. His address last year to the Classical Association was as sparkling as it was profoundly humane; eminent for the depth of its sympathies and for the compass of its understanding, it was no *tour de force*; the speaker made no pretence to technical scholarship, his discourse had a more free air, was more of the world, more comprehensive than is common with such addresses, but yet on its own ground was a brilliant oration.

A quality that made Osler so fascinating a companion, his teaching so vivid and telling, and his parts in debate often so lively, was his wit and humour; the sharpness of the wit tempered by the sweetness of the humour. Indeed, much of his playfulness and whimsical mystifications were, in naturalist's phrase, a protective colouring to cover deep sensibilities. In its *finesse* his conversation resembled that of Henry Sidgwick; not a more or less laboured deliverance of epigrams, but a light, nimble play of insight and fun. Much of its piquancy lay in the half-concealment of the treasures of the mind.

It is a touching thought that with all these attainments, all these accomplishments, we are mourning at this moment, not, or not merely, the skilful doctor, the great scholar, the research student, or even the wise and tactful reformer, but far more the sympathetic friend of all and of a few; one in whom this expansion of his friendship made him none the less a dear brother to those who were nearest to him.

The loss of his one child, an undergraduate of Oxford who was killed in action, smote Osler to the heart. His son had inherited his father's abilities and character, and shared his literary tastes and his pride in the fine library which had been always the library *Gulielmi Osler et amicorum*. This blow to him and Lady Osler was beyond healing; but last summer, during some fine weeks in Guernsey, he regained much bodily health. A fine swimmer, he drew life from the sea. Unhappily, a little later he was caught by the ruthlessly sudden strike of the railwaymen, and had to travel in an open motor-car from Newcastle to Oxford. He reached home chilled and weary, and was attacked by a broncho-pneumonia, which, after many phases and some transient signs of amendment, ended rather unexpectedly in death on December 29. Two days before had arrived in Oxford the "Festschrift," compiled by his friends for his seventieth birthday. This volume, which had been presented in form but delayed in completion, he was never to see; it is now a monument, one among many, to his memory.

C. A.

NOTES.

THE list of New Year Honours includes one earl, three barons, seven Privy Councillors and three in Ireland, nineteen baronets, and a number of appointments to orders of knighthood. Sir Bertrand Dawson, Physician in Ordinary to the King, and Dean of the medical faculty of the University of London, is one of the new peers. Among the new knights are Prof. Arthur Schuster; Dr. E. A. Wallis Budge, Keeper of Egyptian and Assyrian Antiquities, British Museum; Col. W. A. Churchman, Ministry of Munitions Explosives Department; Dr. J. Court, known by his researches on diseases of miners; Mr. F. C. Danson, chairman of the Liverpool School of Tropical Medicine; Mr. D. E. Hutchins, for his services to forestry; Mr. James Kemnal, for public services in connection with the manufacture of munitions; Mr. F. S. Lister, research bacteriologist, South African Institute for Medical Research; Mr. H. J. Mackinder, M.P.; and Dr. F. G. Ogilvie, Director of the Science Museum, South Kensington. Prof. S. J. Chapman, Joint Permanent Secretary, Board of Trade, and Sir Richard Glazebrook have been promoted from C.B. to K.C.B. Dr. G. R. Parkin has been promoted to the rank of K.C.M.G., and Mr. H. N. Thompson, Chief Conservator of Forests, Nigeria, has received the honour of C.M.G.

WE regret to announce the death on January 4, at seventy-eight years of age, of Sir Thomas R. Fraser, F.R.S., emeritus professor of materia medica, University of Edinburgh, and Honorary Physician-in-Ordinary to H.M. the King in Scotland.

THE PRINCE OF WALES, who has recently become vice-patron of the Royal Geographical Society, will be present at the meeting of the society on Monday, February 2, at the Central Hall, Westminster, at 8.30 p.m., when a paper will be read by Major-Gen. Sir Frederick Sykes on "Air Routes of the Empire."

THE *Times* correspondent at New York reports that violent earthquake shocks were felt over the greater part of the Mexican Republic on Saturday night and Sunday, January 3–4. The State of Véra Cruz seems to have suffered most. The Mexican Government Observatory places the centre of the disturbance near the volcano of Orizaba. A shock was recorded by the seismograph at Kew Observatory at 5.25 a.m. on January 4.

ON Tuesday next, January 13, at 3 o'clock, Sir John Cadman will deliver the first of two lectures at the Royal Institution on (1) "Modern Development of the Miner's Safety Lamp," and (2) "Petroleum and the War." The Friday evening discourse on January 16, at 9 o'clock, will be delivered by Sir James Dewar on "Low-temperature Studies," and on January 23 by the Hon. Sir Charles Parsons on "Researches at High Pressures and Temperatures."

THE Ramsay Memorial Fund has received from Prof. H. Kamerlingh Onnes a very substantial contribution of 1571*l*. 9*s*. 5*d*., which has been given or promised by donors in Holland. These generous contributions are evidence of the sympathy felt in Holland for British science and scientific workers, and the respect so widely felt in that country for the memory of the late Sir William Ramsay. Among the subscriptions are:—Philips Gloeslampenfabriek, 500*l*.; Fransch Hollandsche Oliefabrieken, Delft, 300*l*.; Nederlandsche Gist & Spiritusfabriek, Delft, 300*l*.; Van den Bergh's Fabrieken, Rotterdam, 300*l*.; and Lym & Gelatinefabriek, Delft, 100*l*.

ANNOUNCEMENT is made in the *British Medical Journal* that the eighty-eighth annual meeting of the British Medical Association will be held at Cambridge next summer, under the presidency of Sir Clifford Allbutt, Regius professor of physic in the University, who will deliver his address on the evening of Tuesday, June 29. The sectional meetings for scientific and clinical work will be held on June 30, July 1, and July 2, the mornings being given up to discussions, and the afternoons to clinical and laboratory demonstrations. There will be twelve sessions, of which five will meet on each of the three days, and the remainder each on one day. The annual representative meeting will begin on June 25. The annual dinner has been fixed for July 1, and on the evening of July 2 Dr. G. S. Graham-Smith will give the popular lecture. Saturday, July 3, the last day of the meeting, has been set apart for excursions to places of interest in the neighbourhood.

FURTHER excavations at the well-known Anglo-Saxon site of Ravensbury Manor, Mitcham, have brought to light numerous remains of the period. The old gravel-pit is being extended, and further relics will no doubt be found. Six graves have so far been opened up, with the bones of two giant chieftains and a cripple with a diseased thigh-bone. Two swords, a bronze buckle, and an earthenware jar have been found. At earlier excavations no fewer than a hundred skeletons were exhumed. The first discovery was made in 1848, and in 1895 the opening-up of a new gravel-pit by Mr. G. P. Bidder brought to light a quantity of objects. Later digging by Col. H. F. Bidder produced knives, spear-heads, a few swords, pottery, shield-bosses, saucer-shaped brooches, and some beads, whilst a number of female skeletons were found to have been thrown carelessly into the graves of the men. One grave contained a coin of Constantius II., and Mr. Reginald Smith was of opinion that the date of the cemetery was the first half of the fifth century. Great care will, it is understood, be taken to preserve anything of value that comes to light, but at present nothing new has been found.

THE annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 6 and 7, at the Institution of Civil Engineers, Great George Street, London, S.W.1. The retiring president, Mr. Eugene Schneider, will induct into the chair Dr. J. E. Stead, the new president-elect. The council is prepared to consider applications for grants from the Carnegie Fund in aid of research work, of such value as may appear expedient, but usually of the value of 100*l*. in any one year. The awards are made irrespective of sex or nationality. Special forms, on which candidates should apply before the end of

February, can be obtained from the secretary of the institute. The research work must be on some subject of practical importance relating to the metallurgy of iron and steel and allied subjects. The results of research work must be communicated to the institute in the form of a report. By the invitation of the retiring president, Mr. Eugene Schneider, arrangements are in progress for holding the autumn meeting in France next September, provided no unforeseen contingency occurs. Early notice will be given of the precise date and place of meeting and the localities which will be visited.

WE note with much satisfaction that the Government of New Zealand has extended the absolute protection of seals in the area under its control for a period of three years, and that the Prime Minister of Tasmania has decided not to renew the lease of Macquarie Island to the company which so mercilessly exploited the wild life over which it had obtained control. Quite apart from the hideousness of the methods of slaughter, this protection has barely come in time to save these creatures from extermination. Although this danger has, time and again, been pointed out, the authorities allowed commercial interests to prevail. Yet the penguins, seals, sea-lions, and sea-elephants which contrived to maintain a hold on life in those inhospitable regions represent types of animal life which it was our bounden duty to preserve. A hope has been expressed that Macquarie Island may be set apart as an inviolable sanctuary for Antarctic life, and we trust not only that this will be done, but also that steps will be taken to guard against marauders who may be tempted to make occasional raids for the sake of the profits to be gained. To this end the island might be used for the purposes of a biological and meteorological station. Before it is too late we hope that the matter of protection for the whales in the Antarctic seas will also speedily find a place on the Statute-book. The subject has been long under consideration, but as yet nothing has been done on account of the opposition of commercial interests.

DURING 1919 many meteorological features of special interest occurred, and some of these introduced problems well worth discussing. In July and October the weather was exceptionally cold and dry over the British Isles, and the rainfall in both months for the whole country was only 55 per cent. of the normal for the thirty-five years ended 1909. The cold in the autumn was quite remarkable. The Greenwich observations show that the mean temperature for the year was 48·8° F., which is 1·3° colder than the normal for the thirty-five years ended 1915; the mean maximum temperature was 56·7°, and the mean minimum 40·9°. May, June, August, and December were the only months with an excess of temperature. The warmest month was August and the coldest February. There were four months, February, July, October, and November, with a deficiency of temperature amounting to 4° or more. December was 2·4° warmer than the normal, and 3·4° warmer than November, when there were only five days with 50° or above, whilst December had thirteen such days. The total rainfall for the year was 23·4 in., which is 0·1 in. less than the normal. December was the wettest month of the year, and the other months with an excess of rain were January, February, March, and April. The driest month was May with 0·36 in. March and December both registered precipitation on twenty-two days; during the year precipitation was measured on 175 days. Bright sunshine was registered for 1489 hours, which is eleven hours more than the normal for the year. May had the greatest duration of sunshine, 268 hours, and December the least, 21 hours.

THE Report of the Director-General of Public Health, New South Wales, for the year ended December 31, 1917, has recently reached us. It contains the usual full statistical data of the health of the State, and reports on the work of the microbiological laboratory. The latter is chiefly devoted (pp. 150–280) to an exhaustive inquiry on an epidemic of acute polio-encephalo-myelitis. Some 134 cases occurred, mostly in children, of whom 94 died. The chief features were fever in all cases, convulsions in many, and paralysis in a few, with rigidity and mental lethargy, confusion, and drowsiness as a rule. The disease was proved to be the meningitic or cerebral form of acute poliomyelitis (infantile paralysis, Heine-Medin disease).

IN the Journal of the Royal Society of Antiquaries of Ireland (vol. xlix., part 3, June, 1919) Mr. H. S. Crawford publishes a well-illustrated article on the mural paintings and inscriptions at Knockmoy Abbey, which are now partially destroyed, but once covered the entire northern wall of the chancel of the abbey church. The writer adduces arguments to show that they probably date from the sixteenth century. "At an earlier period pictures would hardly have been allowed in a Cistercian church, and at a later the costumes of the figures and the forms of the inscriptions would probably have been different."

IN the Journal of the Royal Anthropological Institute (vol. xlix., 1919, January–June) Prof. F. G. Parsons presents the results of his anthropological examination of a number of German prisoners of war interned in England. He thus states his conclusions: "The more one thinks of it, the more one is convinced that since the sixth century the broad-headed Alpine race has been slowly and steadily supplanting the long-headed Nordic type, not only in Prussia, but in every part of Germany, and the prisoners at our disposal give no reason for thinking that there is any part of Germany in which the Alpine or Slav characteristics have not dominated the Teutonic or Nordic." This view is based on head and face shape and coloration, and, so far as the evidence goes, it is supported by that of stature. The tall provinces are in the north and west of Germany, while the shorter men inhabit the south and east. Curiously enough, after what we have heard of the Pomeranians, they are a short race, the average height being 5 ft. 6·4 in. Of course, it is possible that the exceptionally tall men were drafted into special corps, such as the Guards and Marine Artillery, and that these were not fully represented in the material at the Prisoners' Bureau.

SIR E. BRABROOK has reprinted from the *Anglo-French Review* for October an interesting article entitled "The Anthropological Institutes of France and the United Kingdom." The Société d'Ethnologie de Paris was founded in 1839, and the Ethnological Society of London in 1844. In 1859 the Société d'Anthropologie de Paris was founded by Pierre Paul Broca, and the Anthropological Society of London by James Hunt in 1863. The London society had at first a chequered career; the question of the plurality of races had a political bearing, and some communications made to the society on the characteristics of the negro race were thought to overstep the line which restricts scientific societies in their choice and treatment of subjects for discussion. The question was finally solved by the foundation of the Anthropological (now Royal Anthropological) Institute of Great Britain and Ireland in 1870, which has since enjoyed a useful and prosperous career, though it has never received a State grant such as is enjoyed by its French sister, and has not obtained adequate support from those interested in the problems of our Indian and Colonial Empires. A project has recently been initiated for the establishment among the anthropologists of the Allied nations of a permanent central office of the International Institute of Anthropology, a scheme which, if framed on satisfactory lines, will do much to co-ordinate the work now carried on in Great Britain and on the Continent. Whether Germany will ultimately be invited to share in this organisation depends on the future conduct of that country.

PROF. A. KEITH's important twenty-first Robert Boyle lecture, entitled "Nationality and Race from an Anthropologist's Point of View," has been published by the Oxford University Press (price 2s. net). Prof. Keith begins by classifying the progress of human culture into two stages: that of natural and artificial subsistence. "Man's great bowel, including the cæcum, appendix, and colon, which answered his needs well when his dietary was coarse and uncooked, is ill-contrived to deal with foods which are artificially prepared and highly concentrated." The thesis which he proposes is that "in our modern racial strifes and national agitations we see man's inherited tribal instincts at war with his present-day conditions of life." This he illustrates by a survey of racial and national problems in the United States, Canada, Spanish America, Australia and New Zealand, South Africa—where "the problems of race and of nationality appear in a more acute and tangled form than anywhere else in the world"—and Europe, and by a reference to the Jewish question. As regards the Irish problem, Prof. Keith remarks that, "except for a trick of speech or a local mannerism, the most expert anthropologist cannot tell Celt from Saxon, or an Irishman from a Scotsman. There are, to be sure, certain physical types which prevail in one country more than in another; but I do not know of any feature of the body or any trait of the mind, or of any combination of features or traits, which will permit an expert, on surveying groups of university students, to say this group is from Scotland, that from Wales, the third from Ireland, and the fourth from England." Prof. Keith ends by a strong plea that a knowledge of tribal and racial spirit is essential for statesmen.

PROF. W. TRELEASE discusses the bearing of the distribution of some elements of the existing flora of Central America and the Antilles on former land connections in this area (Bull. Geol. Soc. Amer., No. 29, pp. 649–56). The most important evidence is supplied by the genus Agave, which includes the familiar century plant. Its chief centre is Mexico, but it ranges from Arizona to the Isthmus of Panama, and occurs also in tropical Florida and northern equatorial America. It is represented in the West Indies by about fifty endemic species comprising six distinct types, and from their distribution in the islands the author concludes that the genus was derived from the mainland of Central America at some late Tertiary or early Quaternary time when islands and continents were continuous. Later they spread through the chain over continuous land; the continuity was broken by subsidence or faults when the very deep Anegada Passage, which separates the islands of St. Thomas and St. Croix, was formed, and later subsidences have caused in succession the deeper and lesser water gaps by which the Antilles are divided into groups successively more or less distinct in their Agave flora. These conclusions harmonise with the fact indicated by Eggers: that the greatest break between the northern and southern elements in the Antillean flora coincides with the deepest, and presumably the oldest, break in the Antillean bridge, now represented by the Anegada Passage.

THE geological work on the Western Front forms the subject of an interesting paper by Mr. W. B. R. King in the *Geographical Journal* for October (vol. liv., No. 4). Mr. King was Geologist at General Headquarters in France for more than three years. His problems were mainly concerned with water-supply, which at times presented much difficulty in view of the amount required. The advice of the geologist was also of great importance in mining and tunnelling operations and in the construction of dug-outs.

WE have received a copy of the Rain Map of Australia for the year 1918, published by the Commonwealth Government. It gives the total rainfall for the year and separate maps for each month. Some small inset maps show the areas with rainfall above the average in recent years. The year 1918 was in marked contrast to the two preceding years, both of which had an unusual amount of precipitation. In some respects it resembled 1915, when there was severe drought in the interior of New South Wales and Queensland. Rainfall was good until the end of February, when drought set in over the central and eastern parts of Australia. The westerly, or, as this chart names it, the Antarctic, rainfall in the south seems to have been fairly normal, but its influence was restricted to the coasts in the south-west and south-east. South Australia suffered from drought, and throughout the wheat-belt there was a serious deficiency in spring rains. A cool spring, however, minimised this want, and cereal crops were fairly good in Western Australia, South Australia, and Victoria, but largely a failure in New South Wales and Queensland.

THE shortage of potassium salts and nitrates during the war has directed attention to many possible sources of supply previously neglected. In Memoir 14 of the Geological Survey of South Africa Messrs. Frood and Hall discuss the deposits of saltpetre found as an interstitial filling along the bedding planes at the base of the valleys in a region of hard ferruginous shale near Prieska and Hay, Cape Province. No satisfactory estimate is available of the average composition and depth of the deposits. Nitrification of the animal excreta accumulating near the sheltered portions of the cliffs is believed to be the source of the nitrate, which then passed in solution along the joint planes, producing irregular encrustations and pockets. If this be the correct explanation of their origin, it is improbable that the deposits could be of any great depth.

THE Summary of Progress of the Geological Survey of Great Britain for 1918 (issued in 1919) is of special interest through its description of the bauxitic nature of certain Carboniferous strata in Ayrshire. A clay of Millstone Grit age has been found to be a good refractory, with 26–50 per cent. of alumina, 28–50 per cent. of silica, and combined water 7·5–15 per cent. Most of the alumina is combined with silica, probably as kaolin, but there remains an excess, as in bauxitic clays. This excess is, however, not easily soluble in hydrochloric acid, unlike that in bauxite. Oolitic varieties of the bed contain most free alumina. Basaltic lavas underlie the clay, and the conditions that produce laterite and bauxite seem to have prevailed in southern Scotland in Upper Carboniferous times. The discovery and value of this material will stimulate observation in other localities of Carboniferous rocks. It is pointed out that the quality of the material may vary considerably, and that the presence of titanium dioxide, which occurs as rutile, in a greater proportion than 5 per cent. reduces the refractory property considerably. In the same Summary of Progress a record is given of the personal and official services rendered by the staff of the Geological Survey during the five years of war. Among others, our congratulations go out to Capts. E. B. Bailey and J. E. Richey.

IN a valuable paper read before the Royal Society of Edinburgh (Proceedings, vol. xxxix., 1919, pp. 157–208), Prof. C. G. Knott continues his investigations on the propagation of earthquake-waves through the body of the earth. In his new analysis Prof. Knott does not assume any relation between the velocity of propagation and the distance from the earth's centre. His work, which must have been most laborious, leads him to the following conclusions. He finds that the seismic rays of both the condensational and the distortional waves are concave outwards until they reach a depth of about three-tenths of the earth's radius. To this depth, then, the velocity of propagation must increase with the depth. It then becomes nearly constant, but at still greater depths it decreases a little, so that the rays there are slightly convex outwards. The data furnished by seismological observatories enable him to trace the rays to a depth of six-tenths of the earth's radius, but not beyond. At or near this depth the distortional wave seems to die out, for at arcual distances of more than 120° from the epicentre their characteristic appearance in our seismograms is lost. Dr. Knott thus arrives at a conception of the earth's interior which is practically the same as that advanced by Mr. Oldham thirteen years earlier: that the earth consists of an elastic solid shell down to a depth of about half the earth's radius, that here the rigidity breaks down, and that at a depth of about six-tenths of the earth's radius the elastic solid shell gives place to a non-rigid nucleus of measurable compressibility.

SOUTHPORT, by its report of the meteorological observations made at the Fernley Observatory during the year 1918 and discussed by Mr. Joseph Baxendell, the meteorologist to the Borough Corporation, adds much to our knowledge of the weather at one of the principal English health resorts. The report contains more than detailed observations of the weather, and now that the observatory has continued for forty-seven years the results yield values of much importance. Two local atmospheric pollution stations were started during the year, one to be representative of urban and the other of rural Southport. Hourly wind-direction-frequency normals are given numerically, as well as in diagram form as a frontispiece; they show a preponderance of southerly winds in the winter and of westerly and north-westerly winds from off the sea during the day-hours in the summer months. Mr. Baxendell hopes definitely to establish a marked and persistent meteorological periodicity of nearly 5·1 years, which, he states, is especially noticeable in wind direction. The year 1918 was marked by general warmth and wetness, resulting from a very abnormal predominance of winds from the warmer and more humid half of the compass (south-east through south to west). The table giving the rainfall with different wind directions shows that 78 per cent. of the total amount of rain was with winds from these directions.

THE Fifth and Sixth Reports of the Director of Veterinary Research of the Union of South Africa contain an account by Mr. H. H. Green of an improved method for the estimation of small quantities of arsenic by micro-titration with iodine. It was used for determining the fate of ingested and injected arsenic in sheep. Bacteria capable of oxidising sodium arsenite and reducing sodium arsenate have been isolated from arsenical cattle-dipping tanks. Examination of maize-milling products by dietetic experiments upon pigeons shows a close parallelism between the distribution of vitamine and phosphorus in individual maize-kernels, but not in different samples of maize. In the absence of information about the original grain and the extent of milling, microscopic examination would provide a safer test than the estimation of phosphoric acid. An extensive study of diets containing varying amounts of vitamine shows that the daily demand of pigeons for vitamine is not constant, but depends upon the extent of exogenous metabolism.

TECHNOLOGIC Paper No. 139 of the Bureau of Standards, Washington, U.S.A., contains an account of tests of light aluminium casting alloys. Among other tests, a number were carried out to determine to what extent the mechanical properties of cast alloys could be improved by heat treatment as follows:—Heating for two hours at 500° C., following by cooling in air, the specimens then being left to age several days before testing. Some thirty specimens were so treated, and in all but five or six cases there was a resulting increase in tensile strength of from 5 to 50 per cent. In cases where the heat treatment showed a decrease in strength, the whole group of bars of the heat was of inferior quality, cast and heat-treated ones alike. The hardness was increased by the heat treatment. The effect on elongation was more erratic, but in general a decreased elongation was found in the heat-treated specimens. It would appear that the treatment of light aluminium castings has commercial possibilities. Copies of the paper may be obtained by addressing a request to the Bureau of Standards.

THE *Technical Book Review Index* issued by the Carnegie Library at Pittsburgh, U.S.A., appears quarterly, and is a useful guide to new books on pure and applied science. The compilers have not had the actual books before them while preparing the index, but have obtained their information entirely from reviews that have appeared in scientific and technical journals. The accuracy of the information given depends therefore, in each case, upon the care taken in the review consulted. Books are arranged in the alphabetical order of the authors' names. The title of each book is followed by full reference to journals where reviews of the book may be found, and a short quotation from each review, giving, where possible, some idea of the scope and object of the work. The compilers have wisely refrained from expressing any opinion of their own as to the value of each book, although it appears that an attempt in this direction is made upon the index-cards of the library at Pittsburgh from which this review index has been prepared. It will, however, be found that the extracts quoted from reviews give, in most cases, adequate assistance in forming an opinion as to the merits of each work.

PHOTO-ELECTRIC activity seems destined to play an important part in technical photometry. In No. 349 of the Scientific Papers of the U.S. Bureau of Standards Mr. K. S. Gibson gives an account of experiments on photo-electric spectrophotometry by the null method, using potassium hydride cells now on the market. Such cells give a maximum response, usually near 460$\mu\mu$; consequently, the method admirably supplements the visual and photographic methods, being best in the blue and violet parts of the spectrum, where they become poor, and becoming poor only after they have become trustworthy. By employing the null method, first brought out by Richtmyer, errors due to want of direct proportionality between photo-electric current and exciting radiant power, and to the current through the cell when not irradiated, are eliminated. Experiments have also been carried out on diffuse spectral reflection, and the method is applicable to the measurement of the relative radiant power of two sources and to the measurement of fluorescence. In another publication of the same series (No. 344) Messrs. W. W. Coblentz and H. Kahler give data as to the change in the electrical resistance of the sulphide of silver and of bismuth when exposed to radiations of wave-lengths extending from 0·6μ to 3μ. Galena, cylindrite, pyrites, and jamesonite did not show any noticeable sensitivity. At very low temperatures the intrinsic sensitivity of silver sulphide was greatly increased—a result of interest in connection with the fact that some substances exhibit luminescence only at low temperatures.

PART ii. of a paper on the cutting power of lathe-turning tools was read at the Institution of Mechanical Engineers on December 19 by Mr. George W. Burley, of Sheffield University. Part i. was read in 1913 by Prof. W. Ripper, and a number of points raised in the discussion are dealt with in the present paper, which gives an account of the continuation of the series of experiments. Among the conclusions arrived at is the fact that there is no practical cutting speed below which it is impossible to obtain a satisfactory finished surface on plain-carbon steels by the use of tools of plain-carbon tool-steel, ordinary (non-vanadium) high-speed steel, or superior (vanadium) high-speed steel, but there are upper limits as follows:—For finishing mild steel, 48 ft. to 58 ft. per minute for each of the three varieties of tool-steel; for finishing hard steel, 23 ft. to 28 ft., 17 ft. to 21 ft., and 28 ft. to 34 ft. per minute respectively for the three varieties of tool-steel mentioned above. The cutting power of a high-speed lathe tool is influenced by both the cross-sectional area of the shank of the tool and the nose-radius, but the influence of the latter factor predominates. Thus, with a number of different sections of tool-steel, an increase of 100 per cent. in nose-radius produced an average increase of cutting power of 45 per cent.; whereas an increase of the shank cross-section of the tool of 500 per cent. with a constant nose-radius produced an average increase in the cutting power of only 8·5 per cent. There is no marked difference in the net amounts of energy required per cubic inch of material removed from mild-steel and hard-steel bars at high and low cutting speeds.

Messrs. Longmans and Co. expect to publish in January "Applied Aero-Dynamics," L. Bairstow; "The Design of Screw Propellers, with Special Reference to their Adaptation for Aircraft," H. C. Watts; "Telephonic Transmission, Theoretical and Applied," J. G. Hill; and vol. i. (The Extremities) of "A Manual of Practical Anatomy," Prof. T. Walmsley. Others books, in the press or in preparation, by the same house are:—"An Introduction to the Study of Terra Sigillata, Treated from a Chronological Standpoint," Dr. F. Oswald and T. D. Pryce; "Structural Steelwork," E. G. Beck; "Tuberculosis and Public Health," Dr. H. H. Thomson; "Food Supplies in Peace and War," Sir R. H. Rew; vols. ii. and iii. of "A Manual of Practical Anatomy," Prof. T. Walmsley; and, as already announced, "The Life and Work of Sir Jagadis Chandra Bose," Prof. P. Geddes.

OUR ASTRONOMICAL COLUMN.

THE BIRTH OF THE MOON.—Prof. W. H. Pickering in *Popular Astronomy* (October, 1919) endeavours to reconcile Sir George Darwin's estimate of the moon's age (less than 60,000,000 years) with recent geological opinion, which demands a period of 1,200,000,000 years since the formation of the earth's crust. He suggests that the matter of the moon left the earth at that remote epoch, but remained for ages circulating round the earth as a cloud of fragments. In this form its tidal influence would be small, and the earth would for long retain its assumed primitive rotation period of some four hours. Gravity in the tropics would be much reduced by centrifugal force. Prof. Pickering seeks thus to explain the existence of the huge reptiles like the Atlantosaurus and the Diplodocus, also the fact that heavy reptiles like the Pterodactyls had the power of flight. He suggests that the moon was consolidated from the cloud of fragments in the middle of the Cretaceous period, and quotes geological authorities for a great invasion of land areas by the sea and tremendous volcanic activity at that epoch, which he ascribes to the great tides which the moon would have raised when so near the earth. That epoch would agree well enough with Sir George Darwin's estimate of the moon's age, supposing it to date from its consolidation, not from its leaving the earth.

DISTANCES OF THE STARS OF TYPE F.—Mr. C. F. Lundahl discusses the distances of these stars in *Meddel. Lunds Astr. Obs.* (series ii., No. 21). He works on the same lines as Prof. Charlier in his recent memoir of the B stars; that is, he assumes a constant absolute magnitude, and deduces the distance of each star from its apparent magnitude. The F stars have a wider range of absolute magnitude than those of type B, but the great majority of them are included in a range of about 2 mag.; hence tolerable results for the distances may be expected. In fact, he states that 60 per cent. of the stars the parallax of which has been measured agree with his values within the limits of probable error. He quotes Prof. Plummer's research on the same stars, which was based on the assumption that they were moving parallel to the galactic plane. As that method showed an agreement with measured values for only 40 per cent. of the stars, Mr. Lundahl concludes that his own assumption is nearer the truth. He notes from his results that ζ Tucanæ and η Cassiopeiæ are evidently dwarf stars, while Polaris and still more Canopus are notable giants. The density of distribution of F stars is estimated by two independent methods, which give respectively 8 and 4 cubic siriometers for one star of this type (a sir. = 1,000,000 astr. units).

ABSOLUTE MAGNITUDE AS A FUNCTION OF COLOUR.—Mr. F. H. Seares indicates a relation between colour and absolute magnitude in stars of the same spectral type (Proc. Nat. Acad. Sci., July, 1919). The colour is determined photographically by taking graduated exposures of the star on an isochromatic plate with and without a yellow filter. The ratio of exposure times that give images of equal intensity in the two cases is a measure of the colour. The method has been tested on about 150 stars the absolute magnitude of which has been otherwise determined. The following are the results deduced:—Giant stars of types G and K are decidedly redder than dwarfs; also in type B the brighter stars are redder, but the difference is less marked. On the other hand, in type A the fainter stars are redder, while in types F and M the curve is too flat to permit of the absolute magnitude being found from the colour. Thus the method can be applied only if the spectral type is known, but it promises to be a useful supplement to the spectroscopic method. Experiments are being made to examine whether the necessity of knowledge of the spectral type can be evaded by taking three series of exposures with screens of different colours; if this were possible, the method could be applied to much fainter stars.

CROSS-CIRCULATION AS A PHYSIOLOGICAL METHOD.

IN the mutual co-ordination and integration of the physiological processes in a complex organism, in which actions exerted by the environment on a particular part affect the whole and the functional activity of one organ has its influence on numerous others, there are two chief methods adopted. One is by means of the central nervous system, in which messages received from the periphery along certain nerve-fibres are reflected back, as it were, to outgoing nerve-fibres, setting into play the appropriate muscular or other response, it may be in a distant part of the organism. This method has been compared to a telephone exchange. The other is by means of the blood. Owing to the continual circulation of the same mass of liquid through all parts of the body, it will readily be seen that a chemical substance, produced in any one part and passing into the blood-vessels supplying this part, must be carried, sooner or later, to all other parts, and give rise to effects in any tissue or organ sensitive to it. We have here an actual transport of material, the materials carried, when they result in changes in distant organs, being known as "chemical messengers" or "hormones."

In many cases there is difficulty in discovering to which of these modes of communication a particular reaction is due. Thus when muscular exercise is taken, the depth and rate of breathing increase. We know that carbon dioxide is produced in the combustion process that affords the energy for the muscular work. This passes into the blood, and may be in itself sufficient to set into greater activity the nerve-centre controlling the muscles of respiration. On the other hand, it might be that sensory nerves in the muscle are stimulated by the movements, and that the appropriate message is conveyed by nervous channels, or both chemical and nervous factors may be involved. Perhaps a clearer case is that of the pancreas, which pours its powerful digestive juice into the small intestine as the food arrives there from the stomach. We know now that the chief, if not the only, way by which this co-ordination is effected is that the acid of the gastric contents causes the formation of a chemical messenger in the walls of the intestine. This, passing into the blood, ultimately reaches the pancreas and excites it to activity, but it was for a long time believed to be a nervous reflex. Again, the origin of wound-shock has recently been shown to lie mainly in the production in the injured tissues of poisonous compounds, which are carried by the blood to the rest of the body and cause widespread damage to the capillary blood-vessels, resulting in a failure of blood-supply throughout the body. At the same time the co-operation of nervous factors has not been altogether excluded.

The analysis of many problems of this kind has been greatly assisted by the various methods known as "cross-circulation." It is obvious that if we can make a connection between the blood-vessels of one animal (A) and those of another (B), any chemical messenger produced in A must affect B also, whereas a process in A brought about entirely by the nervous system will have no effect on B. In this mode of experiment the blood of A may either be allowed to circulate through the whole of B, and *vice versa*, or some particular organ only of B may be supplied from A, this organ being cut off from the circulation of B. The details of the procedure cannot be described here, but some recent improvements in the technique may be referred to. The chief difficulty lies in the fact that when the blood comes into contact with any foreign surface that is wetted by it, such as the glass or india-rubber tubes connecting the two animals, clotting occurs. This may be obviated by making the blood incapable of clotting. A substance extracted from the heads of leeches will do this, but it is at the present time almost impossible to obtain it. Other substances having the same effect are too poisonous. Since the blood does not clot in the uninjured blood-vessels themselves, Hédon in France and Dale and Laidlaw in this country have made use of pieces of vein to connect the blood-vessels required. The latter workers desired only to divert the blood from one vein of an animal into another of the same animal, so that no great internal pressure was present, and it was sufficient to pass a short metallic tube (Crile's canula) over each end of the piece of vein, reflecting the ends over the tube and tying them. When this is done, and the tube is introduced into a blood-vessel, the blood comes into contact only with the lining of a normal blood-vessel. Hédon, wishing to connect the artery of one animal with that of another, took a metallic tube long enough to enclose nearly the whole length of the piece of vein and reflected the ends over this. The vein was thus adequately supported against the pressure of the blood in the arteries.

Bazett and Quinby, in the current issue of the *Quarterly Journal of Experimental Physiology* (vol. xii., No. 3), describe a method in which the fact is made use of that if blood is in contact only with a foreign surface not wetted by it, clotting is absent for a long time. They coated the interior of the glass and rubber tubes used with a mixture of paraffin and vaseline, and by interposing a specially constructed stopcock were able to connect the circulation of the two animals or return to normal at will.

These improvements in the technique of cross-circulation should render it possible to investigate problems hitherto difficult to solve. There is one disadvantage in it which must not be overlooked. This is the fact that a fall in the blood-pressure in one animal causes an inflow from the other when there is complete intercommunication between the two. Thus one of the animals may be seriously depleted if the low pressure lasts for any length of time. For this reason the production of wound-shock in one animal by the products of tissue-injury of another seems impossible, because the fall of blood-pressure, which is the most marked symptom of the state, would in itself drain blood from the normal animal and produce a similar state merely by loss of blood, apart from the action of a chemical substance. W. M. BAYLISS.

NICKEL-CHROMIUM STEEL FORGINGS.

DURING the war there was a considerable development of the use of alloy steels, in particular of those containing nickel and chromium. These uses were of the most varied kinds, not the least important being in the construction of internal-combustion engines used in aircraft, where service conditions are very severe. It is not surprising, therefore, that difficulty in complying with the specifications was encountered in manufacture, and much novel experience has been accumulated by technical workers in this field of steel metallurgy.

At the autumn meeting of the Iron and Steel Institute two important papers relating to this class of steel were presented: one was by Messrs. Andrew, Greenwood, and Green, of the metallurgical research department of Sir W. G. Armstrong, Whitworth, and Co.; the other by Mr. R. H. Greaves, of the research department, Woolwich Arsenal. It is interesting and significant to note that the latter paper is entitled "Metallurgical Communication No. 1, from the Research Department, Woolwich."

Messrs. Andrew, Greenwood, and Green, who took up the investigation of defects in the final tests of nickel-chromium forgings, have carried out their work in a most thorough and exhaustive way, following up the manufacture of these from the original casting to the finished article. It needs considerable courage for the investigators in a works to publish evidence showing manifest defects in the products of the firm's work, and the authors are to be commended for their honesty in taking this step. It is but rarely that such cases are met with.

The manufacture of a hollow forging may be divided broadly into three distinct sets of operations: casting, forging, and heat treatment. The authors emphasise the operation of casting as the most important of all, because any defects present in the ingot, generally speaking, persist throughout up to the final treatment. It is essential that not only the metal but also the mould-walls should be clean, and that all loose sand must be prevented from getting into the mould. As a method of assisting in the achievement of these results, the authors suggest the use of a tundish with sloping walls lined with basic material. They say that if the metal were run directly into this from the iron ladle, the sloping walls of basic material would act as a cleanser, since the slag would adhere to the sides of the dish. The cleansing action would be similar to that brought about with mercury when poured through a paper cone with a fine orifice at the bottom. They recommend that ingots should be cast wide-end up, and that the smallest size consistent with requirements should be used. They recommend further a high-ladle, but a low-casting, temperature, since this is found to be advantageous in cleansing the metal. The macrostructure of the ingot is determined by the temperature and method of casting. High-casting temperatures are to be avoided because they give rise to excessive segregation, ghost lines, etc., and coarse crystallisation.

The authors advise that, after casting, the ingot should not be allowed to cool more than is unavoidable, but should be solid forged as soon as possible. This breaks up the crystals, thus refining them. It also assists in the diffusion of the carbon and thus renders the mass more homogeneous. The effect is to produce a much stronger material the thermal treatment of which can be undertaken with greater safety. In carrying this out with large forgings, very slow heating up to the temperature range, 730–760° C., must be adopted. Above this the rate of heating may be quicker. The authors suggest further that they have obtained evidence that mechanical work can be overdone, and that the greater the amount the more prone is the tendency to a laminated fracture. A somewhat similar point was made by M. Charpy in a recent paper published on "The Hot Deformation of Iron and Steel." With regard to the final heat treatment the authors say that the temperature of oil-hardening appears to make little or no difference to the mechanical properties; *the* important factor is the time at the temperature in question. This should be as short as possible, since a prolonged heating even at 850° C. coarsens the grain-size and causes a deterioration in properties.

The paper by Mr. Greaves deals with the "temper brittleness" of a nickel-chromium steel containing 3·5 per cent. of nickel, 0·6 per cent. of chromium, 0·5 per cent. of manganese, and 0·25 per cent. of carbon. This term is applied to the condition induced in such a steel by slow cooling from the tempering temperature, and is revealed by a low absorption of energy in the single-blow impact test on notched bars. The author has found that wide differences in the impact figure with almost identical tensile test results can be produced by suitable heat treatment. He has also found that whereas, after hardening, every tempering treatment involving a final rapid cooling from 600° C. or above produced good impact figures, a final slow cooling produced a considerably lower, and often a bad, impact figure; further, that in any given steel the degree of brittleness which can be produced by a given condition of tempering depends on the original hardening temperature. The higher this is, the lower is the impact figure. He has also found that reheating to about 520° C. produces brittleness, whatever the subsequent rate of cooling, and that this can be removed by reheating to between 600° C. and 670° C. and cooling rapidly.

These results can be explained on the assumption that a critical temperature or temperature range exists in the neighbourhood of 550° C., above which the tough, and below which the brittle, condition is stable. Quick cooling through this temperature retards this change, and the unstable tough condition is retained. Slow cooling results in the production of the stable brittle condition. If the tough material is heated to a temperature rather below the change point, the rate of change to the brittle condition is at a maximum, and brittleness results. The rate diminishes rapidly with fall of the temperature, and below 450° is negligible. Provided, therefore, the critical temperature is not exceeded, the rate of cooling after this reheating is immaterial. Mr. Greaves does not show any cooling or heating curves of his steel. Those published by Messrs. Andrew, Greenwood, and Green on a steel of approximately the same composition indicate that the carbon-change point on cooling occurs between about 490° and 465° C. The character of the curve obtained depends upon the initial temperature from which the steel is cooled.

H. C. H. C.

CEPHALODISCUS AND THE ARCHICHORDATES.[1]

THE history of Cephalodiscus, dredged at 245 fathoms in the Strait of Magellan by the *Challenger*, and at first taken for an Alga, and then for a compound Ascidian, goes back only three dozen years. Moreover, the sole species (*C. dodecalophus*) held the field for twenty-one years before the other species made their appearance; but now, with Dr. Ridewood's memoir before us, the total number of species reaches from twelve to sixteen, though further research may reduce that number. It is noteworthy that whilst the majority group themselves around the South Pole, four occur in the Indian and Pacific Oceans.

In the present memoir Dr. Ridewood, already known as an authority on the subject, keeps to the classification adopted previously, the group Pterobranchia (Aspidophora of Allman) having three subgenera of Cephalodiscus, viz. Demothecia, colony branched, with a continuous cavity throughout the cœnœcium; Idiothecia, colony branched, but each aperture leading into a tube occupied by one zooid and its buds; and Orthothecus, in which the colony is cake- or cone-like, each aperture entering a tube holding a zooid and its buds. The author first treats of the structure of the zooids, the similarity of which throughout the whole series is noteworthy; only in the reduced male zooids of *C. sibogae*, Harmer, is there a divergence. This fact alone would give differences due to variations in the cœnœcium less weight.

Amongst other features of interest are the enlargements at the ends of the tentacles, for instance, in the original species, which the author terms "end-swellings with refractive beads," and it is curious that no special function has been assigned to them. Similar enlargements at the tips of the branchial filaments are prominent features in Filograna and the so-called Salmacina, and great weight has been placed on them specifically, and even generically, by certain observers. In all probability they are sense-organs in both groups, since they are not connected with secretion, nor do they perform the function of opercula in Filograna (a Serpulid), in which form they are present or absent with puzzling indifference, for the plasticity of the species is phenomenal. The changes in the character of the epithelium on the dorsal and neural surfaces of the arms, and on the two surfaces of the post-oral lamellæ, are probably due, as in other forms (*e.g.* the Serpulids), to differences in function. The length of the testis is thought by the author to be a specific character, but that of the ovary is not.

Details are given of a new species, *C. evansi*, a branched form, in which each ostium leads into a tube ending blindly in the middle of the branch. The other three species procured in the expedition were formerly known, viz. *C. nigrescens*, Lankester, *C. densus*, Andersson (which the author considers to be a variety of the next), and *C. hodgsoni*, Ridewood. Thereafter a discussion on the Demothecia occurs, the species being extremely difficult to distinguish either by cœnœcium or zooids, and it is possible that future observers may reduce the number of species, since the variations of both cœnœcium and zooids in a single species are considerable.

No new feature is given in connection with reproduction and development further than that the author thinks there is no certain relation between the number of arms and the sex, as Andersson did, and that in *C. hodgsoni* the short stalk of the egg spreads over the egg-shell. Males, females, and hermaphrodites are found in *C. hodgsoni*, *C. aequatus*, *C. nigrescens*, *C. solidus*, and *C. densus*, whilst no males have yet been found in *C. dodecalophus*, *C. levinseni*, and *C. gracilis*. In *C. sibogae* and *C. agglutinans* only males are known, and in *C. gilchristi* and *C. evansi* both sexes frequent the same colony.

The author makes no allusion to the systematic position of Cephalodiscus in zoological classification, or to the homologies of the organs which have received the attention of many zoologists in connection with that classification. Dr. Masterman's Archichordata (Trimetamera), therefore, stands as before, with its two classes (1) Hemichordata (*e.g.* Balanoglossus) and (2) Diplochordata (*e.g.* Phoronis, Cephalodiscus, and Rhabdopleura), though not without dubiety in certain aspects, which even the labours of Spengel, Weldon, Cori, Fowler, De Selys-Longchamps, Lankester, Harmer, Gilchrist, Ridewood, Schepotieff, Davidoff, Hill, Gravier, Pixell, and Roule have not quite elucidated. Much of the dubiety is connected with the notochord and the gill-slits. Dr. Harmer thought that the proboscis-vesicle and "heart," with the notochord, essentially agreed with the condition in Balanoglossus, as described by Mr. Bateson; but Dr. Masterman, keenly working at Actinotrocha, Tornaria, Phoronis, and the young forms of Cephalodiscus, held that the primitive types had a double notochord, and his beautiful and accurate drawings speak for themselves whatever interpretation may be put

[1] "British Antarctic (*Terra Nova*) Expedition, 1910. Cephalodiscus. By Dr. W. G. Ridewood. With 12 text-figures, 5 plates, and a map (Published by the Trustees of the British Museum (Natural History), 1918.) Price 12*s*.

on them. Dr. Harmer's notochord, proboscis-vesicle, and heart are Dr. Masterman's subneural gland, subneural sinus, and preoral sac respectively, and Masterman has demonstrated that the subneural gland of Cephalodiscus and the "Eicheldarm" of Balanoglossus occupy entirely different relationships from the surrounding organs in each case, and therefore cannot be homologous. In both Balanoglossus and Actinotrocha there is a large subneural sinus. The presence of pleurochords in Cephalodiscus, of lateral grooves in Tornaria, and of pharyngeal pleurochords in Rhabdopleura, terminating (as in Tornaria) in oral grooves, which Morgan has shown grow outward into serial pouches, are points of interest in connection with Dr. Masterman's view. Besides, in Balanoglossus there are other chordoid parts in addition to the notochord of Bateson and Harmer. Larval Enteropneusta, again, have a pharynx with simple, paired pleurochords terminating in lateral grooves. It has to be borne in mind that Davidoff describes the notochords and nervous system in certain Tunicates as arising from paired rudiments, and the same observation has been made by Brooks in Salpa. In any case, as Masterman shows, Roule's view that Actinotrocha is a trochophore cannot be held, since the cavity of the latter is a hæmocele, whereas the hæmocele of Actinotrocha is restricted to a small space between the cœlomic sacs. The whole subject is a complex one, yet it may be that further research will weld these diverse views into harmony. Meanwhile, Masterman's opinions have much in their favour.

The memoir concludes with a useful synopsis of the species of Cephalodiscus, and the five plates are excellently drawn and lithographed, the map at the end showing at a glance the distribution of the various species, the whole forming a worthy tribute to the methodical and patient industry of the author, who, along with Dr. Harmer, of the same great museum, has done so much to extend our knowledge of this very remarkable group.

W. C. M.

THE ITHACA AGRICULTURAL EXPERIMENTAL STATION.[1]

AGRICULTURAL experts visiting the United States always include the Ithaca Experimental Station in their programme if they can possibly manage to do so, for it is one of the finest and largest in that country of large institutions. Incidentally also, it appeals to all who read and loved Fenimore Cooper in their younger days, for it is situated in the lake country, and still preserves some of the waterfalls and woods associated with his heroic, if somewhat mythical, warriors.

The reports before us are bulky volumes, each of a thousand or twelve hundred pages; they are in keeping in point of size with the whole institution. The list of the staff occupies four closely printed pages, and includes nearly two hundred names. The number of printed copies of bulletins, reports, etc., sent out during one year only was 3,014,000. The State grant was 450,000 dollars in 1913; it rose during the war to 779,401 dollars for the year 1917–18. An Englishman reading these figures, and realising how greatly the income of this one institution exceeds that of all English agricultural colleges and experimental stations put together, begins to gasp when he finds the acting Dean declaring:—"The greatest single need of the college at the present time is more funds for research"; and again, "In common with other colleges in the University, the College of Agriculture is suffering because of the inadequate salaries which members of the staff are receiving."

The investigations cover the whole field of agriculture, but as no summaries are given it is not easy to find one's way through them.

A large number of the bulletins deal with diseases and pests of farm and garden crops, devoting special attention to practical methods of coping with them. In this type of work the American investigator excels; we have scarcely begun to make provision for field-work in plant pathology in Great Britain, although a promising start has been made with the more fundamental investigations. An extended series of observations on the nodule organism (*Bacillus radicicola*) of soybean is given in Bull. 386; the general result is that nodule formation can be considerably checked or stimulated by the presence or absence of certain salts and by variations in the amount of soil-moisture. Chlorides, phosphates, calcium salts, and certain organic compounds such as sugars, starch, oxalic, lactic, and citric acids, increase the amount of nodule formation; increases in moisture-content had a notable effect also. On the other hand, nitrates, ammonia compounds, and sulphates reduce it, though they do not kill the organism.

The direct assimilation of certain carbohydrates by green plants is discussed in Memoir 9 (1916). Saccharose, glucose, maltose, and fructose are directly absorbed and utilised by plants (green maize, Canada field pea, timothy, radish, vetch, etc.); moreover, they produce a characteristic branched-root system. It is suggested that the absorbed sugar is largely utilised in the root itself, but little migrating to the stems and leaves; this diminishes the downward migration of the sugar produced by photosynthesis and leads to increased top growth. Certain plants, such as radishes, vetch, and Canada field pea, are able to utilise lactose, although this sugar has not been found in the vegetable kingdom. Curiously enough, however, galactose is toxic to green plants, although it is utilised by various fungi. The bearing of the results on the old question of the source of carbon for plants is obvious, and the author concludes, as Laurent did in 1904, that the organic matter of soil plays a direct part in the nutrition of green plants, and in certain circumstances, notably in glass-house work, this part may be very important.

The soil surveys of Oneida County (Bull. 362) and of Orange County (Bull. 351) are typical of this kind of work as done in America. They form interesting reading, and would be helpful to a young man wishing to settle on the land but uncertain to which part of the country to turn.

Costs of production of farm crops form the subject of an important investigation (Bull. 377, 1916). In 1912 and 1913 the average costs of producing oats per acre in New York State were respectively 23·51 dollars and 22·34 dollars per acre, *i.e.* 4*l.* 18*s.* and 4*l.* 13*s.* respectively. It is interesting to compare these figures with the Rothamsted data, where the cost in 1913 was 6*l.* 4*s.* per acre. In both cases one of the largest single items is labour; in New York State it was 3·60 dollars per acre (15*s.*), at Rothamsted 21*s.* 4*d.* per acre, although the rate of wages paid in New York was double that paid in this country. The New York yield was 33·5 bushels per acre, that at Rothamsted 48 bushels.

Bull. 338 contains an interesting study of fertile and infertile soil otherwise similar in character; it was found that the former more readily accumulated nitrates than the latter. The most obvious cause was the difference in compactness of the soil, the fertile being less compact and having a smaller volume-weight than the less fertile one. An extensive bacteriological

[1] Reports of the Agricultural Experimental Station, Ithaca, New York, for the Years 1914–17.

examination was made by H. J. Conn, but it led to no result, indicating the weakness of present-day methods. The bacterial numbers fluctuated with the moisture-content, as at other centres. Some interesting soil-moisture relationships are brought to light in Bull. 352 (1914).

E. J. RUSSELL.

THE RAINFALL OF THE UNITED STATES.

PROF. ROBERT DE C. WARD, of Harvard University, contributes an article on "Some Characteristics of the Rainfall of the United States" to the *Scientific Monthly* for September. The article is essentially of a popular character, but it is dealt with in a strictly scientific manner, and references to the several works from which the information is selected are given throughout, so that a closer and more minute study can be made where thought desirable. Many of the characteristics dealt with are among the most important, and certainly the most interesting, associated with rainfall. There is an endeavour to explain the cause of the special characteristics, a feature in many discussions of the present day. It has often been said in the past, with respect to meteorology, that there are bricks enough, but that we now require builders. Those who have been familiar with meteorology for the last half-century note with satisfaction its practical development.

Referring to the annual and monthly rainfall, Prof. Ward associates the varying amounts with the tracks of cyclones and the general pressure distribution which constitute the rain-producing conditions. The ratio of wettest and driest years to the mean fall is given for the United States generally. Where the annual rainfall ranges from 5 in. to 30 in. the fall in the wettest years may be expected to amount to about 180 per cent. of the average, whilst in the driest years the total is not likely to be less than about 55 per cent. of the average. Years with precipitation above the mean are less frequent than years with precipitation below the mean. It is emphasised that it is always instructive to investigate the weather-map conditions in all cases of unusually wet or dry periods, and to follow especially the tracks of low-pressure systems.

Dealing with periods with or without precipitation, the article states that "over most of the country the number of consecutive rainy days has been between 10 and 20. . . . On the north-western coast (Western Oregon), where the rainfall is heavy and the cyclonic activity is marked, more than 30 days in succession (30 to 40) have been rainy. . . ."

It is said that droughts may occur anywhere in the United States, especially where cyclonic controls of precipitation are weak. There is a distinct relation between droughts and forest fires—"a pre-requisite of a forest fire is a drought."

The Government meteorological reports, such as the Annual Report of the Chief of the Weather Bureau and the Monthly Weather Review, give much valuable material with respect to rainfall. As a rough-and-ready classification of excessive rainfalls, mention is made of 10 in. or more in a month; 2·50 in. or more in twenty-four hours; and 1 in. or more in an hour. Referring to secular variation of rainfall, it is pointed out that trustworthy conclusions cannot be drawn, as few observations go back to 1850, and most observations date from later than 1870. A period of observations for twenty-five years, 1887–1911, for all districts of the United States "lends no colour to the theory of a cycle in precipitation," and curves for New England, the Western Gulf, and North Carolina for 1879–1911 "show no approach to uniformity of distribution in time or space." For non-instrumental evidence a study has been made of the "rings" of trees in Arizona and California, "it being assumed that the thickness of the annual layers of tree-growth gives an approximate measure of the annual amount of precipitation. . . . The fact that the 'big trees' have continued to thrive for three thousand years has been taken to indicate a remarkable uniformity of climatic conditions rather than a series of oscillations."

C. H.

RETIREMENT OF SIR OLIVER LODGE.

ON January 1 the City of Birmingham gave expression to its high appreciation of the work of Sir Oliver Lodge as Principal of the University. At a meeting in the Council House, at which the Lord Mayor (Alderman William Cadbury) presided over a representative gathering of the leading citizens, an illuminated address was presented to Sir Oliver and Lady Lodge. The address, which was read by Sir Gilbert Barling (Vice-Chancellor of the University), was as follows:—"To Sir Oliver Lodge, F.R.S., LL.D., and Lady Lodge: On the eve of your departure from Birmingham we desire to express to you our deep sense of loss, our sincere appreciation of your great services, and our warmest wishes for your happiness and well-being in your new home. To you, Sir Oliver, we owe much as a physicist. Your distinction has added lustre to our city. As academic leader you have started our University on its career with lofty ideals. You have done much to form public opinion as to the meaning of true education in all its forms and among all classes, and your ethical teaching has ever been directed towards social amelioration. You may be satisfied that your labours of nearly twenty years have left a deep and lasting mark on the community which you have so long adorned. To both of you we wish good-bye with the deepest regret, and our most kindly feelings accompany you."

Sir Gilbert added that it was the intention of the subscribers to present also more substantial evidence of their kind feelings in the form of a motor-car, and a jewel for Lady Lodge. He reminded his audience of the greatness of the task which Mr. Joseph Chamberlain had set before the first Principal of the University, and he bore eloquent testimony to the admirable way in which Sir Oliver had realised the ideals of that statesman and justified his choice.

Sir Oliver Lodge in his reply emphasised the debt which the city owed to those public-spirited men who had gone before. He hoped the city had become proud of the University which it had brought into being. It took a little time always to know what an institution was worth, but the University was the crown of the city. He referred to the difficulties under which the University had laboured through lack of funds, but he believed that a better day was dawning. The State and the city were co-operating to a greater extent than before. One of the first uses he proposed to make of his freedom was to visit America. He had often been asked to go, but had never before been free to do so.

THE CHIPPAWA-QUEENSTON HYDRO-ELECTRIC DEVELOPMENT SCHEME.

AMONG the whole of the world's sources of water-power the Niagara Falls stand in a position of unique importance. Not only is the gross capacity of 5,000,000 h.p. a magnificent industrial asset of unrivalled proportions, but the actual development of the Falls at the present time has enabled the Hydro-Electric Power Commission of Ontario to create the largest system of electric transmission in the world. There are altogether ten plants belonging to the commission in various parts of the province, aggregating 248,000 h.p., and supplying nearly 200 municipalities, to which Niagara contributes the supply for 118. The transmission lines comprise 455 miles of 110,000 voltage, double circuit, and 2100 miles of low tension. Such has been the achievement of the commission up to the end of last year.

There is now in hand a most important extension of this remarkable system. The Chippawa-Queenston project, as it is designated, will within a few years' time increase the serviceable capacity by from 200,000 h.p. to 300,000 h.p., and, ultimately, by 1,000,000 h.p. The first instalment of the work is expected to be ready by the spring of 1921, at an estimated cost of 5,000,000*l*. We gather the following interesting particulars of the project from a recent series of articles in the *Engineer*:—

Instead of the relatively small head (between 135 ft. and 165 ft.) of the actual Falls, it is proposed to utilise nearly the full difference in level, amounting to 330 ft., between the surfaces of Lakes Erie and Ontario. In order to effect this, a canal nine miles in length will be excavated so as to connect the Welland River with the Niagara River at Queenston, and the Welland River itself will be widened and deepened for $4\frac{1}{2}$ miles from its mouth. The channel thus formed will deliver water to a power-house below the Falls under a head of 305 ft., which will enable 30 h.p. to be developed for each cusec of flow instead of the 14 h.p. per cusec which is all that is available from the existing installation. The mean velocity of flow will be 2 ft. per sec. in the Welland River and 6 ft. to 7 ft. per sec. in the canal, resulting in a discharge of 10,000 cusecs at low-water level.

The canal route lies mainly in the solid rock of the Niagara Limestone formation, with the remainder ($1\frac{1}{2}$ miles) in earth and loose material. In rock the cross-section will be rectangular, 48 ft. in width; in earth it will be prismatic, with a bottom width of 70 ft. and side-slopes of 1 in $1\frac{3}{8}$, pitched with stone facing.

At the delivery end of the canal a forebay will be formed in solid rock 1000 ft. long, widening to 300 ft. at the extremity. Penstocks of riveted steel plates, 14 ft. in diameter and about 450 ft. in length, will extend down to the power-house at the foot of the river-bank.

The initial generating plant will consist of 4 to 6 units of 50,000 h.p. each. On each turbine-shaft there will be a 3-phase, 25-cycle, 12,000-volt internal revolving field generator of 43,900 kilovolt-amperes at a power factor of 85 per cent.

BRYSSON CUNNINGHAM.

THE ORGANISATION OF CHEMICAL INDUSTRIES.

AT the meeting of the London Section of the Society of Chemical Industry, held at Burlington House on Monday, January 5, two interesting papers were read by Mr. E. V. Evans and Dr. G. S. Walpole on the present position of the chemical industry of Germany. The authors of these papers were deputed to visit a number of important chemical factories in the Rhine Valley in the early part of last year. They are well-known chemists with considerable experience of chemical plant on a large scale. The information which they were able to disclose was valuable and suggestive. Mr. Evans and Dr. Walpole described the German chemical factories as being maintained in a state of perfection, but paralysed at the moment through lack of labour and raw materials. They contrasted the huge and well-staffed factories in Germany with the smaller equipments in this country, and dealt in particular with the manufacture of dyestuffs and intermediate products which has been developed in this country since the outbreak of war.

During the war the demand of the country for raw materials for war purposes was so great as to make it impossible to organise this new industry on a scale adequate to compete with the German chemical industry. The authors of the papers were satisfied that the ability and knowledge of British chemists were at least equal to those of their German competitors, but they directed attention to the fact that it was not possible in the long run for a number of firms in this country, each producing a limited number of products in comparatively small quantities, to compete successfully with the huge German factories, all amalgamated into one organisation and capable of turning out in a relatively small number of places the huge quantities of dyes required by the world.

To enable this country to retain the trade in dyestuffs and intermediates which were now being manufactured here, and to enable it to do a certain amount of export trade in these commodities, there must be an organisation comparable with that of Germany, and time would be required to build up such an organisation. Meanwhile, some protection against the importation of German dyestuffs and intermediate products was necessary, and the trade could not flourish until some of the existing Government restrictions were removed.

The action of the Government in licensing the importations of German dyestuffs was a useful measure and had been of great value. It is to be hoped that these important papers will stimulate the chemical trade of this country and the Government Departments concerned to study the better organisation of chemical industries here and to put forward some carefully considered scheme.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE break in the continuity of sectional proceedings due to war conditions had, to a great extent, prevented those interested in geology throughout the country from keeping in touch with one another, and full advantage was taken of the opportunity for reunion offered by the Bournemouth meeting. Although arranged at short notice, the standard of former years was well maintained in the communications presented, and every moment of the week was full of interest.

The district has long been famous for its geological features, and consequently much interest has been taken locally in this branch of science. As a result, the papers by Dr. W. T. Ord on the Tertiary rocks of the Hampshire basin and the erosion of Bournemouth Bay, coupled with Mr. H. Bury's contribution on the history of the Chines, gave rise to considerable discussion. Important records of the rate of marine erosion at the present time and in recent years were contributed by many of those taking part in the discussion, and the Borough Engineer's measurements taken a short time ago were confirmed by collateral evidence.

Mr. Reginald Smith's paper on the Post-Tertiary geology of the area round Bournemouth, with special reference to the worked flints collected from many of the beds, was introductory to a joint discussion with Section H, and produced a very animated controversy. An admirable exhibit of such flint implements was arranged specially for this meeting by Mr. Scott, and added point to many of the remarks.

A second joint meeting, namely, with Section D

(Zoology), on subjects of less local interest, stimulated the most important discussions held during the proceedings of the Section. Mr. C. Tate Regan initiated one of these on the past history of continents as indicated by the distribution of fresh-water fishes; and Mr. D. M. S. Watson, a second, on palæontology and the evolution theory. Mr. Watson submitted that the data of palæontology cannot suggest the mechanism of evolution in the way that experimental biology and genetics can, but any evolutionary scheme must be consistent with these palæontological facts. The fossil record shows that intermediate groups rarely occur between two types; that innovations in any form, once initiated, tend to persist; and that innovations only arise from the more primitive members of a stock, *i.e.* from those which have retained their evolutionary plasticity.

The suggestion offered from the palæontological argument is that evolution is due to the operation of a variety of non-correlated factors, and that the initiation of a great group may be brought about by a set of nearly contemporaneous saltations.

Most of the speakers who followed commented on conditions seen in the groups they were specially interested in, and cases of convergence, divergence, homoplasy, rejuvenation, and extinction were instanced from the biological and palæontological records, all of which had to be taken into consideration in formulating any scheme of evolution. As showing the difficulties to be overcome, the case of the great auk was mentioned. Here a well-known bird had become extinct, yet no reason could be assigned save by postulating that a racial senility had set in, with a consequent loss of plasticity. The difficulties confronting the explanation of extinction in former ages were correspondingly greater in that we could not know accurately the conditions prevailing at those times.

The consensus of opinion was, however, that a restatement of the palæontological record in the light of present biological experimental results had become necessary, and the hope was expressed that this discussion might stimulate some such work.

Two exceedingly valuable contributions on aspects of geological research in our Colonies were presented by Dr. Miller on the pre-Cambrian rocks of Central Canada, and by Mr. A. E. Kitson on the discovery of diamonds in the Gold Coast. The former paper records a reasoned attempt to place the correlation of the pre-Cambrian rocks of Canada on a sound basis. This is very important in view of the fact that many minerals of economic value are associated with that series. The author directed attention to certain points where he had altered former correlations of these rocks, and especially to the discarding of the term "Huronian." The reason justifying the changed nomenclature is that Logan's name "Huronian" included two series of rocks, and later writers have applied it sometimes to one set and sometimes to the other, thus leading to confusion. New names have, therefore, been adopted for each set.

Mr. Kitson's discovery of diamonds in the Gold Coast was made so recently that no estimate can be made of its ultimate importance. Unfortunately, the paper was read at the end of the sectional proceedings, and there was not sufficient opportunity for discussion of the many interesting points raised. The whole question of the conditions of production of diamond in Nature is again opened up by the fact that no important basic igneous rocks, like the kimberlite of South Africa, occur in the whole surveyed area of the Gold Coast. The specimens so far obtained were exhibited, and all were small, but exploitation of the diamantiferous gravels may lead to the discovery of larger and more valuable specimens.

Other interesting communications on British geology were presented by Prof. S. H. Reynolds on the Lower Carboniferous rocks of the Avon section, Clifton; by Dr. Evans on the correlation of the marine Devonian rocks of North Devon and Somerset; and by Prof. Kendall and Dr. Gilligan on types of faults in the Coal Measures.

Two important papers have been left for consideration until the end, though they were read at an early part of the proceedings. In such an interesting district from a geological point of view it was felt that the Sectional Excursions ought to bulk largely, and consequently the general arrangement of the programme was correlated with the excursions to be held during the meeting. The first day's programme, therefore, included a description of the Tertiary rocks of the Hampshire basin by Dr. W. T. Ord, and was followed by an excursion under his leadership to the Bournemouth cliffs, where the Lower Tertiary rocks were examined. This examination was continued, three days afterwards, by a visit to Barton and Hordle led by Mr. H. W. Monckton, when the Upper Eocene beds, long famous for their marine fossils, were searched by many of the party with considerable success.

The lecture by Sir Aubrey Strahan on the geology of the Mesozoic rocks of the Bournemouth area was introductory to visits to Swanage, Lulworth, and Kimmeridge, the first two led by the author and the last by Dr. J. W. Evans. On these various excursions the structures which dominate the whole trend of the southern coastline were demonstrated, as was the manner in which the effect of these structures had been modified by subsequent denudation. Several of the curious natural phenomena, such as Lulworth Cove, Stair Cove, Durdle Door, etc., familiar to most geological students through the activity of the Committee for the Collection of Geological Photographs, were fully explained in the field.

The classic section at Kimmeridge was visited on the day following the official termination of the meeting, but, none the less, a large party was led by Dr. Evans along a most interesting coast section.

ECONOMICS AT THE BRITISH ASSOCIATION.

At the meeting of the British Association held in Bournemouth last September, Sir Hugh Bell presided over Section F (Economics), and in his presidential address emphasised the need for increased production, holding that by thus serving the common weal each one would at the same time be serving his own best interests.

In the discussion of problems of labour and capital a paper was read by the Right Hon. F. Huth Jackson on "The National Alliance of Employers and Employed." Comparison was made between the objects of the alliance and those of the Whitley Committees. While the latter stood for improvement in the commercial and working conditions in single industries, the former was also intended to bring together the employers and employed in all industries in a particular area with the object of improving not only the industrial, but also the housing, educational, and recreational conditions of the district.

Problems arising out of the war conditions were dealt with from three sides. The Hon. Sir Charles G. Wade approached the question of prices from the side of Government control, making special reference to the experience of Australia. The degree of success attained by the method of price-fixing during the war must not, he held, be taken as a guide for peace conditions. Apart from complete State control of industry, the effect of price-fixing had always been, and inevitably would be, the creation of a scarcity of the article the price of which was fixed; and moreover, the regulation of the price of any one commodity would necessitate the application of similar control to every link in the chain of production of that article. The only way to maintain an adequate supply of capital and sufficient production under a system of fixed prices was to institute complete State control of all production and distribution, but this was impracticable. His remedy, therefore, was, while refraining from any control of prices, to apply publicity to costs and profits by means of profiteering tribunals.

Dr. J. C. Stamp was also on the track of the profiteer, but rather with the aim of making up the deficit in the national revenue. For this purpose he believed a substantial increase in the income- and super-taxes would result either in a hindrance to the accumulation of capital or in a great addition to working-class burdens, and was therefore inadvisable. Nor did he argue for the levy on capital, which would fail, he believed, to bring about distributive justice. His solution of the problem lay in the taxation of the profits of all businesses in excess, not of their own pre-war profits, but of a normal rate of interest on capital. He believed that in this way it would be possible to reach those businesses which, through good fortune, received abnormal profits, and therefore had a high capacity for bearing taxation without ill-effects to the community.

The elimination of the gold standard during the war destroyed the system under which gold and credit were interchangeable, and wrecked the stability of the system of debts based on the gold unit. The gold standard, Mr. R. G. Hawtrey maintained, must be restored, but this must be done with judgment. The business community was hostile to deflation through fear of contraction of trade; the sudden re-introduction of the gold unit and the reduction of the value of paper below its face value involved an increase in the burden of debts, which would bring serious difficulties; and the reduction of the gold value of the monetary unit below its former nominal value was open to the imputation that public faith had been broken. His argument was that to make possible an unvarying gold currency unit, without which the stability of debts was impossible, it was necessary that the demand for gold currency should be kept as steady as possible. For this purpose, international co-operation was required, with the object of stabilising the general level of prices as measured by index numbers, and of regulating the actual amount of note issue in each country. Such international co-operation need not be universal; the inclusion of the financially strong countries would be sufficient; and this could be begun so soon as the Anglo-American exchange could be brought to par.

ENGINEERING AT THE BRITISH ASSOCIATION.

At none of the meetings of the British Association in recent years have such large numbers been attracted to the Engineering Section as at Bournemouth during the meeting in September last. Not only was the hall in which the meetings were held uncomfortably crowded almost throughout the whole of the proceedings, but on the last day many members were unable to gain admission. This was probably due to the fact that many of the papers were of a popular and descriptive nature, and dealt with matters of great interest in connection with the war. The authors in all cases were leading authorities who had been mainly responsible for the development of the special branches with which their papers dealt. The British Association, being for the purpose of the advancement of science among the general public, should encourage this type of paper rather than the highly specialised technical type which is better suited for the various learned and technical societies.

Prof. Petavel's presidential address was followed by the report of the Committee on Complex Stress. This report embodied six important papers by members of the committee, viz. the strength of tubular struts; stresses in aeroplane wing frameworks; the soap-film method of stress estimation; eccentric loading; effect of low-frequency alternations of tensile strength; and the strain energy function and the elastic limit. A summary of the work was given by Prof. Coker and Dr. Haigh.

Of the three papers read on the Wednesday, the first was "An Account of the British Tanks Used in the War" by Sir E. H. Tennyson-d'Eyncourt, the Director of Naval Construction, who traced the history of these devices from the war chariots of the ancients, through the one horse-power one-man "tank" of the Battle of Hastings, viz. the knight in armour, down to the highly developed vehicle which proved such a valuable ally to our infantry during the great war. The author dealt frankly with the thorny questions concerning the development of the Tanks from the time that they were first proposed to Mr. Churchill until they appeared on the Somme in September, 1916. The various types were explained and the reasons given for the successive modifications.

Prof. Inglis read a paper on portable military bridges, describing in detail the type of bridge with which his name is associated, and which proved so valuable in the final advance of our armies on the Western front. In connection with this paper a demonstration was given at the Christchurch bridging centre on the same Wednesday afternoon, when Inglis bridges of various types were constructed and used to convey Tanks across the river. The final paper on that day was by Mr. R. J. Walker, entitled "The Development of Geared Turbines for the Propulsion of Ships," in which the great advantages obtained by the substitution of turbines for reciprocating engines were clearly shown.

Thursday morning (September 11) was devoted to aeronautics, and opened with a paper on airships by Wing-Comdr. Cave-Browne-Cave, who discussed the questions of rigid and non-rigid types, fabric materials, gases, fire risk, etc. Mr. Bairstow, of the National Physical Laboratory, traced the progress of the scientific development of aviation during the war, and explained the various instruments devised for the investigation of the stresses on the aeroplane structure during various evolutions, and also of the inherent stability of aeroplanes when uncontrolled by the pilot. It would appear that although the factor of safety is ample for normal flight, it is reduced to a very small margin by unskilful handling in the air, and no aeroplane has yet been devised which could not be crumpled in the air by suitable mishandling. Col. Tizard dealt with the problem of the reduction of engine performance at a great height to a standard pressure, density, and temperature; at present this reduction involves a great deal of uncertainty. Prof. Bryan gave a summary of investigations which he has carried out on the sound emitted by air-screws when running with tip speeds exceeding the velocity of sound. Under such conditions the sounds emitted at various parts of the revolution reach the ear simultaneously and give rise to unpleasant sensations. Capt. Rolleston West read an interesting paper on the application of air-brakes to aeroplanes so as to enable them to make steep landings and short runs when alighting in a restricted space.

The morning of Friday (September 12) was devoted to electrical papers, and opened with a paper by Capt. J. Robinson on directive wireless telegraphy as applied to aircraft, in which, after explaining the principles involved, he described the various improvements developed mainly by himself during the war. This will undoubtedly find an extensive application, not only for aerial, but also for marine navigation. Prof. Fortescue explained the application of the three-electrode thermionic valve as a generator of high-frequency alternating current, and described, with the aid of numerous lantern-slides, the various arrangements adopted by the Navy embodying this device for the purposes of radio-telegraphy and telephony. Dr. Eccles followed with two papers describing special arrangements of three electrode valves, one being an improvement on the ordinary method of connection as explained in the previous paper, and the other a relay device whereby a snap of the finger and thumb several feet from a telephone receiver is caused to upset the stability of the device and operate a relay. A paper on the ignition of gases by hot wires was read by Dr. Thornton, who reported briefly on some unexpected results obtained, and indicated the lines along which the probable explanation might be found.

The final day opened with a paper by Comdr. Gwynne on submarine mining; our pre-war mining policy was referred to and compared with that of other countries, as was also our position at the outbreak of war. The author discussed the development of the various types of mines during the war in so far as was permissible. This was very aptly followed by a paper on the paravane or otter, which was devised by Comdr. Burney, and proved a very effective weapon against both mines and submarines. Mr. R. F. McKay, the author of the paper, also showed a number of kinematograph films illustrating the various stages in their manufacture and application. Prof. Thornton read a very interesting and suggestive paper on the relation between the thermal conductivity and the velocity of sound in insulating materials. The meetings concluded with a short note by Prof. Bryan on the improvement of the efficiency of radiators in the heating of rooms.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

IN Section H (Anthropology), which met under the presidency of Prof. Arthur Keith, communications were fewer in number than usual, as one afternoon's session was given up to an excursion to the museum at Dorchester. In quality, however, they were quite up to the average. The meetings were well attended, and, as a rule, a high level of discussion was maintained.

Several papers dealt with physical anthropology and questions relating to racial distribution. Prof. F. G. Parsons, in his paper on "Racial Characters of the Modern Briton," raised the question of the relative value and practicability in use of the various methods of estimating race. In discussing the value of the cranial index he insisted on the contrast between the typical German population and that of the British Isles; the modern Briton had, on the average, the lowest cranial index in Europe, while a methodical examination of German prisoners of war had revealed that the Germans, even in Schleswig-Holstein, were round-headed. The Germans, in association with their Pan-Germanic views, had refused to collect or publish the evidence which showed the facts.

Prof. H. J. Fleure, in a comparison of an ancient and a surviving type of man, recorded the survival in remote parts of Wales of a primitive type which, in common with those found in similar "nests" in Europe and North Africa, resembled in many ways pre-Neolithic types such as that of Combe Capelle. This type, it was suggested, may have contributed to a considerable degree towards the evolution of the Mediterranean and the Nordic types. Mr. L. H. Dudley Buxton submitted the results of measurements, both of the living and of ancient skulls, made in Cyprus. Both series of measurements showed a common differentiation into two distinct types.

An important communication on the Finnic problem by Mr. H. Peake dealt with the origin and relation of the Nordic and Mongoloid elements in the Finnic population in the light of a fresh examination of the archæological evidence. The first wave of these Mongoloid people would appear to have arrived in the Baltic region on the retreat of the Ice Sheet; towards the close of the Neolithic age they were driven northward by the arrival of the Nordic people in Scania and West Gothland. In the middle of the Bronze age further Mongoloid peoples were occupying the margins of the Finnish lakes. The present Nordic element in the population was traceable to an immigration of Nordic people from Sweden which took place about A.D. 1000.

Miss M. A. Czaplicka discussed the relation of history and ethnology with special reference to North Central Asia. The present classification for Eastern Europe and North and Central Asia was historical rather than ethnological, and an uncritical adoption of the history of the Jinghis Khan period had led to the use of such terms as "Mongolic type," although such an original type did not exist in the sense in which there was a "Tungusic" or a "Turkic" type.

In prehistoric archæology a communication by Dr. R. R. Marett described recent excavations in Jersey on the site of La Cotte de St. Brelade, and also in a recently discovered cave on the north coast of the island. In the latter, shells of various species, including *Astralium rugosum*, which is at present confined to southern waters, and pieces of antler, which Dr. Andrews is disposed to bring into close relation with Pliocene deer from Auvergne, have been found in hard breccia, associated with small stalactites of unique occurrence in the island. A communication from Mr. T. W. M. de Guérin described a sculptured human figure recently discovered on the dolmen of Déhus, Guernsey. There is evidence that the worship of the divinity represented existed for a very long period in the island, extending probably from the Æneolithic until well into the Iron age. In a joint meeting with Section C (Geology) Dr. Reginald Smith opened a discussion on the age of the flint implements of the Bournemouth district.

In Mediterranean archæology Prof. J. L. Myres described excavations on sites in Cyprus in 1913, among them being the necropolis at Lapathos on the north coast, in which a sequence of tombs was obtained covering the "early" and "middle" periods of the Bronze age. The date-marks showed that the "middle" period began not earlier than the twelfth dynasty of Egypt. Mr. Stanley Casson ably summarised the results of discoveries (mostly in Macedonia) made in the Balkans during the war. It is interesting to note that the evidence thus obtained goes to show that the early culture of Macedonia pertains to the north rather than to the south.

A number of papers dealt with primitive religious cults, amongst them being a detailed study of the death ritual of Eddystone Island of the Solomons by Mr. A. M. Hocart, and an examination of the mother-cults of India by Dr. W. Crooke. Mr. Peake's communication on "Santiago: The Evolution of a Patron Saint" dealt with the survival of a menhir cult in the Iberian peninsula and its association and confusion with the cult of St. James.

In a joint meeting with the Psychology sub-section, Prof. Carveth Read read a paper on "Magic and Science," and the Rev. H. J. D. Astley a paper on the relation of primitive art and magic.

Papers of a general ethnographic character were few in number. Mr. F. J. Richards's paper on the Badaga clans of Southern India was a valuable and comprehensive study, which included a detailed account of an interesting and important harvest festival. Mr. E. W. Pearson Chinnery in his paper on "Stonework and Goldfields in New Guinea" described a number of stone objects, including pestles and mortars, which showed that the country was visited at some time, presumably in search of gold, by a stone-using people, differing in many respects from the present inhabitants. In a second paper Mr. Chinnery described the people of the hilly country of the interior, and maintained that there was in these regions an extensive Negrito element similar to the Mafulu described by Williamson.

An afternoon session was devoted to a visit to the Dorchester Museum, where the party was hospitably entertained by the Curator and Mrs. Acland. A visit was also paid to the Maumbury Rings, where the results of the excavations were explained by Mr. C. Prideaux.

REWARDS FOR MEDICAL DISCOVERY.[1]

I. DEFINITIONS.—Medical discovery may here be defined as being: (1) The ascertainment of new facts or theorems bearing on the human body in health, and the nature, prevention, cure, or mitigation of injuries and diseases of human beings. (2) The invention of new methods or instruments for the improvement of sanitary, medical, and surgical practice, or of scientific and pathological work.

II. REASONS FOR REWARDING MEDICAL DISCOVERY.—These are: (1) To encourage medical investigation. (2) To discharge a moral obligation incurred by the public for its use of private effort.

III. VARIOUS POSSIBLE TYPES OF REWARDS.—(1) Titles and honours given by the State, by universities, and by other public bodies. (2) Prizes and medals. (3) Patents. (4) Promotions and appointments. (5) Pecuniary awards by the State.

IV. GENERAL PRINCIPLES OF ASSESSMENT.—It will probably be agreed that in the interests of the public all medical discoveries should, if possible, receive some kind of acknowledgment or recompense. But in view of the very variable conditions, nature, and effects of particular investigations, it will often be difficult to assess the kind of recompense most suitable for each.

In the first place, a distinction should be drawn between *compensation* and *reward*. By compensation is meant an act of justice done for the purpose of reimbursement of losses; by reward, an act of grace in appreciation of services rendered.

The following different cases should next be considered:—

A. Discoveries involving pecuniary or other loss to an investigator, either by direct monetary sacrifice, or by expenditure of time, or by diminution of professional practice, without corresponding pecuniary gains. A great example is that of Edward Jenner, who occupied himself so closely with the investigation of vaccination against smallpox that he lost most of his medical practice, and also considerable sums in expenses. The plea for compensation in such cases is unanswerable; and in 1802 and 1807 Parliament fully acknowledged its obligations under this head by giving Jenner compensation in two sums of 10,000*l.* and 20,000*l.*

B. Discoveries which have increased the professional emoluments of the investigator by enhanced practice or other means. Such are, frequently, improvements in surgical operations or medical treatment, which lead to increased practice. Another case is that of serums, etc., which may have been protected and put on the market. Here compensation cannot be demanded, and pecuniary awards may be generally held to be unnecessary. On the other hand, honours are often, and justly, bestowed upon such work.

C. Discoveries which involve neither gain nor loss to the investigator. This class includes most of the good, and sometimes great, clinical, pathological, and sanitary discoveries achieved in the world. Here also compensation can scarcely be demanded, and honours are already often given; but pecuniary awards should be sometimes bestowed as an act of grace when the value of a discovery to the public (or to a Government) greatly exceeds the emoluments of the investigator; and this principle should hold even in the case of men who were directly paid for undertaking the researches which led to their discoveries, especially when such payment was (as usual) small and the resulting discovery great.

The following particular cases, which sometimes occur, should be specifically noted:—(1) Men who have refused lucrative posts in order to complete their researches. (2) Men who have refused to protect their work for fear of limiting its application. (3) Men who have carried out investigations for Governments for little or no payment on patriotic grounds.

The following considerations must generally be borne in mind:—

(*a*) Honours (which are always much esteemed) are usually given as much (or more) for clinical success as for medical discoveries, though the latter possess a far wider influence and application than do the former.

(*b*) When given for clinical work or for discoveries under class B, honours often confer distinct pecuniary advantages by enhancement of practice, but for discoveries under classes A and C they have no such effect, and cases are on record where they tend to reduce emoluments by unfitting recipients for certain posts.

(*c*) Most people enter the medical profession (at considerable expense) not only from altruistic motives, but also to make a living, and it is usually only at a later period that they take up scientific investigation—either from a sense of duty, or from predilection, or merely because a good opportunity offers. When, therefore, a man finds that his scientific work, however successful and important it may have been, has actually yielded him less emolument than he might have obtained from ordinary clinical work, he feels naturally discouraged, and his experience prevents young men of ability from following his example, and therefore tends to check the prosecution of studies which are of the highest value to humanity.

(*d*) In the public interest, then, this committee begs to insist upon the principles:—(1) That no medical discovery should be allowed to entail financial loss upon him who has made it. (2) That the compensation or reward which he deserves should be assessed

[1] Report presented by the Joint Committee of the British Medical Association and the British Science Guild on Awards for Medical Discovery. The members of the joint committee are:—*Representing the B.M.A.*: Sir T. Clifford Allbutt, K.C.B., F.R.S.; Dr. R. T. Leiper; Prof. Benjamin Moore, F.R.S.; Mr. E. B. Turner; and Prof. J. S. Haldane, F.R.S. *Representing the B.S.G.*: Lt.-Gen. Sir Alfred Keogh, G.C.B.; Col. Sir Ronald Ross, K.C.B., K.C.M.G., F.R.S.; Prof. W. Bayliss, F.R.S.; Dr. D. Sommerville; Sir Richard Gregory; and Lt.-Col. O'Meara, C.M.G.

as being equal to the difference between the emoluments which he has actually received and those which a successful clinician might have received in the same time.

This is obviously the principle which was accepted by Parliament in the case of Jenner in 1802 and 1807.

Additional reasons for insisting upon this principle are :—(1) That few medical discoveries are patentable. (2) That such discoveries seldom give good grounds for promotion or for administrative appointments in the public services.

V. PARTICULAR ASSESSMENTS.—Whether a particular discovery should receive a large or small assessment will depend not only on the considerations given above, but also on the following :—

(1) *Width of Application.*—For example, the work of many of the older anatomists, physiologists, and parasitologists, of Pasteur, and of investigators of immunity has affected most recent discovery. Discoveries on widespread diseases, such as the work of Lister, of Laveran, and of Koch, are often, though not always, more important than those on more limited maladies.

(2) *Difficulty of the Work Done.*—For example, the solution of a difficult problem requires more study and also more time and cost, and therefore deserves more recompense, than a lucky chance observation.

(3) *Immediate Practical Utility.*—A strong plea for State remuneration can be made on behalf of cases of this kind, unless they come under class B. It is strange that at present they never receive it, while academical recognition is also often not forthcoming for them.

(4) *Scientific Importance.*—Discoveries which are not of present practical utility may become so at any moment, and should obviously be included in the scheme if they are sound and of wide application.

Medical discoveries made by persons who do not themselves belong to the medical profession should be included in all schemes of reward.

Of course, each case must be judged on its merits, and the assessment will not always be easy.

VI. STATE AWARDS FOR MEDICAL DISCOVERY.—Honours, prizes, and medals, being bestowed by H.M. the King or by public bodies and learned societies, are acts of grace which are generally given after much consideration, and the committee does not purpose to consider them. But the subject of *pecuniary awards* lies entirely within its province.

During the last few years the British Government has disbursed an annual grant of about 60,000*l.*, under the Medical Research Committee, for subsidising *investigations in progress* authorised by the committee and carried on by workers selected by it. This grant does not remunerate discoveries *already made*, but proceeds upon the principle of payment for benefits *already received*, deserves close attention, and has been recognised in other countries.

We think that both principles are sound, but they apply to two different classes of research, and are, indeed, complementary of each other. Payment for prospective benefits is "good business" only when some return is almost certain; and for this reason subsidised researches must frequently deal with simple and straightforward questions, admitting of immediate experimental reply. But, as a matter of fact, most of the greatest medical discoveries were built upon a much more speculative and uncertain basis, and were achieved by men who neither sought nor received subsidies for those investigations—as, for instance, Küchenmeister, Jenner, Simpson, Lister, Koch, Laveran, Bancroft, Manson, Bruce, Mackenzie, and a score of others who have so greatly improved medical practice. Surely the State should encourage this class of investigation also, partly because it costs the State nothing in so doing, and partly because it seems to achieve the greatest results. And there is only one way to encourage it: by paying for discoveries when made. Payment for benefits received is always not only "good business," but also a moral obligation. There are at present hundreds of medical men and others in this country who possess the knowledge, the brains, and the opportunity for private independent discovery without subsidies, but do not attempt it because medical research work does not pay even when brilliantly successful. Let these men also be brought into the fold of research by offering them reward when they succeed.

We therefore suggest that, in addition to assisting investigations in progress, it is proper for the State to remunerate those of its citizens who have already conferred the benefits of medical discovery upon it, just as it is proper for a patient to pay his doctor. And this policy will be not only an act of justice, but also an act of wisdom.

Our proposals are in detail :—(1) That Parliament should follow the precedent of Jenner by paying *compensation* when due for losses incurred in achieving medical discoveries. (2) That Parliament should provide an annual sum, say of not less than 20,000*l.*, for life-pensions to be given as rewards to such of his Majesty's subjects as have made worthy medical discoveries, such pensions amounting to between 500*l.* and 1000*l.* a year.

Such pensions would be preferable to donations in capital, and the sums suggested would be sufficient, because men of science seek only such independence as will enable them to employ their talents in the manner they think best.

The procedure of allotment should be similar to that used for the Nobel prizes, and for the honours and medals of learned societies—that is, full particulars of the work of all applicants should be kept and considered.

Parliament grants large subsidies to soldiers and sailors, has appointed a Commission to consider awards to inventors, and allows patents. It should not, therefore, complain if, the medical profession, which has done so much for the nation during the war, now asks for some similar consideration.

(This committee is concerned only with medical research, but recognises that similar awards should be given to workers in other fields.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—At the beginning of the coming term Prof. R. H. Yapp will take up his duties as successor to the late Prof. G. S. West in the Mason chair of botany, and Dr. William Cramp will succeed Prof. Gisbert Kapp in the chair of electrical engineering.

LONDON.—The following courses of advanced lectures in physiology are now commencing :—"The Regulation of Respiration" (Guy's Hospital, Borough, S.E.), by Dr. M. S. Pembrey and Mr. J. H. Ryffel, at 4.30 p.m. on Thursdays, January 8, 15, 22, and 29, and February 5, 12, 19, and 26; "The Reaction of the Blood and Acidosis" (St. Bartholomew's Hospital), by Mr. J. W. Trevan, at 4.30 p.m. on Wednesdays, January 28, February 4, 11, 18, and 25, and March 3, 10, and 17; and "Physiologically Balanced Solutions" (Physiological Laboratory of the University, South Kensington, S.W.7), by Mr. W. L. Symes, at 5 p.m. on Tuesdays, January 27, February 3, 10, 17, and 24, and March 2, 9, and 16. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

Other advanced courses to be delivered are:—Six lectures on "The Physical Properties of Soil" (Imperial College of Science and Technology), by Mr. Bernard A. Keen, on Tuesdays at 4.30 p.m., beginning on February 3; and a course on "A General Survey of the Globe and its Atmosphere," with practical work (Meteorological Office, South Kensington), by Sir Napier Shaw, on Fridays at 3 p.m. during the second term, beginning on January 23.

DR. D. W. CARMALT JONES has been appointed to the chair of systematic medicine in the University of Otago, New Zealand.

MISS F. M. G. MICKLETHWAIT has been appointed principal of the Horticultural College, Swanley. Miss Micklethwait holds the diploma of the college, and was a Beit research fellow; she has published a number of papers on her researches upon chemical subjects.

IN connection with the London County Council's lectures for teachers on recent developments in science, a lecture on "Aviation" will be given by Lord Montagu of Beaulieu at King's College, Strand, W.C.2, on Tuesday, January 13, at 6 p.m. The chair will be taken by Major-Gen. Sir Frederick H. Sykes.

THE Civil Service Commissioners announce that an examination will begin on May 4 next for the purpose of filling ten vacancies for assistant examiners in the Patent Office. The examination will be confined in the main to candidates who have served in his Majesty's Forces, and will consist of a qualifying examination followed by interview by a selection board. The subjects of the qualifying examination are English composition, *précis*-writing, general knowledge, and *one* of the following: General chemistry, electricity and magnetism, mechanics and mechanism. The limits of age are twenty to thirty. Initial salary 150*l*. a year, together with a war bonus. Copies of the regulations and forms of application may be obtained by writing to the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. The last day for making application is March 4.

IN a pamphlet on college studies, published by the Stanford University of California, Prof. H. W. Stuart, professor of philosophy in the University, points out that the old discussion on the relative merits of literary and scientific studies in the training of a well-educated man has now become the problem whether citizenship in the modern world can be based on the contemplation, criticism, and enjoyment of life, or whether it requires a capacity for constructive participation in the activities of life in addition. It is remarked that while a literary education supplies a direct acquaintance with the characteristic interests and experiences of life, and a scientific education a knowledge of the means and machinery of life, neither recognises adequately those interests which find expression in the family, amongst friends, in play, or in the responsibilities of citizenship. Culture, in Prof. Stuart's opinion, expresses a personal capacity for conduct, not the body of knowledge of which the person makes use. It must comprise both literary and scientific discipline and study and experience of social science. The evidence of culture in an individual is the proper fulfilment of his functions in the society in which he lives, and each age must have its own standard of culture.

SOCIETIES AND ACADEMIES.

LONDON.

Aristotelian Society, December 15, 1919.—Prof. A. N. Whitehead in the chair.—Dr. G. E. **Moore**: External and internal relations. The most important part of what is meant by those who say that no relations are purely external seems to be the proposition that *every* relational property belongs *necessarily* to every term to which it belongs *in part*. This proposition is false, the truth being that *some* only among relational properties belong necessarily to those terms which possess them. To say that the property P belongs necessarily to the subject S is to say that from the proposition, with regard to any term, A, that it has not got P, it *follows* that A is numerically different from S. And this has been falsely taken to be true of every P and every S, because it is, in fact, true that from the proposition "S is P" it *follows* that any term, A, which has not got P is, *in fact*, other than S. The proposition that if p is true, then the conjunction "q is true and r false" *must* be false, has been compared with the proposition that if p is true, then "q is true and r false" is *necessarily* false in the sense that r *follows* from q. From the proposition "from 'p is true' it *follows* that 'q is true and r false' is false," it does not follow that, if p is true, then r *follows* from q.

Geological Society, December 17, 1919.—Mr. G. W. Lamplugh, president, in the chair.—Prof. S. J. **Shand**: A rift-valley in Western Persia. Asmari Mountain, near the oilfields of Maidan-i-Naftun, in the Bakhtiari country of Western Persia, is an inlier of Oligocene limestone among the beds of the Fars system (Miocene), the latter consisting, in the lower part, of bedded gypsum with intercalated shales and a few thin limestones. The mountain is a whale-back, formed by a simple symmetrical anticline plunging at both ends. The north-western end plunges rather steeply, and shows no abnormal structures; but at the south-eastern end the fold has collapsed along its length for a distance of three miles, letting the gypsum-beds down into a trough in the limestone. This trough is bounded by two main faults hading north-eastwards and south-westwards respectively, with an average hade of 20°, and marked by steep escarpments. The gypsiferous beds which once completely filled the trough have been partly removed by erosion, clearly revealing the fault-walls in the lower part of the valley.

MANCHESTER.

Literary and Philosophical Society, December 16, 1919.—Sir Henry A. Miers, president, in the chair.—C. E. **Stromeyer**: The study of nationalities. Although structural peculiarities are very useful for differentiating non-related species, they are of little use for the purpose of classifying branches of one species, and it is necessary to study their characteristics. There are very marked differences amongst the characteristics of different nationalities, *i.e.* the Semitic and Slavonic races have wonderful memory gifts, and the Scandinavians are pre-eminently inventive. The author dealt with the vague words employed in defining various characteristics and with the reagents which might be employed for revealing fundamental characteristics of different nationalities.—W. J. **Perry**: The historical process. The study of the geographical distribution of peoples in various stages of culture, and of the migrations of peoples, suggests that the degree of civilisation possessed by any community that has advanced beyond the pure hunting stage is the result, direct or indirect, of cultural influences propagated from some original centre. It seems as though the fundamental arts and crafts of civilisation were invented in one place, and that the knowledge of them was carried to the outlying parts of the earth, thus producing the various degrees of culture possessed by different communities. The study of archæological remains supports this contention. If this conclusion be accepted, it becomes possible to regard the study of human society from a point of view different from that commonly adopted. We can examine the effects of various social institutions on behaviour. The hunting tribes, the most primitive men of whom we have direct knowledge, display a uniform type of behaviour: they are peaceful, truthful, monogamous, honest, kind to children and animals, and thus, presumably, represent the normal type of human behaviour. The people above them in culture have adopted the institutions of civilised peoples to varying degrees, and their modes of behaviour appear to correspond to their historical experience. The wide range of culture which exists in the world makes it possible to examine in detail the effects upon human beings of various social institutions, and thus to pave the way for the foundation of a science of society, the ultimate aim of which will be to determine which institutions are fitted to develop men to the greatest possible extent.—Prof. F. E. **Weiss**: Green jade work by natives of New Zealand.

PARIS.

Academy of Sciences, December 8, 1919.—M. Léon Guignard in the chair.—A. **Laveran**: Obituary notice of Prof. R. Lépine, correspondant of the Academy of Sciences.—C. **Moureu**, C. **Dufraisse**, and P. **Robin**: The stabilisation of acrolein. Part 4. Compounds hindering the formation of disacryl.—C. **Richet**: Injections of gum or of plasma after bleeding. A criticism of a recent communication by M. Barthélemy. The animal must have lost more than 70 per cent. of its blood before the injection of solution or plasma, or its survival cannot be regarded as decisive.—V. **Grignard**, G. **Rivat**, and Ed. **Urbain**: Researches on the chlorination of methyl formate and methyl chloroformate. Details of a semi-industrial method for the preparation of the ultimate chlorination product, CCl_3CO_2Cl.—M. Paul Janet was elected a free Academician in succession to the late M. Landouzy.—G. **Valiron**: Regular ensembles of zero measure.—M. **Mesnager**: Elementary solution of the rectangular plate fixed at the edges, carrying a load uniformly distributed or concentrated at its centre.—E. **Belot**: Possible causes of the light curve and the pulsation of Cepheus.—I. **Tarazona**: Observation of the solar eclipse of November 22, 1919, at the astronomical observatory of the University of Valencia, Spain. The first contact was found to be 8·4 seconds earlier than calculated.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the second quarter of 1919. Observations were made on eighty-one days, and the results summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Ed. **Fouché**: Search for a characteristic equation applicable to atmospheric air. The equation is of the Clausius form,

$$\left[p+\frac{\psi}{(v+n)^2}\right](v-b)=RT,$$

in which ψ is a function of the temperature only. The constants n, b, R are determined from experiments by Witkowski, pressures ranging from 1 to 130 atmospheres and temperatures from −145° C. to +100° C.—G. A. **Hemsalech**: The origin of luminous radiations emitted by vapours in an electrical resistance tube furnace. The spectrum results from two independent emissions, one of which is of thermal and the other of electrical origin.—P. **Jolibois**: An apparatus for rapidly mixing homogeneous liquids.—E. **Mesnard**: Cyclonic formations of the atmosphere.—Ph. **Flajolet**: Perturbations of the magnetic declination at the Lyons Observatory (Saint-Genis-Laval) during the first and second quarters of 1919.—L. **Blaringhem**: Floral anomalies observed in hybrid plants from *Linaria vulgaris* × *L. striata*.—P. **Descombes**: The use of trees in extracting water from the atmosphere. Evidence from various sources of the increased deposit of moisture, as dew, caused by trees.—A. **Piédallu**: The *rôle* of iron in the blue *casse* of wines.—Mlle. Lucienne **Dehorne**: Hermaphroditism and scissiparity.—H. **Bierry**: Inanition, temperature, and glycemea.—A. **Richaud**: The action of ouabaine and of strophantine on the salivary secretion, and the mechanism of this action.—A. **Clerc** and C. **Pezzi**: The antagonism of adrenalin and quinine.—C. **Oberthür**: The symbiosis of ants and the caterpillars of Lycæna.—A. **Paillot**: Natural immunity in insects. Study of a case of humoral immunity.—C. **Nicolle**, A. **Cuénod**, and G. **Blanc**: Experimental demonstration of the *rôle* of flies in the propagation of trachoma (granular conjunctivitis).

CAPE TOWN.

Royal Society of South Africa, October 15.—Dr. J. D. F. Gilchrist, president, in the chair.—Sir Thomas **Muir**: Additional note on the resolvability of the minors of a compound determinant.—J. **Moir**: Colour and chemical constitution. Part ix. An empirical law of change of colour. The wave-lengths of the absorption spectra of all the halogen derivatives, and many other derivatives of phenolphthalein and fluorescein, can be calculated from the formula

$$\frac{n}{n_0}=\frac{\lambda_0}{\lambda}=1-0{\cdot}0115m-0{\cdot}000037m\,N,$$

in which n=frequency, λ=wave-length, m=number of halogens, etc., and N=atomic number of halogen in question. All the groups investigated have very similar effects on the colour, a most remarkable fact.—J. S. **Thomson**: South African Alcyonacea.

BOOKS RECEIVED.

Has the North Pole been Discovered? By T. F. Hall. Pp. 539. (Boston, Mass.: R. G. Badger.) 2.50 dollars net.

Glass Manufacture. By Dr. W. Rosenhain. Second edition. Pp. xv+258. (London: Constable and Co., Ltd.) 12*s*. 6*d*. net.

Cours de Chimie à l'usage des Etudiants P.C.N. et S.P.C.N. By Prof. R. de Forcrand. Deux^e. édition. Tome i. Pp. viii+437. Tome ii. Pp. 527. (Paris: Gauthier-Villars et Cie.) 14 francs and 18 francs respectively.

Democracy and the Press. By Dr. F. H. Hayward and B. N. Langdon-Davies. Pp. xii+76. (Manchester and London: The National Labour Press, Ltd.) 1*s*. 6*d*.

The School Geometry: Matriculation Edition. By W. P. Workman and A. G. Cracknell. Pp. xi+348. (London: W. B. Clive.) 4*s*. 6*d*.

Pensées sur la Science la Guerre et sur des Sujets très Variés. By Dr. M. Lecat. Pp. vii+478. (Bruxelles: M. Lamertin.)

Pre-Palæolithic Man. By J. Reid Moir. Pp. 67+29 plates. (Ipswich: W. E. Harrison.) 7*s*. 6*d*.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 8.

ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts), at 3.—Major H. E. Wimperis: How Airmen Find Their Way (Juvenile Lecture).
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound: Sounds of the Sea (Christmas Lectures).
PHYSICAL SOCIETY OF LONDON (at Exhibition of Apparatus, in conjunction with the Optical Society, at the Imperial College of Science), at 4.—Prof. F. J. Cheshire: Some Polarisation Experiments; at 8.—Prof. Rankine: The Use of Light in the Transmission and Reproduction of Speech.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—J. Shepherd: Failures of Turbo-Generators and Suggestions for Improvements.
OPTICAL SOCIETY, at 7.30.
INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—T. Clarkson: Steam Vehicles.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. F. M. R. Walshe: Forms of Peripheral Neuritis among Troops Serving with the Egyptian Expeditionary Force, 1915–1919.

FRIDAY, JANUARY 9.

GEOGRAPHICAL ASSOCIATION (at the London Day Training College), at 2.—Prof. R. N. Rudmose Brown: Spitsbergen.—At 6.—Sir Charles P. Lucas: Islands, Peninsulas, and Empires (Presidential Address).
ROYAL ASTRONOMICAL SOCIETY, at 5.—J. K. Fotheringham: The Longitude of the Moon from 1627 to 1918.—Prof. H. H. Turner: The Suggested Decrease of Period of Stars in Phillips's Group II., with particular notes on R Hydræ, S Tauri, U Herculis, R Aquilæ, χ Cygni, S Cygni, and S Coronæ Borealis.—Dr. J. L. E. Dreyer: The Original Form of the Alfonsine Tables.—C. Davidson and W. V. Woodman: An Equatorial Mounting for Eclipse Observations.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Sir Anthony Bowlby: The Application of War Methods to Civil Practice.
MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.—Dr. S. S. Berry: A New Species of Mitra from California.—Dr. A. E. Boycott: Local Variation in Size of *Clausilia bidentata* and *Ena obscura*.—H. C. Fulton: Molluscan Notes, IV.
PHILOLOGICAL SOCIETY (at University College), at 8.—Dr. W. Perrett: The Perception of Sound.

SATURDAY, JANUARY 10.

GEOGRAPHICAL ASSOCIATION (at Regent Street Polytechnic), at 10.30 a.m.—Capt. C. E. Hodges: Demonstration of the Value of the Cinematograph in Geographical Teaching.
GEOGRAPHICAL ASSOCIATION (at the London Day Training College), at 3.—M. de Carle S. Salter: Rainfall as a Geographic Function.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Bragg: The World of Sound: Sound in War (Christmas Lectures).

MONDAY, JANUARY 12.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Capt. H. Thomas: Geographical Reconnaissance by Aeroplane Photography.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association), at 8.—A. R. Munro: Right-angle Belt Drives.
SURVEYORS' INSTITUTION, at 8.—E. M. Konstam and C. H. J. Clayton: Land Drainage from the Administrative and Engineering Points of View.

TUESDAY, JANUARY 13.

ROYAL HORTICULTURAL SOCIETY (at Vincent Square), at 3.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir John Cadman: Modern Development of the Miner's Safety Lamp.
INSTITUTION OF CIVIL ENGINEERS, at 5.30.—J. Mitchell: Whitby Harbour Improvement.—R. F. Hindmarsh: The Design of Harbours and Breakwaters with a View to the Reduction of Wave-action Within Them.—J. W. Sandeman: Wave-action in Harbour Areas; with Special Reference to Works for Reducing it at Blyth and Whitby Harbours.—W. Simpson: The Improvement of the Entrance to Sunderland Harbour, with Reference to the Reduction of Wave-action.
ROYAL PHOTOGRAPHIC SOCIETY and THE RÖNTGEN SOCIETY (at the Royal Photographic Society), at 7.—Major G. W. C. Kaye and Others: Discussion on Some Aspects of Radiology and Radiometallography.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. A. C. Haddon: The Outrigger of Indonesian Canoes (illustrated by Lantern Slides).

WEDNESDAY, JANUARY 14.

ROYAL SOCIETY OF ARTS, at 3.—L. Pendred: Railways and Engines (Juvenile Lecture).
ROYAL UNITED SERVICE INSTITUTION, at 3.—Major A. Corbett Smith: The Traditions of the British Navy.
FARADAY SOCIETY, ROYAL MICROSCOPICAL SOCIETY, OPTICAL SOCIETY, and PHOTOMICROGRAPHIC SOCIETY, in co-operation with the Optical Committee of the British Science Guild (at the Royal Society), at 4.30 and 8.—Sir Robert Hadfield, J. E. Barnard, Sir Herbert Jackson, Prof. F. J. Cheshire, Prof. A. W. Porter, and Others: Symposium and General Discussion on the Microscope: Its Design, Construction, and Applications.
ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Mr. Vivian: Thomas Campion: His Works.—Canon Westlake: The Gild of Our Lady of Rouncyval.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at the Institution of Civil Engineers), at 6.—Capt. H. J. Round: Wireless Direction and Position Finding.

THURSDAY, JANUARY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England (with Musical Illustrations).
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.
LINNEAN SOCIETY, at 5.—Dr. B. Daydon Jackson: Methods of Botanic Illustration during Four Centuries (Lantern Lecture).
CHEMICAL SOCIETY, at 8.—L. E. Hinkel and H. W. Cremer: The Condensation of Acetoacetic Ester with *p*-Dimethylaminobenzaldehyde and Ammonia.—G. S. Butler and H. B. Dunnicliff: The Action of Alcohol on the Sulphates of Sodium.—M. Nierenstein, C. W. Spiers, and in part the late K. C. R. Daniel: Guarana Tannin.—R. Lessing: Studies in the Composition of Coal: (1) The Behaviour of the Constituents of Banded Bituminous Coal on Coking; (2) The Mineral Constituents of Banded Bituminous Coal.—P. Ray and P. V. Sarkar: The Hydrazino-thiocyanates of certain Divalent Metals.

FRIDAY, JANUARY 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—J. H. Reyner: The Development of Automatic Telephony.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Low Temperature Studies.

SATURDAY, JANUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. Noyes: The Anglo-American Bond of Literature.

CONTENTS.

PAGE
Water-power and Dartmoor . . . 461
Radio-communication and the Thermionic Valve. By A. R. . . . 462
Catalysis. By W. C. McC. L. . . . 463
The Neglected Study of Probabilities. By Prof. G. H. Bryan, F.R.S. . . . 464
The Study of the Familiar . . . 465
Vaccine-Therapy . . . 466
Our Bookshelf . . . 467
Letters to the Editor:—
The Deflection of Light during a Solar Eclipse.—Sir Arthur Schuster, F.R.S. . . . 468
The Magnetic Storm of August 11–12, 1919.—Dr. C. Chree, F.R.S. . . . 468
Relativity and Radio-activity.—Prof. J. Joly, F.R.S. 468
British Botanic Gardens and Stations.—Dr. W. E. Freeman; The Writer of the Article . . . 469
Natural History of South Africa. (*Illustrated.*) . . 469
Industrial Research. By A. P. M. Fleming . . . 470
Sericulture in India . . . 471
Sir William Osler, Bart., F.R.S. By C. A. . . . 472
Notes . . . 474
Our Astronomical Column:—
The Birth of the Moon . . . 479
Distances of the Stars of Type F . . . 479
Absolute Magnitude as a Function of Colour . . . 479
Cross-circulation as a Physiological Method. By Prof. W. M. Bayliss, F.R.S. . . . 479
Nickel-Chromium Steel Forgings. By H. C. H. C. 480
Cephalodiscus and the Archichordates. By W. C. M. 481
The Ithaca Agricultural Experimental Station. By Dr. E. J. Russell, F.R.S. . . . 482
The Rainfall of the United States. By C. H. . . . 483
Retirement of Sir Oliver Lodge . . . 483
The Chippawa-Queenston Hydro-electric Development Scheme. By Dr. Brysson Cunningham. 483
The Organisation of Chemical Industries . . . 484
Geology at the British Association . . . 484
Economics at the British Association . . . 485
Engineering at the British Association . . . 486
Anthropology at the British Association . . . 487
Rewards for Medical Discovery . . . 488
University and Educational Intelligence . . . 489
Societies and Academies . . . 490
Books Received . . . 491
Diary of Societies . . . 492

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THURSDAY, JANUARY 15, 1920.

SURGERY OF DEFORMITIES.

Menders of the Maimed: The Anatomical and Physiological Principles Underlying the Treatment of Injuries to Muscles, Nerves, Bones, and Joints. By Prof. A. Keith. (Oxford Medical Publications.) Pp. xii + 335. (London: Henry Frowde; Hodder and Stoughton, 1919.) Price 16*s*. net.

PROF. KEITH'S book is undoubtedly one of the most interesting and instructive which have yet been written on this important branch of surgical work. The author treats the subject from an entirely new point of view; instead of following up each forward step and discussing the influence which the various workers in this field had on that progress, he gives us a *résumé* of the career of the workers who made this advance possible.

Nothing could be clearer or more concise than the way in which Prof. Keith has selected from the career of the men who are chiefly responsible for this progress the various points of importance in making us understand the influence which these men had on the progress of the surgery of deformities.

The book enables us to understand how great was the handicap under which these pioneers had to conduct their studies. It shows us how two men such as John Hunter and Hugh Owen Thomas, whilst working in widely different fields, the one finding most of his data in the dissecting room and the other gathering all his observations from clinical studies at the bedside, each arrived at practically the same conclusions in regard to the healing of wounds and the cure of disease.

These are two men who in their practice had found that the proper treatment for inflamed or injured bones or soft tissues was not the method of movements and massage which was the popular one in their time, but fixation, which promotes rest of the tissues and allows Nature's reparative changes to come unhindered into action.

Hunter perhaps better than any other clearly defined the relationship between fixation and massage in an injured or diseased joint in the principle which is enunciated in his book on "Diseased and Wounded Joints respecting their Motion," in which he states that "nothing can promote contraction of a joint so much as motion before the disease is removed."

The subject with which Prof. Keith deals is one that has always interested surgeons, and although of late years the great advances which have been made in abdominal surgery have tended to overshadow this important branch of surgery, yet no more opportune moment could have been selected for the publication of this work.

The hundreds, or rather thousands, of soldiers and ex-soldiers who are to-day walking about in our cities with deformities of joints, with mal-united fractures, or with paralysis of one or more limbs are a constant reminder of the importance of a clear grasp of the principles for the treatment of these injuries.

The great disadvantage under which a medical man labours at the present time is that he can find in no library a trustworthy history of the work of those who have gone before him in any special field. The result is that careful and capable workers in some special branch of surgery or medicine are often found struggling with the solution of a problem which has already been solved, or proved by the work of a forerunner to be of little importance.

This is where Prof. Keith's book is of such great value. He forces us to realise the work which has been accomplished by the men who were the pioneers in the art, and in a few all too short chapters follows up that progress through the careers of those who followed.

No part of the book is better conceived than the chapters which Prof. Keith has devoted to the growth of bone and the practice of bone grafting. Here we follow down through the years the gradual increase of knowledge from the work of Goodsir and Syme to that of Albu and Hey Groves. We see how each succeeding investigator added in some way to what was known of the subject, and built up our present knowledge, which is daily increasing and changing.

At no time in the history of the subject has there been such an immense number of cases on which this problem of bone regeneration and bone transplantation can be studied, and in many cases fractures have occurred of a bone graft soon after its implantation, with a subsequent union of the parts of the graft.

The book is intended primarily as a *résumé* of the history of the subject, and does not enter into a discussion of treatment except in the broadest sense of the term, and perhaps its one weak spot is the short discussion on the relative values to be placed on different lines of treatment.

This is seen in the remarks on the relative advantages of the treatment of fractures by means of plating as compared with non-operative methods. Here Prof. Keith follows entirely the report of a commission, and from the purely theoretical point of view decides that the results of the treatment of fractures by plating is superior to those obtained by splints, etc., and does not realise that we are comparing the work of the best surgeons on the staff of a hospital, who alone would perform the operation, with, in many cases, the work of a newly qualified house-surgeon.

In many respects the book fills a gap in medical literature, and will be of great help not only to the general body of medical workers, but also more particularly to those who are specially engaged in this line of work.

THE OIL-HARDENING INDUSTRY.

The Hydrogenation of Oils: Catalysers and Catalysis and the Generation of Hydrogen and Oxygen. By Carleton Ellis. Second edition, thoroughly revised and enlarged. Pp. xvii+767. (London: Constable and Co., Ltd., 1919.) Price 36s. net.

"FAT hardening" and "hydrogenation" are the trade terms for the chemical process of saturating liquid oils with hydrogen in presence of finely divided nickel. These operations, which a few years ago were conducted with great secrecy, are now regarded as more or less normal in every soap factory, and the usual extensive literature has grown up to describe them. Much of this is naturally diffuse, and much again inaccurate, so that there was ample room for an authoritative book on the subject. This was provided by Carleton Ellis in 1914, but since its publication the strides made in the oil-hardening industry have been very great, making a second edition, which endeavours to bring the subject up to date and offers suggestions of future possibilities, more than welcome.

The book has now swollen to 700 pages, and is replete with information; it is essentially a work of reference for the expert, and necessarily filled with far too much detail to be easily readable by chemists in general.

The first edition, reviewed in NATURE of May 20, 1915, deservedly established a very high reputation for the author, which will be enhanced by the new volume. Doubtless this contains the inevitable printer's errors and minor inaccuracies, but we are less concerned to seek for these than to thank the author for his unselfish labours on behalf of his future readers.

The plan followed is first to discuss the methods of hydrogenation in detail, much of the plant being illustrated and full account taken of the patent literature. The next section, occupying more than 150 pages, is devoted to the many aspects of the subject of the activity of the base metals as catalysers. The vexed question as to whether metallic nickel or nickel oxide is the active agent is fully discussed in so far that the opinions and experiments of the protagonists are given at length, but the author refrains here, as elsewhere in the book, from giving the reader any lead as to which theory is the more probable. There follows an important chapter on the analytical constants of hydrogenated oils.

Although first introduced for providing hard fats for soap-making, hydrogenation has proved equally applicable to edible oils. As fats naturally fetch a higher price as foodstuffs than as soap-making materials, their technical production in the edible form has been extensively studied. Reference is made to other uses and properties of hardened oils.

The hardening process has also been extended to petroleum, where many new problems arise, which are now described. Not only does crude petroleum contain unsaturated constituents, but these are also formed in some quantity during the cracking processes.

The first stage in any hardening process is the production of hydrogen of the necessary purity and cheapness. A variety of methods for making hydrogen are in practical operation, and still more have been suggested, so that it is not surprising that fully a quarter of the book is devoted to the description of these. In the future the cheap production of hydrogen will play a great part in the formation of ammonia from the air, and through ammonia of nitrates, and so influence increased soil fertility.

The fat-hardening industry has had more than its share of patent litigation, famous cases having been fought both in this country and more recently in America. The report of the English case is given, substantially as published in the British official journal, in an appendix, whilst the case of The Procter and Gamble Co. *v.* The Berlin Mills Co. is reprinted in such detail as to occupy eighty pages.

E. F. A.

POLITICAL SCIENCE.

A New Chapter in the Science of Government. By Benchara Branford. Pp. xlviii+190. (London: Chatto and Windus, 1919.) Price 5s. net.

THIS book is not perhaps likely to become popular. It is defective both in shape and in style; nor is the language of the author free from eccentricity and even ambiguity. It is possible that some reason may be urged for such phrases as "Britamerindian Commonweal" or "Britamerindian re-orientation of politics," in which the author seems to take an especial pleasure. But phrases like "a spiritual instrument of exploration on the rough politico-economic *terra incognita,*" or "feeling of communitary responsibility," or "an extension of our synoptical categories," or "a synoptical survey of the grand human bi-directional spiral," are disturbing, and may well be forbidding, to general readers.

Still, Mr. Branford takes a clear and strong view upon certain points which vitally concern the theory of government. Nothing can be better than the passage in which he defines the guiding spirit of the new era (p. 143). It is almost too late to advocate now the rights of women; for womanhood has already entered upon its political heritage; but he rightly bases the enfranchisement of women upon their interest, which is at least equal to men's, in the good order of the State (p. 28). Mr. Branford will carry the assent of all wise thinkers in proposing "to drop the rootedly false distinction between manual work and brain work," a distinction which "has worked so fatally and so long against the humanisation of all labour, against its higher productivity, and against the social solidarity and happiness of mankind" (p. 100). All that he says about Labour is worthy of serious regard. It is only right, too, to express an acknowledgment of the passages (for example, on pp. 79 and 80) in which he defines the successive relations between the family and the city, the region, the nation, the State, and humanity as a whole.

But when the book is judged in the light of its title, as "a new chapter in the science of government," it cannot be said that Mr. Branford's positive reforms are altogether convincing. The most original of them seems to be an inference which he draws from the "warp and weft," as he calls them, of society, *i.e.* the geographical or regional and the occupational or industrial divisions of mankind. He sees clearly that, so long as mankind is distributed geographically into countries or nations, and into these alone, patriotism itself must be exposed, as it was in Germany, to the danger of assuming a selfish, violent, and aggressive character. He finds, or hopes to find, a counter-balancing force in the various occupations of mankind. Thus if all Englishmen are naturally united in the cause of England, the miners or the railwaymen, not in England alone, but all the world over, may be united in support of their own industry. There will then be an international or cosmopolitan sense balancing the local patriotic sense of particular countries. This is, or was in the days before the war, the idea of the Labour Party; but when the war broke out, even the Socialists in Germany suffered their vocational or occupational feeling to be merged in their patriotism; and so it remained, at least until the scales of victory began to incline against the German Empire.

Mr. Branford looks forward to a "Grand Council of Humanity," which he conceives as "a world-bicameral legislature," containing, after the manner of the British Constitution, two Chambers, the Lower being geographical and the Upper occupational; and it is through this Grand Council that he hopes to attain the solution of the political, social, and industrial problems which are now dislocating the civilised world. Upon the whole, if Mr. Branford cannot be said to have made a solid contribution to political science, he has thrown out a good many suggestive ideas which may well bear fruit in the political history of the new-born age. J. E. C. WELLDON.

AMERICAN BOOKS ON AGRICULTURE.

(1) *Productive Agriculture.* By Prof. John H. Gehrs. Pp. xii+436. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 5*s.* 6*d.* net.

(2) *Farm Concrete.* By K. J. T. Ekblaw. Pp. xi+295. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 8*s.* 6*d.* net.

(3) *Peach-growing.* By H. P. Gould. (The Rural Science Series.) Pp. xxi+426+xxxii plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 10*s.* 6*d.* net.

(1) FROM the house of the Macmillan Co., of New York, there issues a constant flow of good agricultural books, and it is gratifying to find that the three now to hand are fully equal to some of their predecessors.

The first book, by Prof. J. H. Gehrs, of the Warrensburg State Normal School of Montana, is written for school children of the upper classes who propose to take up farming as the business of their life. It is frankly vocational: "this is not primarily a book *about* agriculture, but one *on* 'Productive Agriculture.' . . . Unless this book helps to increase the average yields, improve stock, make for better and more fruit, and promote better farm management, it will have failed of the purpose for which it was written."

It may at once be stated that the book deserves to achieve success. The subject-matter is very interesting; the book is full of bits of old country-lore that always make a strong appeal to the country child and the countryman, and the information so far as we can see is sound. Under the heading "Wheat," for instance, the author gives a chart showing the production in bushels of the more important wheat countries of the world with the percentage that each contributes to the world's total. This brings out in striking manner the fact that Europe normally contributes 51·4 per cent. of the world's wheat—a sufficient explanation of the present scarcity. North America contributes only 27·6 per cent.—little more than European Russia. A chart is then given to show the production in certain of the States. North Dakota and Kansas easily come first, followed by Nebraska, Minnesota, Washington, etc. In yield per acre it is gratifying to note that Great Britain stands first with 33·4 bushels, followed by Germany with 30·7, France with 20·1, and the United States with 15 bushels. The cost of production per bushel is stated to be lower in Great Britain than elsewhere; but to this English farmers might not agree. The low position of the United States is not to the author's liking: "Why European countries produce larger yields an acre than the United States is an important question for study. Our natural resources are ordinarily as great as those of European countries."

America scores, however, in the efficiency of the farm labourers and the use of machinery. The portrait of Cyrus H. McCormick, who devised the modern reaper and thus revolutionised the growth of wheat, occupies a prominent place in the book, and much space is rightly devoted to machinery. A table is introduced showing how the time required of man labour to produce and thresh a bushel of wheat has fallen since 1832 from $3\frac{1}{2}$ hours to 10 minutes only, and the cost of the labour has fallen from $17\frac{3}{4}$ cents to $3\frac{1}{3}$ cents. Maize naturally claims a good deal of attention as the most important farm crop in the States in respect both of money value and of food value. The United States contributes no less than 78 per cent. of the world's supply; Iowa and Illinois are the largest producers, but Indiana, Nebraska, Missouri, and Ohio grow large amounts; these and Kansas constitute the famous "corn belt" of the States. Of oats, as of wheat, Europe is the chief producer, growing no less than 61·2 per cent. of the world's total; but in point of yield Germany comes first with 57·4 bushels, followed by the United Kingdom with 44·7, France with 30, and the United States with 29·4 bushels. Later chapters deal with animals; the style is equally good, and the matter equally interesting; a brief history of the principal breeds of live stock is given, with descriptions of their characteristics, valuable features, and methods of treatment. Next come sections on the soil, laying special stress on physical properties, then sections on fertilisers, and finally chapters on choosing a farm.

Altogether the book is one of the most successful for its purpose we have yet seen, and we imagine it will make a vivid appeal to the American students for whom it is written.

(2) The other two books are more specialised. Mr. Ekblaw writes about farm concrete, a subject of which we are likely to hear much more in this country in the future, for the making of concrete requires only sand, cement, and gravel (or similar substances); it can be moulded to almost any shape and adapted to almost any farm building purpose. The author deals with natural cement, made by calcining and then pulverising natural argillaceous limestone without preliminary mixing and grinding; and Portland cement or artificial cement, made by mixing finely ground argillaceous and calcareous materials in proportions approximately of three parts of calcium carbonate to one of silica, alumina, and iron oxide, then calcining and finely pulverising. Portland cement, it is interesting to note, was invented by an Englishman, Joseph Aspdin, in 1824, and for many years we led the way in its manufacture; but now the United States leads, surpassing all other countries both in manufacture and in use. Several varieties of concrete are made, but the constituents are always cement, a fine aggregate (usually sand) and a coarse aggregate (usually pebbles or broken stones), the purpose of the fine material being to save cement by filling up more closely the pore spaces; an apparatus called the voidmeter is described for estimating the amount of pore spaces of different materials. Reinforced concrete as used for buildings is concrete in which steel or other material is embedded to increase its strength. It was invented by a French gardener, Jean Monier, in 1876, and has proved very successful. Its use is still somewhat empirical, the underlying principles not being quite understood, but sufficient useful knowledge has been gained to reveal its great promise for the future.

Great stress is laid on the fire-resistant properties of concrete for building purposes. The building regulations in New York are severe; a building to be considered fireproof must withstand when fully loaded a temperature of 1700° for four hours, and then be subjected to a stream of water discharged from a $1\frac{1}{8}$-in. nozzle under a pressure of 60 lb. without failure. A number of systems of reinforced concrete have successfully passed the test.

The rest of the book is devoted to the special purposes for which concrete can be used on the farm. For building purposes it takes the place of both brick and wood; it can be used for buildings, posts, mangers, floors, yards, and the farmhouse itself. The book will be of great interest to country builders and estate agents who wish to build as cheaply and quickly as possible.

(3) The last book on the list, "Peach-growing,"

by Mr. H. P. Gould, follows the same lines as the other special crop-books of the Rural Science Series, of which Dr. L. H. Bailey is the editor. It is a worthy member of the series. Opening with an account of the history and economic position of the crop, the author proceeds to discuss the details of laying out and managing a peach orchard, the pests, and other details which the intelligent grower ought to know. References are given to bulletins of colleges and agricultural experiment stations, where further information can be gained.

HANDBOOKS OF CHEMISTRY.

(1) *Senior Practical Chemistry.* By H. W. Bausor. Pp. viii+217. (London: W. B. Clive. University Tutorial Press, Ltd., 1919.) Price 3*s.* 6*d.*

(2) *Volumetric Analysis for Students of Pharmaceutical and General Chemistry.* By Charles H. Hampshire. Second edition. Pp. 127. (London: J. and A. Churchill, 1919.) Price 5*s.* net.

(3) *The Preparation of Substances Important in Agriculture: A Laboratory Manual of Synthetic Agricultural Chemistry.* Third edition. By Prof. Charles A. Peters. Pp. vii+81. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 4*s.* net.

(4) *Salt and the Salt Industry.* By Albert F. Calvert. (Pitman's Common Commodities and Industries.) Pp. vii+151. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2*s.* 6*d.* net.

(5) *Industrial Chemistry.* By Dr. Clerk Ranken. (The People's Books.) Pp. 126. (London and Edinburgh: T. C. and E. C. Jack, Ltd.; T. Nelson and Sons, Ltd., 1919.) Price 1*s.* 3*d.*

(1) THESE small books differ from each other perhaps as widely as it is possible for five chemical books to differ, except in one matter, namely, that each author seems to be fully competent to deal with his subject. Mr. Bausor disclaims responsibility for the character of the course of work given in his "Senior Practical Chemistry," as it is designed to meet the requirements of the Senior Cambridge Local Examination in Practical Chemistry. We may be old-fashioned, but we still think that the qualitative character of things should be studied before an attempt is made to estimate their quantity. To say the least of it, it appears strange to us that a student, after having made preparations and done experiments some of which demand considerable manipulative skill, should then be instructed how to bend and cut glass tubing, and how to take small quantities of materials out of bottles by means of a spatula. But we suppose that this is a matter of the syllabus. The final section deals with qualitative analysis, but only so far as the detection of the acid and the base of a single salt.

(2) The title of Mr. Hampshire's manual sufficiently indicates its scope. This author also works to a syllabus, but one that is much more definite and restricted than in the preceding case. In order to make the volume more generally useful, the applications of methods to substances that may be of little importance to those who are not students of pharmacy are printed in smaller type. But the majority of these will be found of interest to any earnest student of analytical chemistry, and those who have to direct their work will find in these small-print examples an excellent help towards getting out of the ruts that "laboratory work" is so apt to suffer from.

(3) The three other volumes differ from the first two in that the authors are not guided by syllabuses prepared by others. Prof. Peters gives within his few pages of large type a really surprising amount of information. The substances of which the preparation on a laboratory scale is described are superphosphate, ammonium sulphate, four potassium salts, lead nitrate, lead arsenate, lime-sulphur (the product of boiling lime and sulphur together in water), copper sulphate, Paris green, Bordeaux mixture, and paraffin oil emulsions. But the book will prove far more interesting than if it consisted merely of these practical directions. The use and manner of action of each substance are referred to, or of each constituent of a mixture, and the reason for employing the mixture rather than the single active substance. The last line of the preface informs us that "a few simplified spellings have been used." We have failed entirely to find consistency in these simplifications. *Ph* is replaced by *f* in *sulphate*, but not in *phosphate*. Final *e's* are sometimes omitted, but by no means always, and the same may be said of the *e* in the final syllable *ed*. *Coold, cald, lims, eg, brot, floc, thot, enuf, thru, volum* are examples of the simplifications, while, on the other hand, the author uses *feldspar*, although in this country the *d* has been omitted for more than a generation. These peculiarities mar the book, for they cannot fail to distract attention from the main subject. A students' manual of chemistry is not the place to introduce spelling reforms.

(4) Mr. Calvert, in his monograph on "Salt," restricts himself almost entirely to the history of the Cheshire salt district and its industry. The scant treatment of this subject at the hands of authors in general is ascribed to the comparatively

small group of men engaged in the industry, and their jealousies of one another and especially of outsiders. They have endeavoured to keep their secrets as well as their profits. The author says that the story is, for the most part, a chronicle of bitter struggles to maintain a monopoly, even at the cost of ruinous losses, and the stubborn persistence in "obsolete methods." But the chapter on the "latest methods of salt-making" leads us to hope that these times are now of little more than historic interest. The book is well illustrated, showing ancient works from old prints, salt-mine interiors, subsidences of land consequent on salt mining, and the most modern apparatus.

(5) "Industrial Chemistry" is, of course, a much more extensive subject than any of the preceding. Though the price of this volume is less than half that of any of the others, it is not the smallest book, and, bound in a very presentable green cloth, it shows what is possible in book production even in these times. It is difficult to see how anyone could have got more information into the same space than Dr. Ranken has, or to find any section of this wide subject that he has passed over, and yet the volume is a true "people's book," and does not leave any impression of undue condensation. The first chapter, being headed "Catalysis and Catalysts," may tend to repel the non-technical reader, but he has only to pass over the title and all will be well. The honesty of the author is highly commendable when he says that "there are fashions in chemistry as in other lines, and the views concerning catalysis held to-day may be absolutely unfashionable to-morrow." This is true of other matters than catalysis. C. J.

FRESH-WATER BIOLOGY.

(1) *Fresh-water Biology.* By Prof. H. B. Ward and Prof. G. C. Whipple. With the collaboration of a Staff of Specialists. Pp. ix + 1111. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 28*s.* net.

(2) *Aquatic Microscopy for Beginners; or, Common Objects from the Ponds and Ditches.* By Dr. A. C. Stokes. Fourth edition, revised and enlarged. Pp. ix + 324. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 10*s.* 6*d.* net.

(1) PROFS. WARD AND WHIPPLE and their twenty-five collaborators have produced a volume to which students may refer for precise information upon the organisms met with in fresh water in North America. Introductory chapters deal with general biological factors and methods of collecting. Succeeding chapters, devoted respectively to single orders or classes, give a general account of the occurrence, a brief description of the anatomy (including reference to the features used in classification) and of the life-history and biological relations, and, finally, a key to the genera, and in several cases also to the principal species of the group. The information in the key about any given genus includes not only the diagnostic characters, but also in most cases an illustration and some reference to the frequency, the range, or other data; thus the whole information "forms a solid panel and appeals promptly and as a whole to the eye and mind of the student."

Much good work has been put into this book, and especial mention may be made of the excellent chapters on Turbellaria, Trematodes and Cestodes, and free-living Nematodes, the last-named noteworthy for the detailed figures. The chapters on Cladocera, Copepoda, Ostracoda, and Mollusca are provided with numerous original illustrations. In the chapter on Rotifers, Prof. H. S. Jennings has given a very useful account of the biology and structure of these animals, and a survey of the families, pointing out the various modifications from the Notommatoid type from which the author (with Wesenberg-Lund) considers the other families to have been derived.

In addition to the notes on habitat given throughout the book, here and there are short notes on points of special importance connected with the distribution. Two of these may be cited as examples. Reference is made to the finding by Prof. Garman, in September, 1916, of large numbers of the fresh-water medusa *Craspedacusta* (*Limnocodium*) *sowerbii* in a creek near Frankfort, Kentucky. This medusa, first found in 1880 in the Victoria Regia tank in the Botanic Gardens in Regent's Park, and afterwards in tanks in other gardens in Europe and America, is now recorded for the first time from other than artificial surroundings. Dr. Ortmann, in a short note under *Mysis relicta,* states that, so far as the North American stock of this species is concerned, there is no reason to assume that it is a marine relic; it may be regarded as an immigrant into the Great Lakes in Glacial times.

This excellent treatise should greatly stimulate the study of the fresh-water fauna of North America, and will be very helpful for comparative purposes also to workers in this country.

(2) The author, who modestly styles himself "only a beginner" writing for beginners, has given his descriptions of the microscope and its parts and of aquatic organisms in language as

little technical as possible. The biology and some elementary points of structure of each group are briefly considered, and useful keys are provided to aid the reader in finding at least the generic name of the more common organisms which the author has collected from a single pond in New Jersey. Special attention has been devoted to certain groups—*e.g.* Gastrotricha, Rotifera, Polyzoa. Here and there the desire to be non-technical in terminology has been carried a little too far—*e.g.* the egg-masses of Cyclops should not be called "external ovaries," and the term "contractile vesicle" is not a good substitute for "contractile vacuole"—the latter term could have been quite easily defined. Helpful illustrations (198) as aids in diagnosis of the genera are given, but we would suggest that when the book reaches a fifth edition figures should be added of some of the commoner transparent animals, *e.g.* a rotifer, a polyzoon, Daphnia, in which the chief internal organs are clearly shown and labelled.

OUR BOOKSHELF.

The Elements of Astronomy for Surveyors. By Prof. R. W. Chapman. Pp. x+248. (London: C. Griffin and Co., Ltd., 1919.) Price 5s. net.

SIR JOHN HERSCHEL'S dictum in his well-known panegyric on star-catalogues, that "every well-determined star from the moment its place is registered is as effective for mapping down the intricacies of a petty barony as for adjusting the boundaries of transatlantic empires," may be taken as the *raison d'être* of this book. The author is professor of mathematics and mechanics in the University of Adelaide, and doubtless the southern continent gives scope for surveying on a large scale in which astronomical observation is a necessity.

The book is on conventional lines, the first six chapters dealing with the elements of geometrical astronomy, including one which explains at some length with examples the conversion of sidereal into mean time and similar arithmetical processes. The latter half of the book consists of chapters on the determination of true meridian, on azimuth of a mark, of latitude, time, and longitude. Most of the recognised methods are concisely explained, and illustrated in some cases by examples taken from actual experience. Use is made of the observation of circumpolar stars at elongation for determination of azimuth, and for time the observation of altitude of the sun or a star near the prime vertical is recommended and discussed in full detail. The inclusion of a few pages on the almucantar is a useful addition to the book, which will fulfil its intended purpose of providing an elementary exposition of the principles of the formulæ used by the surveyor.

Organic Chemistry for Students of Medicine. By Prof. James Walker. Second edition. Pp. xi+332. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1919.) Price 10s. 6d. net.

THIS second edition of Prof. Walker's book for medical students does not differ substantially from the first edition as issued in 1913. It may, however, be useful to direct the attention of medical students and their teachers to a volume which has been written specially to suit their requirements, and the value of which is shown by the publication of a further issue.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Promotion of a Plumage Bill.

ALL lovers of animals must sympathise with any efforts to prevent the ruthless destruction of bird-life for trade purposes, referred to by Mr. H. J. Massingham in his letter in NATURE of December 25. It is open to grave doubt, however, whether the measures announced are the best that can be devised or will meet with a sympathetic following. They are the formation of a "Plumage Bill group," designed to fight the plumage trade and to bring pressure upon the Government to introduce a Bill forbidding the importation of all birds' skins for millinery purposes, with a few exceptions.

From time immemorial plumage has been employed to satisfy the decorative and æsthetic instincts of mankind, though to-day public opinion is rightly determined that it must be procured under conditions conforming with our humane sentiments. We may well inquire, therefore, whether the æsthetic demands for plumage can be met without outraging these. The ostrich in South Africa supplies a forcible case in point. In times past the wild bird was hunted for its precious plumes, and would have become almost extinct ere this had not its domestication been undertaken. As it is, the wild bird is now preserved and is increasing in numbers, and hundreds of thousands of domesticated birds lead a pampered existence on the ostrich farms. A big industry has arisen of the highest importance to agricultural South Africa, representing in pre-war days an annual export value of about 3,000,000*l*.

It is submitted that what has been accomplished with the ostrich may be possible with other birds supplying ornamental plumage; that, like it, others may give rise to industries and yield their plumage in conformity with the highest humane demands. One ventures to suggest that, instead of pursuing a repressive policy, the efforts of Mr. Massingham and his associates would be better directed in instituting studies and investigations as to conditions under which plumage-birds could be reared on an industrial basis.

Mr. Massingham appears to have an unworthy view of the issues involved in his announcement, for in the plumage trade he sees "no other purpose than to feed the profits of a small band of East End traders and to satisfy the frivolity of some women." Though ostrich plumes are exempted from the operations of the proposed Bill, yet so sensitive is the inter-relationship between plumage of all kinds that when the Anti-Plumage Bill was introduced in 1913 the trade insecurity engendered was so far-reaching as to constitute one of the principal causes of the serious slump in the South African ostrich industry, involving the loss of millions of pounds—a slump from which, the war supervening, the Union is only slowly recovering. The introduction of another Bill would be viewed with alarm in South Africa, and would have a serious international bearing, particularly upon our Ally, France, involving thousands of workers and millions of capital. It surely were wise not to attempt it when other measures are possible which would afford a wide stimulus to industry and to the study of bird-life.

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Musical Drums with Harmonic Overtones.

IT is well known that percussion instruments as a class give inharmonic overtones, and are thus musically defective. We find on investigation that a special type of musical drum which has long been known and used in India forms a very remarkable exception to the foregoing rule, as it gives harmonic overtones having the same relation of pitch to the fundamental tone as in stringed instruments. Five such harmonics (inclusive of the fundamental tone) can be elicited from the drumhead in this type of instrument, the first, second, and third harmonics being specially well sustained in intensity and giving a fine musical effect. The special method of construction of the drumhead which secures this result will be understood from the accompanying illustration (Fig. 1). It will

FIG. 1.—Drumhead giving harmonic overtones.

be noticed (1) that the drumhead carries a symmetrical distributed load, decreasing in superficial density from the centre outwards (this appears as a dark circle in the middle of the membrane, the load consisting of a firmly adherent but flexible composition, in which the principal constituent is finely divided metallic iron); and (2) that a second membrane in the form of a ring is superimposed on the circular membrane round its margin.

The character of the vibrations of this heterogeneous membrane which give rise to its remarkable acoustic properties have been investigated by us. It is found, as might have been expected, that the fundamental pitch and the octave are derived respectively from the modes of vibration of the membrane without any nodal lines and with one nodal diameter. The third harmonic, we find, owes its origin to the fact that the next two higher modes of vibration of the drumhead (those with two nodal diameters and with one nodal circle respectively) have identical pitch, this being a twelfth above the fundamental. There is reason to believe that the fourth and fifth harmonics similarly arise from some of the numerous more complex modes of vibration of the drumhead becoming unified in pitch in consequence of the distributed load at the centre and round the periphery of the membrane. The central load also improves the musical effect by increasing the energy of vibration, and thus prolonging the duration of the tones.

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SIVAKALI KUMAR.

210 Bowbazaar Street, Calcutta, India,
December 10.

Power from the Sun.

MR. A. A. CAMPBELL SWINTON, in his letter on the above subject in NATURE of December 18, states that "it is hopeless to expect to be able to effect anything of this nature with the heat-engine, for with this we should scarcely reach the 2 per cent. efficiency nearly attained by vegetation."

For nearly four years immediately preceding the war I was engaged by the Sun Power Co. (Eastern Hemisphere), Ltd., and the Shuman Engine Syndicate, Ltd., on the problem of the utilisation of solar energy, upon which these companies spent a considerable sum of money, the experiments being conducted on a large scale in America and Egypt, while the trials of the necessary low-pressure engine (which made an easy record for such engines) were made in this country. The results of the whole of this work are recorded in my two papers both bearing the title "The Utilisation of Solar Energy," one being read before the Society of Engineers in April, 1914, and the other before the Royal Society of Arts in April, 1915.

At p. 540 of the Journal of the Royal Society of Arts of April 30, 1915, it was shown that the overall thermal efficiency of the sun power plant erected in Egypt was 4·32 per cent., which is to be compared with the performance of the best steam-engine and boiler of 11·5 per cent. At p. 560, *ibid.*, it was shown that the theoretical efficiency of an engine working between the same limits of temperature would be 5·9 per cent., and that, consequently, the relative efficiency of the sun power plant to this ideal engine was no less than 73·2 per cent. From this it will be seen that Mr. Campbell Swinton's estimate of the thermal efficiency of 2 per cent. for a sun-power steam plant is more than 100 per cent. too low.

It is well that any wrong impression which the lower figure might give should be corrected, for in these days of extremely expensive coal it is desirable that inventors, experimenters, and financiers should not be discouraged from attempting to utilise solar energy, which some of us think is bound to be realised in the future. In the Royal Society of Arts paper it was shown that the cost of solar energy was equivalent to coal at 3*l.* 10*s.* a ton, and from this it is obvious that had the companies had more time in which to develop and construct plants before the war, they would have been paying handsomely, with coal at its present prices, in Egypt, Chile, and other sun-bathed countries.

ALFRED S. E. ACKERMANN.

25 Victoria Street, Westminster, S.W.1,
January 6.

TRIODE VALVES AS ELECTRIC AMPLIFIERS.

AMONG the most exquisite tools that modern wireless telegraphy now proffers to investigators working in the fields of pure science, that known as the amplifier stands out as being of the most obvious promise in various directions. The amplifier offers the means of magnifying varying electro-motive forces and currents, otherwise imperceptible, so that they come within the range of ordinary laboratory measuring and recording instruments. It was developed during the war to a high pitch of excellence, not only for the improvement of wireless telegraph signals, but also for other kinds of signalling and for listening under water and under the ground—that is to say, it has been fully developed for the magnification of the high-frequency currents used in wireless telegraphy and for currents of telephonic frequency. Descriptions of the apparatus have now been published in many places, and the tool as thus developed will in due course take its place in the laboratory. For many purposes, however, an amplifier that will faithfully magnify slow variations of a current or electro-motive force is demanded, and since little has been published about such apparatus, the following notes of methods used in the writer's laboratory during the past few years are now presented.

As the term is usually understood nowadays, an amplifier consists of one or more of the three-electrode thermionic vacuum valves of wireless telegraphy associated with auxiliary transformers or analogous apparatus. This particular kind of valve may for brevity be called a triode valve, or even a triode. It comprises a hot filament for supplying electrons, which serves as cathode, a plate, or cylinder, which serves as anode, and an intervening grid, all contained in a highly evacuated bulb. The bulbs generally used in amplifiers are about the same size as the common incandescent filament lamp, but the filament cathode of the triode is proportioned so as to become white hot when a battery of about 5 volts is joined to its terminals to supply about three-quarters of an ampere of current. A battery of, say, 50 volts, connected with its positive pole to the anode and its negative pole to the cathode, causes a current of order one milliampere to flow when the grid is at the same electric potential as the mid-point of the filament, and of perhaps twice this value when the grid is given a potential one volt higher.

The reason for this influence of the grid may be briefly explained as follows: When, in obedience to the electro-motive force applied between anode and filament, an electron current flows from the filament, the distributed electric charge in the space creates an electric field that tends to repel electrons back to the filament, or, in other words, gives rise to a back electro-motive force acting against the battery. But making the grid positive relative to the filament partially neutralises the field of the space charge, and therefore reduces the back electro-motive force. This influence is greater the closer the mesh of the grid; in some commercial triodes one volt on the grid will cancel ten volts of the back electro-motive force, or, in other words, one volt applied to the grid is worth ten volts applied in the anode circuit. At the same time, the current flowing on to the grid when one volt is applied between grid and filament is, perhaps, only a microampere; the multiplication of current performed by the triode is thus a thousandfold. Moreover, since the energy input to the grid is, in the assumed circumstances, 1×10^{-6} watt, and the consequent additional energy output of the high-voltage battery in the anode circuit 50×10^{-3} watt, the energy ratio is 50,000. Not all this output is available for use, however; we may, in fact, scarcely hope to use half of it.

It is worth while emphasising here a difference between an electro-magnetic transformer and a triode regarded as a transformer. The transformer may be arranged to give in its secondary circuit a voltage many times that applied to the primary, but the current is correspondingly diminished to keep the output of the energy equal to the input (losses being neglected). But in the case of the triode valve the current, as well as the electro-motive force, is multiplied, and the consequently multiplied energy output takes place at the expense of the high-voltage battery.

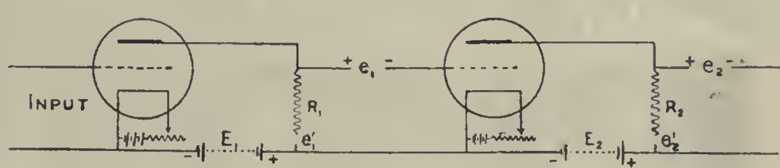

FIG. 1.

The most highly developed type of amplifier is that intended for the magnification of currents alternating more than 100 times per second, and consists of a number of triode valves linked in tandem by means of the mutual inductance of transformers. The earliest instruments were probably constructed by de Forest. Excellent instruments can now be made for any frequency between 100 and 1,000,000. It is stated that Mr. H. J. Round, of the Marconi Co., has used up to twenty-two triodes in tandem, and obtained magnifications of potential difference of about half-a-million-fold. As already stated, amplifiers for rapidly alternating current have been described elsewhere, and are not the subject of this article.

The type of amplifier described in Fig. 1 may be used for magnifying currents that vary slowly. It appears to have been conceived first in the French Military Radio-telegraphic Laboratory in Paris. In this apparatus the linkage between successive triode valves is accomplished by means of resistances and batteries. Considering the anode circuit of the first bulb, we see that it contains a resistance R_1 and a high-voltage battery E_1. Let $E_1=80$ volts, $R_1=30,000$ ohms, and the current be 1 milliampere. At present ignore the batteries marked e_1, e_1'; then the fall of potential along R_1 is $30,000 \times 10^{-3}=30$ volts. Such a potential difference applied between the grid and filament of the second triode would put this tube completely out of action. It is therefore necessary to introduce a neutralising battery of about 30 volts at the point marked e_1, or at the point marked e_1'. In the latter case the battery will, in fact, be a portion of the battery E. Suppose

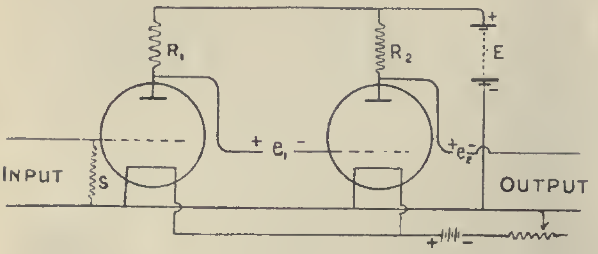

FIG. 2

this to be done, and imagine an electro-motive force e_g to be applied between the input terminals of the amplifier. Then it can be shown that the consequent increase of current in the anode circuit is

$$\frac{ge_g}{R_1+1/h_a},$$

where g is the triode's voltage factor, and h_a its differential conductance. These parameters are frequently of the order

$$g=10 \text{ and } h_a=10^{-4}.$$

The electro-motive force handed on to the second triode from the terminals of R_1 is clearly of magnitude

$$\frac{R_1 ge_g}{R_1+1/h_a}.$$

Using the value of R_1 suggested above, we find that the multiplier of e_g becomes

$$\frac{30 \times 10^3 \times 10}{40 \times 10^3}=7 \cdot 5.$$

The amplification approaches the limit 10 (that is, the value of g) the greater we take the value of R_1; but obvious practical reasons limit the magnitude of this resistance.

This type of amplifier, usually spoken of as a resistance cascade amplifier, has been much used by the Americans and the French for amplifying rapidly varying currents, but in that case a condenser is substituted for the battery at e_1; a "grid leak" of order a megohm must then be connected between grid and filament in each triode in order to avoid the accumulation of negative electricity on the now insulated grid. The complete instrument is then usually connected so as to utilise a common battery of 4 or 6 volts for all filaments, and a common battery of about 80 volts for all anodes. Adopting common battery connections, a finished two-stage amplifier is seen in Fig. 2. The grid leak S connected between the first grid and its filament might be about a megohm, and is necessary only when the circuits from which the input to the amplifier comes are such as would otherwise leave the grid insulated. According to the computations given above for one stage, the amplification with this two-stage instrument should be

$$7 \cdot 5 \times 7 \cdot 5=56\text{-fold}.$$

Finally, a mode of connection due to the present writer may be described. It is shown in Fig. 3, arranged to constitute a two-stage amplifier suitable for use with slowly varying currents. The first triode of the pair has resistances Q_1, R_1, S_1, connected so as to constitute with the bulb the four arms of a balanced Wheatstone bridge. The high-voltage battery E_1 is connected across two opposite corners of the bridge. An electrical stimulus applied to the grid causes the balance to be disturbed, and a corresponding potential difference arises between the filament lead and the junction of Q_1 and R_1. This difference of potential is conveyed to the next triode by direct connections. The magnification is the same as that obtained with the arrangement of Fig. 2 when resistances S_1, S_2 are taken of the same value as R_1 in that figure. A grid leak S is used when necessary, for the reason explained before.

In conclusion, it would be well to point out that in deciding upon the resistances and the voltages to be employed in constructing these amplifiers, the characteristics of the triodes should be kept in mind with the view of using them all at such adjustments that the relation between input and output potential differences is linear, and the magnification therefore free from distortion.

W. H. ECCLES.

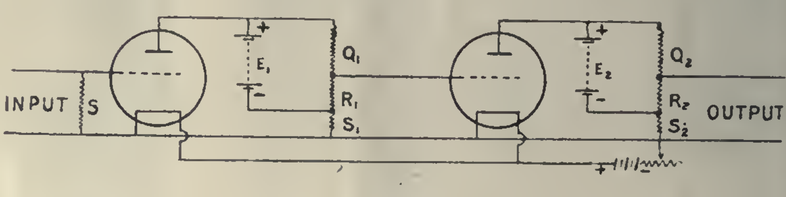

FIG. 3.

INDIAN GEOLOGY.[1]

THE appearance of a manual of Indian geology of so excellent a character as the present work, written by an Indian geologist, is an event of some importance, since it furnishes a fresh and convincing answer to the argument so often

[1] "Geology of India for Students. By D. N. Wadia. Pp. xx+398+xx plates. (London: Macmillan and Co. Ltd., 1919. Price 18s. net.

put forward that the Oriental mind, though it may assimilate the ideas of Western science with ease, is yet incapable of applying the principles of that science to original research. It is true that the author in his preface modestly admits that the book is in the main a compilation; yet the able manner in which he has marshalled the facts, and the clearness of his reasoning, especially when dealing with matters that are still open to controversy, show that he is by no means lacking in originality of thought and expression.

As a text-book for the use of the elementary student, perhaps, the work is not all that is required. There is still room for a book which would lead the student gradually to a knowledge of the science, by illustrations drawn from the rich field of observation that lies open to him in India itself. No systematic attempt is made to explain the meaning of geological terms, and the book presupposes a knowledge of the subject which the average student certainly would not possess. To the advanced student, in the sense that every scientific man is a student throughout his life, the book must prove extremely useful.

There are many pitfalls awaiting the student who fails to profit by the pertinent advice (p. 41) "not to commit the mistake of merely trying to memorise the dry summary of facts regarding the 'rocks' or 'fossils' of a system, or consider that the idea of a geological system is confined to these. These are the dry bones of the science; they must be clothed with flesh and blood by comparing the processes and actions which prevailed when they were formed with those which are taking place before our eyes in the world of to-day. A sand-grain or a pebble of the rocks is not a mere particle of inanimate matter, but is a *word* or *phrase* in the history of the earth, and has much to tell of a long chain of natural operations which were concerned in its formation. Similarly, a fossil shell is not a mere chance relic of an animal that once lived, but a valuable *document* whose preservation is to be reckoned an important event in the history of the earth. . . ." (The whole passage is too long to quote, but it furnishes a good example of the author's style.) In the making of tables of rock-sequence and correlation it is impossible to avoid what appear to be definite statements regarding a formation the position of which may be doubtful; and when the student merely learns these tables by heart for examination purposes (a practice which too often defines the limits of the candidate's knowledge of the subject), he is apt, having missed the qualifying explanation given in the text, to unload his modicum of knowledge with results disastrous to himself. Thus, in the general table of formations (p. 47), the rocks of the Simla area, from the Blaini boulder bed upwards, are boldly correlated with the Vindhyans of the peninsula,

FIG. 1.—Bellary Granite-Gneiss Country, Hampi. From "Geology of India for Students."

though it has not yet been proved that this boulder bed is not the equivalent in age of the Carboniferous Talchers. The Simla and Jaunsar slates, the Dalings of Sikkim, and the Shillong quartzites in Assam are all correlated with the Dharwars of Southern India, and, probable as these correlations may be, even as regards lithological resemblance there is little in common between these formations and the highly altered schists and jaspers of the typical Dharwars. Again, in the table giving the Cambrian succession of the Punjab Salt Range, the salt marl is placed at the base of that system, though it has recently been shown that there is good reason to believe this peculiar formation to be of Tertiary age.

FIG. 2.—"Marble Rocks" (Dolomite marble), Jabalpur. From "Geology of India for Students."

The arrangement of the book follows the usual lines. The physical features, mountains, glaciers, etc., are each briefly dealt with in the opening chapter. (Some of these are again described in a chapter on "Physiography" towards the end of the book (chap. xxv.), a somewhat peculiar arrangement, resulting in a good deal of repetition.) Then follow the various systems from Archæan to Pleistocene and Recent, the information with regard to each being carefully and clearly given in sufficient detail. Full advantage is taken of recent advances in our knowledge of Indian geology. Allusion is made to the revolutionary ideas of Dr. Smeeth and his band of workers in Mysore concerning the age of the Dharwars, which would make them the oldest rocks of the Peninsula (p. 69). Insistence is laid (pp. 135, 150) upon the importance of the stratigraphical break at the close of the Carboniferous period, which separates the Dravidian and Aryan groups of Sir T. Holland's classification of the Indian geological sequence. Full attention is also given to the recent discovery in Kashmir of beds containing the characteristic flora of the Talcher series, associated with marine strata, thus fixing a base limit for the Gondwana system, and closing a long-standing controversy.

A useful chapter on "Economic Geology" closes this part of the work, and then follows a special chapter on the geology of Kashmir, where, as the author remarks, "within a small geographical compass one of the finest developments of the stratified record seen in the Indian region and perhaps in the world" is revealed, in a situation more accessible to the student than any other in the whole length of the Himalaya. It may here be remarked that much remains to be done before the geology of this fascinating country is worked out in detail.

The book is written in clear and good English, and is well got up. Very few typographical errors have been noticed, but among them may be mentioned "Jena," presumably for "Jura" of Spiti (p. 165); "corrosion" for "corrasion" (p. 277); and twice (pp. 198, 200) "*Physa princepii*" for the typical fossil of the intertrappean beds of the Deccan, named in honour of the well-known secretary of the Asiatic Society of Bengal, James Prinsep. Numerous photographic views, diagrams, and maps add to the interest of the work, most of which are taken with due acknowledgment from the publications of the Geological Survey of India. Of the author's own views, two have been selected for reproduction, one showing a typical landscape in the crystalline area of the peninsula, and the other that unique feature in one of the great peninsular rivers—the falls on the Narbada, near Jabalpur. T. H. D. L.

METEOROLOGY IN THREE DIMENSIONS.[1]

IN 1916 Mr. W. H. Dines put together in a concise report the information then available about the pressure, temperature, and density of the atmosphere up to heights of 15–20 kilometres. His report is now published, and should prove extremely useful and informing both to the new generation of meteorologists and to the wider circle whose interest in the atmosphere is non-professional.

The first nine sections deal with the methods and places of observation, the averages and seasonal variations of pressure, temperature, and density, and the stratosphere and troposphere; short accounts of humidity and atmospheric motion are also included.

The tenth and eleventh sections are concerned with the results of the statistical treatment of the original data; the interpretation of these results will provoke much discussion. First, the correlation coefficient between (1) the mean temperature of a vertical column extending from a height of 1 km. to a height of 9 km. and (2) the pressure at the *top* of the column is 0·95. The hydrostatic equation connecting variations of pressure at 1 km. and 9 km. with variations of the mean temperature of the column of air is

$$\frac{\delta p_9}{p_9} = \frac{\delta p_1}{p_1} + \frac{k\delta T}{T^2}.$$

From this it follows that if $\frac{\delta p_1}{p_1}$ is (1) zero or (2) proportional to $\frac{\delta p_9}{p_9}$, then the correlation coefficient between p_9 and T is unity.

The first condition is not fulfilled in temperate latitudes; the second condition would be satisfied if the isobars at 9 km. were parallel to those at 1 km.—*i.e.* if the wind-directions at these levels were identical. But in the troposphere convection is always tending to make the direction of the wind the same at all levels, so that the magnitude of the correlation coefficient found by Mr. Dines may be due to the effectiveness of convection in regulating the wind. It would be interesting to know the differences from parallelism permitted by the 0·05 by which the actual coefficient falls short of unity.

Secondly, if T_0, P_0; T_1, P_1, etc., are the temperatures and pressures at heights of 0, 1, 2, . . 13 kilometres, then the correlation coefficients between corresponding T's and P's, beginning with T_0, P_0, are as follows: ·11, ·42, ·66, ·77, ·84, ·85, ·86, ·86, ·86, ·71, ·32, −·19, −·36, −·28. It follows that pressure and temperature go up and down together with great regularity at all heights between 3 km. and 9 km. Presumably the same would hold for the surface were it not for the effects of radiation and of the surface water of the ocean upon the surface temperature of the air.

Two outstanding deficiencies in the information available call for comment. There are no records from the United States, India, Australia, South Africa, South America, and Japan. This is no doubt partly due to the difficulties of recovering records in these countries if the ordinary European method of investigation is used; but it is also due to the defects of pre-war international meteorological organisation in which no place was found for an active permanent bureau. Further, the information about atmospheric motion is hopelessly inadequate. This arises less from lack of original records than from the absence of any proper arrangements for summarising the results of pilot-balloon ascents. A young meteorologist seeking a field of independent research might do worse than turn to the statistical treatment of vectors.

Before the war the investigation of the free atmosphere was, broadly speaking, pure research; the work had no direct application in forecasting or climatology, and the means of investigation were slight and relatively expensive. During the war a knowledge of the actual conditions of the atmosphere at least up to 20,000 ft. (6 km.) became essential for heavy artillery and for aviation, and their importance for actual daily forecasting began to be dimly recognised. Now that artillery operations are over and aviation is practically restricted to low levels, there is a great risk of the investigation at higher levels by aeroplanes and kite-balloons being neglected; and instead of information being available an hour or two after it was obtained, records would again creep in months or years out of date, with no possibility of immediate practical usefulness. E. GOLD.

[1] Meteorological Office. Geophysical Memoirs, No. 13. "The Characteristics of the Free Atmosphere." (London: Meteorological Office, 1919.) Price 2s. net.

SIR THOMAS R. FRASER, F.R.S.

WHEN, in 1877, and then in his thirty-sixth year, Thomas Richard Fraser was called to succeed Sir Robert Christison as professor of materia medica in Edinburgh University, it could scarcely have been anticipated how closely he was to rival his great master in his length of tenure of the chair and in the distinction with which he was to fill it. In his varied spheres of action Fraser attained a commanding position as a physician, as an investigator, and as a professor.

Gifted with acute senses and a fearlessly logical mind, and trained in the habits of accurate observation and experiment in the laboratory, Fraser brought to the hospital wards a rare combination of qualities. He had few equals as a diagnostician and therapeutist. As a teacher, his unswerving scientific attitude to the problems of clinical medicine had on the thousands of students who passed through his hands an influence scarcely to be overestimated. He taught not only accuracy of method, but also precision of language. His gifts as a physician were recognised by his holding, among other distinctions, the offices of physician to the King in Scotland, and of president of the College of Physicians of Edinburgh, of the Association of Physicians of Great Britain and Ireland, and of the Indian Plague Commission. He was knighted in 1902.

As an investigator, Fraser was one of the pioneers of experimental pharmacology. His greatest discoveries—from the point of view of their immediate practical application—were those which, in strophanthus and physostigmine, added to our Pharmacopœia remedies still in everyday use for the purposes for which he recommended them. For far-reaching scientific value they were even exceeded by the monograph which he wrote in collaboration with Prof. Crum Brown on the relation between chemical constitution and physiological action, embodying one of the most suggestive and fruitful researches in the history of pharmacology. For his researches he was made a laureate and Barbier prizeman of the French Academy of Sciences, and was awarded the Macdougall-Brisbane and Keith prizes of the Royal Society of Edinburgh.

Fraser combined an aptitude for both science and business. He took a keen interest in educational problems and an active part in introducing many university reforms. For twenty years he acted as dean of the faculty of medicine, and for ten years represented that faculty on the University court, and his University on the General Medical Council.

Endowed with a remarkably lucid and quick mind himself, Fraser was intolerant of mental slowness in others, sparing of praise, and at times not slow to censure. But he expected a man's best, and his standard was high. He carried himself—a keen, spare, scholarly figure—with a faint, indefinable hauteur, which may have been to many a barrier to close intimacy. But when this barrier was surmounted, and when he could lay aside the cares of too unremitting labour and of indifferent health, he would weave a grace and charm which few could resist or forget. Especially in later years he fought a continual battle with bronchitis and emphysema with a fortitude which is surely characteristic of sufferers from this condition. That he was so long permitted to lead an active life—for he retired only two years ago—was due in no small measure to the loving care and encouragement of Lady Fraser and the kindly supervision of his staunch friend and physician, Sir James Affleck.

Plummer, Gregory, Fowler, Withering, Lister, Simpson, Hughes Bennett, Christison, Brunton, Fraser—alumni or professors of the University of Edinburgh, a roll enviable and for one medical school possibly unequalled—file before us in retrospect. Their achievements in adding to our knowledge of remedies for disease and for pain stretch from the picturesque twilight of empiricism to the clear light of scientific method. With the passage of the last to that unknown bourn, we salute their memory.

J. A. G.

NOTES.

A SPECIAL general meeting of the Royal Society will be held on January 22, at 3.30, to admit H.R.H. the Prince of Wales as a fellow of the society.

THE meeting of February 5 has been set apart by the council of the Royal Society as a meeting for a discussion on "The Theory of Relativity," to be opened by Mr. Jeans and continued by Prof. Eddington, the Astronomer Royal, and others.

THE International Research Council has been constituted, by successive meetings in London, Paris, and Brussels, as a Federation of National Research Unions. Under its auspices unions are being formed for the organisation of international work and co-operation in different departments of science, the unions already instituted being for astronomy, geodesy and geophysics, mathematics, and (provisionally) chemistry and biology. The question of international organisation in science is raised, to a great extent, by Article 282 of the Peace Treaty, which states that "treaties, conventions, and agreements of an economic and technical character not included in a specified list cease to be operative." That this article was intended to cover conventions on scientific matters appears from the list of exceptions, in which the Metric Convention and the International Agricultural Institute at Rome are included.

WITH the view of obtaining the opinion of representatives of pure and applied science upon the subject of the co-ordination of international effort and action, a special meeting of the Conjoint Board of Scientific Societies was held at the Royal Society on January 8. After much discussion the following resolutions were passed:—"(1) That the executive committee be requested to appoint committees for the purpose of considering the desirability of forming in branches of science, as recommended by the Brussels Conference, international unions connected with the International Research Council, or of joining such Unions if formed independently. (2) That these committees be authorised to make recommendations with regard to the proposed statutes and the constitution of national research councils. (3) That the committees consist of representatives nominated by the principal societies concerned, together with additional members nominated by the executive committee."

WE regret to see the announcement of the death on January 11, at seventy-three years of age, of Father J. N. Strassmaier, the distinguished Assyriologist, whose work with Father Epping on Assyrian astronomy is well known.

THE Scientific Instrument, Glassware, and Potash Production Section of the Board of Trade has been transferred from 7 Seamore Place, W.1, to the main offices at Great George Street, S.W.1.

THE council of the Geological Society of London has this year made the following awards:—Wollaston medal, Prof. Baron Gerard Jakob de Geer (Stockholm); Murchison medal, Mrs. (Dr.) E. M. Shakespear; Lyell medal, Mr. E. Greenly; Wollaston fund, Mr. W. B. R. King; Murchison fund, Dr. D. Woolacott; and Lyell fund, Dr. J. D. Falconer and Mr. E. S. Pinfold.

THE Secretary of the Department of Scientific and Industrial Research announces that the Research Association for the British Launderers' Industry has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the association is to be registered as a non-profit-sharing company, the promoters have applied to the Board of Trade for the issue of a licence under section 20 of the Companies (Consolidation) Act of 1908. The secretary of the committee engaged in the establishment of this association is Mr. J. J. Stark, 162–165 Bank Chambers, 329 High Holborn, W.C.2.

WITH the approach of a return to normal conditions, the Natural History Museum, we are glad to learn, is developing a policy of adding to the national collections by means of exploration. Thus Mr. Willoughby Lowe, who has already made several expeditions to Africa on behalf of the museum, has recently started on a mission to the West Coast of Africa for the purpose of collecting specimens for South Kensington, and Capt. Hubert Lynes, R.N., has just left England on an expedition to Darfur, where he intends to make a special survey of the avifauna of the Jeb-Maria Mountains, which should yield many forms new to science to the Bird Department. Other similar expeditions are, we believe, contemplated by the museum authorities.

A MEETING of surgeons, representing the surgical staffs of all the great teaching hospitals of Britain, assembled in the theatre of the Royal College of Surgeons of England on January 8, under the chairmanship of Sir Rickman J. Godlee, and resolved to form an "Association of Surgeons of Great Britain and Ireland." British surgeons have thus followed the precedent set by their colleagues the physicians, who formed a similar association a number of years ago. The object of the newly formed association is to permit surgeons on the staffs of the greater hospitals to meet together from time to time at various centres in order to exchange observations and compare results. The association will stand as the representative body for British surgeons, and in that capacity will represent British interests at international surgical congresses. Sir John Bland-Sutton was elected president of the new association.

ACTIVE steps are now being taken in the movement to establish a memorial to Lord Lister in Edinburgh. The movement had already begun to take shape in 1914, but its progress was arrested by the outbreak of war. The war, which has caused delay, has given at the same time an overwhelming demonstration of the value of Lord Lister's work. The University and Royal Colleges of Physicians and Surgeons in Edinburgh, under the control of which the memorial will be established, have determined to provide an institute for research and teaching in medicine. A site has been secured, and a committee is now being formed to make an appeal to the public for a sum of 250,000*l.* Mr. Balfour, Chancellor of the University, has consented to be president of the committee, with the Duke of Atholl, Lord Rosebery, Lord Beatty, Lord Glenconner, Lord Leverhulme, and Sir J. Lorne McLeod as vice-presidents.

THE Journal of the Washington Academy of Sciences for December 19 announces that Mr. E. C. McKelvy, of the Chemical Division of the Bureau of Standards, died on November 29, in his thirty-sixth year, as the result of burns caused by an explosion of ammonia-condensing apparatus containing petroleum-ether cooled by liquid air. Mr. McKelvy was born at Upper Sandusky, Ohio, on May 9, 1884. He joined the staff of the Bureau of Standards in July, 1907, and was chief of the physico-chemical section of the Chemistry Division at the time of his death. His work for several years past had been on the physical constants of ammonia and other substances used in commercial refrigeration. He was a member of the Washington Academy of Sciences and one of the associate editors of its Journal, and had been secretary of the American Chemical Society since 1915.

AN exhibition of radiographic prints has been arranged by the Röntgen Society, and is being shown at the Royal Photographic Society's house at 35 Russell Square, W.C.1. The exhibition is open free to the public until February 7, between 11 a.m. and 5 p.m. daily. The two hundred or so prints which are hung on the walls of the gallery well illustrate present-day practice in both medical and industrial radiology as developed by some of the leading X-ray workers in this country. We hope to make extended reference to the subject in a future issue. Incidentally, the growing custom of holding joint meetings of kindred societies is one much to be commended, and we are glad to note that the Röntgen Society, in addition to its recent joint meeting with the Faraday Society, has similarly co-operated during the present exhibition with the Royal Photographic Society. Furthermore, it has arranged, in the near future, joint meetings with the Institution of Electrical Engineers and the Electro-therapeutic Section of the Royal Society of Medicine. The officers of the Röntgen Society deserve every support for their energy and enterprise.

REFERENCE is made in the *Times* of January 12 to an exceptionally high velocity, at the rate of 180 miles an hour, attained by the north-west wind at 25,000 ft. over southern England on January 9 as a precursor to the recent rough and stormy weather. Deep cyclonic depressions had spread in from the Atlantic, the central area of one passing over the northern parts of Ireland and England on January 10, and a second disturbance skirted our north-western seaboard on January 11, when the barometer in the Hebrides fell to 28·3 in. The intensity of the storm was greatest in the English Channel. In the Scilly Isles the wind attained the velocity of 68 miles an hour in a gust during the evening of January 11. Inland the gusts attained an hourly velocity of 50 to 55 miles. Thunderstorms occurred in many parts of the country, and heavy rain was general, whilst in the Shetlands snow covered the ground to the depth of 6 in. On January 13 the Daily Weather Report of the Meteorological Office showed that the wind in the south of England was blowing at 12 miles an hour, whilst at 4000 ft. it had increased to a rate of 54 miles an hour. During the morning a storm area had its centre over Thorshavn, where the barometer stood at 29·05 in. There were indications of the approach of another disturbance from the Atlantic. The storms have occasioned several wrecks, resulting in serious loss of life.

THE death is announced of the well-known Argentine geographer and naturalist, Dr. Francisco P. Moreno. Dr. Moreno was born in Buenos Aires on May 31, 1852, and doubtless inherited his love of natural science from his mother, who was the daughter of an English botanist. He spent his early years in exploring Patagonia and various parts of the Andes, and devoted himself especially to the making of anthropological and ethnological collections. His first contribution to science, on the prehistoric cemeteries of Patagonia, appeared in the *Revue d'Anthropologie* so long ago as 1874. In 1877 Dr. Moreno gave his collection to the Argentine Government to form the beginning of the Anthropological and Archæological Museum of Buenos Aires. In 1880 Buenos Aires became the federal capital, and two years later the city of La Plata was founded to replace it as the provincial capital. Dr. Moreno then devoted his thoughts and energies to the planning and foundation of a great museum at La Plata which should illustrate the natural history of the Republic. His scheme was realised in 1889, and the well-known publications of the La Plata Museum under his direction began in the following year. In 1898 Dr. Moreno came to London as representative of Argentina in the dispute as to the Argentine-Chilean boundary, which had been referred for settlement to the British Sovereign; and in 1900 he produced his report in four handsome volumes well illustrated with photographs. At the same time he brought and exhibited to the Zoological Society the famous piece of the skin of an extinct ground-sloth which he had discovered in a Patagonian cave. Dr. Moreno was an honorary corresponding member of the Royal Geographical Society, and received the Founder's medal in 1907. He was also a foreign correspondent of the Geological Society and a corresponding member of the Zoological Society of London.

DISPATCHES published in the daily papers last week contain brief accounts of destructive earthquakes that were felt over the greater part of Mexico during the night of January 3–4. The first shock occurred at 9.45 p.m. on January 3; this was followed by a second of great intensity at 10.25, and by a slighter shock at 11 p.m. The epicentral area lies about fifty miles west of the city of Vera Cruz, near the southern end of the Gulf of Mexico, after-shocks being especially frequent to the south of Jalapa. The principal damage, so far as is yet known, is at Cordoba, Jalapa, Coscomatopec, Calcahualco, Teocelo, and Cosautlan. The area within which injury to property occurred is, however, considerable. The city of Vera Cruz is deprived of gas and water, owing to many breaks in the mains, and, even so far west as Mexico City (150 miles from the coast and nearly 200 miles from Vera Cruz), the walls of large buildings were cracked. As in all destructive shocks, the central area was completely isolated, but the unusual violence of the principal shock is also evident from the change in the course of the River San Francisco, the rupture of water-mains at Vera Cruz, and the uprooting of thousands of trees in a forest twenty-five miles from that city. The loss of life is still unknown, but is sure to be considerable. At Coscomatopec it was increased by the rush of people to the church when the first shocks were felt. According to the officials of the Mexican Government Observatory, the centre of disturbance was situated in the volcano of Orizaba, but the earthquake was clearly tectonic, possessing none of the characteristic features of volcanic earthquakes, though the opening of a new crater in the volcano may be connected with the same movement which caused the earthquake. One point of some interest is its occurrence near the north coast of Mexico, the principal seismic regions lying on the south or Pacific side.

IN "Memoirs of the Bernice Pauahi Bishop Museum, Honolulu," vol. v., part iii., for 1919, Mr. T. G. Thrum publishes a long series of native documents from the Fornander collection, giving the Hawaians' account of the formation of their islands, the origin of their race, and their migrations. The records now printed in the original language, with English translations, include fifteen mythical tales, twenty-five traditionary stories, and the legend of Kawelo, which extends to six chapters. The publication is of great importance from the points of view of ethnology, folklore, and linguistics.

IN the Journal of the Royal Anthropological Institute (vol. xlix., January–June, 1919) Mr. J. Reid Moir discusses the occurrence of humanly fashioned flints in the Middle Glacial Gravel at Ipswich. These implements and flakes do not exhibit marked signs of abrasion by water action, and the writer regards it as a possibility that the place where these Middle Glacial specimens are now found cannot be far removed from the deposits in which they rested in an unabraded state, and that the water which laid down the Middle Glacial deposit did not flow at a turbulent rate. The only dateable artefacts so far recovered from this gravel are some small platessiform flint implements, which, though small, otherwise resemble closely the well-known early Chellean implements. "The occurrence of flint implements of early Chellean form in a gravel presumably more ancient than the Glacial Chalky Boulder Clay will no doubt come as a surprise to many archæologists, but there does not seem to be in this case any escape from such a conclusion."

IN the *Public Health Journal* for November (vol. x., No. 11, Toronto) Prof. Fraser Harris discusses the medical and allied professions as a State service.

He considers that the advantages of such a service far outweigh the possible disadvantages. Among the advantages are mentioned the speedy exclusion of quacks and irregular practitioners, and of the struggles for existence and rivalries among the regular practitioners, while the public health would be maintained as never before; treatment would be prompt and of the highest quality; specialists of all sorts easily accessible; and all manner of special treatments readily available for the rich and poor alike.

THE weekly mortality statistics of the influenza epidemic beginning in the autumn of 1918 for thirty-nine large American cities have been subjected to a preliminary analysis by Prof. Raymond Pearl (Reprint No. 548 from the Public Health Reps., Treasury Dept., U.S. Public Health Service). There was considerable variation among the several cities in the relative degree of explosiveness of the outbreak. The analysis appears to demonstrate that an important factor causing this variation was the magnitude of the *normal* death-rates occurring at the same time as the influenza epidemic in respect of pulmonary tuberculosis and diseases of the heart and of the kidneys.

IN *Medical Science: Abstracts and Reviews* for December (vol. i., No. 3) the influenza epidemic of 1918–19 is reviewed in all its aspects. In the civilian population of the United States the total number of deaths attributable to the epidemic was estimated at not fewer than 450,000, a death-rate of more than 4 per thousand. In the County of London some 22,750 deaths were caused by it. The statistics of the Life Insurance Bank of Gotha show that, whereas in 1889–90 epidemic influenza caused no deaths in the age period 15–30, in 1918 the greater number of deaths occurred in this age period—an experience similar to that which obtained in this country.

WE have received a copy of the general report of the Survey of India for 1917–18. Shortage of officers necessitated the curtailment of field work. Several officers and survey parties were supplied for Persia, Mesopotamia, and East Africa. New maps published included 43 one-inch sheets, 65 half-inch sheets, 4 quarter-inch sheets, and 13 sheets of the million map. The report gives useful index maps of all the sheets published up to the present on various scales by the Indian Survey Department.

THE United States Geodetic Survey has published a report on the connection of the arcs of primary triangulation along the ninety-eighth meridian in the United States and in Mexico (Special Publication No. 54). Mr. W. Bowie, the writer of the report, points out that this connection not only makes it possible to compute with greater accuracy than hitherto the dimensions of the earth, but also enables Mexico to extend new areas from the ninety-eighth meridian arc, which can be based on the North American datum, as the United States standard datum is now called. It had been intended to carry out this work in 1913, but the unsettled conditions in Mexico made it necessary to postpone the observations until 1916. The arc of the ninety-eighth meridian was completed to the Canadian frontier in 1907.

THE value of large-scale maps in war is the subject of an unsigned article in *La Géographie* (vol. xxxii., No. 7) on the Service Géographique of the French Army. This Service was practically created by the war, when it was realised that the available maps of France were on too small a scale to be of use. Maps on scales of 1/80,000 and 1/200,000, although valuable for war in the open, were unsatisfactory for trench warfare. Large-scale plans were available only for the neighbourhood of Paris and certain fortified places. It was decided to make maps of the war area on a scale of 1/20,000, 1/10,000, and 1/5000 (*plans directeurs*). Of these the smallest scale was for artillery use, the second for Staff work in general, and the largest scale, confined to front-line areas, for infantry use. Generally speaking, the 1/20,000 proved to be the most useful. It is hoped that this will be extended to the whole of France and be periodically revised. The urgency of the demand in war-time did not allow of detailed resurvey for this work, so recourse was had to existing survey material, land valuation plans, and aerial photography. Specimen sheets of the maps accompany the article.

IN the Bulletin of the Central Meteorological Observatory of Japan (vol. iii., No. 1) Prof. T. Okada attempts to discover a forecasting formula, starting from the undoubted fact that in Japan a hot August means a good crop, and a cold August a bad one, resulting in famine in 1902, 1905, and 1913. Prof. Okada connects the temperature of northern Japan with the sun-spot cycle, but more definitely finds a correlation between the August temperature in that region, the March pressure difference between Zikawei and Miyazaki, and the South American pressure for March to May, using data from Santiago and Buenos Aires. The South American data give larger correlation coefficients (0·5 or 0·6 with $P.E. < 0{\cdot}1$) than the Zikawei-Miyazaki pressure differences (0·3 or 0·4 with $P.E. > 0{\cdot}1$). Treating the districts of Hokkaido and Tôhoku separately, he obtains the yearly variation in the rice crop for the former as $0{\cdot}53x + 0{\cdot}26y$, and for the latter as $0{\cdot}18x + 0{\cdot}10y$, where x is the yearly variation of South American pressure, March to May, and y the yearly variation of pressure gradient, Zikawei-Miyazaki. The table of comparative results shows a fair agreement in sign between calculated and actual yields, especially for Hokkaido, and the conclusion is drawn that, in general, abnormally low pressure in the southern part of South America from March to May and abnormally small pressure gradient in March between Zikawei and Miyazaki are followed by a failure of the rice crop in northern Japan.

DR. G. R. WIELAND, in his "Classification of the Cycadophyta" (*Am. Journ. Sci.*, vol. xlvii., p. 391, 1919), reviews "the gymnosperm phylum," and goes much further than this in providing a table in which the evolution of dominant and specialised land-plants is correlated with the climates of successive geological periods. In this suggestive diagram various types are shown as moving towards "ascendancy and extinction" or "simplification and reduction," sharply or gently from a previous parallel course of evolution.

"Basic or semi-immortal types" of vegetation are represented by a horizontal line running across the bottom of the diagram. Elsewhere Dr. Wieland has lamented the depletion of the already small group of palæobotanists. If he could give us a general treatise on the problems expressed so concisely in his diagram, he might win a keen body of adherents.

MR. GEORGE BARROW, in a paper on "Some Future Work for the Geologists' Association" (Proc. Geol. Assoc., vol. xxx., p. 1, 1919), revives in a remarkable degree the view that some of the features of the chalk surface round London are due to marine erosion, acting probably in Pliocene times. It is urged that the quartz-pebbles of the pre-Glacial high-level gravels were washed into the chalk basin by the waters of a shallow sea, which cut passages in the escarpments and thus originated many of the wind-gaps. The chalk escarpments, together with those of the Lower Greensand, were, in their first form, ridges left by the marine denudation of the softer Gault and Eocene strata. If the "beach deposits" (high-level gravels) are of Pliocene age, no serious post-Pliocene bending of the region can have occurred, since they lie at approximately the same levels. Mr. Barrow suggests that they are little later than the Lenham Beds, and the members of the Geologists' Association are now invited to prove their age by a diligent search for fossils.

DR. R. E. SLADE and Mr. G. I. Higson, of the British Photographic Research Association, communicate to the Journal of the Royal Photographic Society (December, 1919) the results of their investigations, which show that the shape of the characteristic curve of a photographic plate depends not only on the thickness and opacity of the film and the time and method of development, but also on the relation of the different sizes of grains in the film to each other and the quantity of each size present. This new factor they claim to be the most important. If the grains are all of the same size, the curve is the steepest possible. If the grains are of various sizes, the curve is the sum of the curves due to each group of particles of the same size. The larger grains are more sensitive than the smaller grains. Uniformity of grain-size is, therefore, desirable in plates for black-and-white work, and the authors find that the steepness of the curve can be foretold from photomicrographs of the grain. Photomicrographs and curves are given in illustration.

IN May, 1914, we mentioned in these columns two methods which had been devised for reducing the measurement of the horizontal component of the earth's magnetic field to that of an electric current. In the first—due to Prof. Hicks and tested in practice by Mr. W. A. Jenkins (*Phil. Mag.*, October, 1913)—the earth's field was reversed by the current in a coil, and the reversal determined by the time of oscillation of a small magnet. In the second—due to Sir A. Schuster and tested at the National Physical Laboratory by Mr. F. E. Smith (*Terrestrial Magnetism*, March, 1914)—the earth's field was annulled by that of the coil, and a small magnet set itself at right angles to the field. In *Terrestrial Magnetism* for September, 1919, Prof. W. Uljanin, formerly of the Kazan University (from which the staff had to flee on the capture of the town by the Bolsheviks in September, 1918), gives an abstract of a paper he published in Russian in 1915 describing a third method. It retains the sine principle of the Kew magnetometer, but substitutes for the deflecting magnet a pair of coils through which a standard current measured by the potentiometer method is sent. The method gives results at least as accurate as those given by the magnetometer, and takes only a tenth of the time.

TWO useful papers on three-electrode thermionic valves have been published recently by the Bureau of Standards, Washington. The first paper, by Mr. J. M. Miller, discusses the connection between the input impedance of the valve and the load in the plate circuit. Theoretical relations are obtained which enable us to calculate the input impedance when the impedance in the plate-circuit is known. It is shown that the results are in excellent accord with experiment. It is interesting to notice that when the load in the plate circuit is inductive, the impedance can be represented as a negative resistance, in which case the valve can act as a generator. The second paper, by Mr. L. M. Hull, gives a partially successful attempt to obtain a method of rating thermionic-valve generators. A clear theoretical statement of the problem is given, and important theoretical conclusions are deduced, but experimental work is still in progress. The problem is one of considerable commercial importance, as thermionic-valve generators are now the standard source of supply for radio-telephone and radio-telegraph systems, except in the few cases when very high power is necessary. The present empirical method used for rating these generators is of little value. All interested in the subjects discussed in these papers, the numbers of which are 351 and 355 respectively, can obtain a copy of them by sending a request to the Bureau.

IN the U.S. Bureau of Standards Scientific Paper No. 350, entitled "Equilibrium Conditions in the System Carbon, Iron Oxide, and Hydrogen in Relation to the Ledebur Method for Oxygen in Steel," it is shown that mixtures of iron oxide and Acheson graphite are not, and mixtures of iron oxide with "cemented" iron or white iron (annealed or unannealed) are, reduced at 900° C. by the carbon in them when hydrogen is passed over them at rates of two litres per hour, or faster. Because of these facts it is probably impossible to determine by the Ledebur method more than 75 per cent. of the oxygen present in steels as ferrous oxide. The effect of rate of passage of hydrogen on the Ledebur oxygen-content of certain steels is shown. The paper can be obtained on application to the Bureau.

SCIENTIFIC Paper No. 347 of the U.S. Bureau of Standards describes an investigation carried out at the Bureau on the heat-treatment of alloys of the duralumin type, and the effect on the mechanical properties observed of variations in the various heat-treatment conditions. Conclusions are also drawn as to the best conditions for the commercial heat-treatment of this alloy. A theory of the mechanism of hardening during the ageing of duralumin is proposed, based on the decreasing solubility with decrease of temperature of $CuAl_2$ in aluminium. The precipitation of this compound, suppressed during quenching, proceeds during ageing, and takes place in a highly dispersed form. To the presence of this highly dispersed constituent is due the hardness of the aged alloy. Those interested may obtain a copy of the paper on application to the Bureau.

A SHORT list of books dealing with entomology, containing 165 titles, has just been issued by *Mr. F. Edwards*, 83 High Street, Marylebone, W.1. Many of the books listed are much reduced in price.

THE latest scientific catalogue (New Series, No. 89) of *Messrs. J. Wheldon and Co.*, 38 Great Queen Street, W.C.2, contains upwards of 1500 items relating to pure and applied chemistry, astronomy, electricity, mathematics, meteorology, physics, etc. In addition, particulars are given of many sets and long runs of scientific serials and transactions of scientific societies which Messrs. Wheldon have for disposal. The price of the catalogue is 2*d*.

THE following are among the announcements of books to be published by *Messrs. Macmillan and Co., Ltd.*, between now and Easter:—"Cytology: With Special Reference to the Metazoan Nucleus," Prof. W. E. Agar, illustrated; "The Principles of the Phase Theory: Heterogeneous Equilibria between Salts and their Aqueous Solutions," D. Clibbens, illustrated; "The Theory of Determinants in the Historical Order of Development," Sir Thomas Muir (vol. iii.: The Period 1861 to 1880); "A Manual of the Timbers of the World: Their Characteristics and Uses," A. L. Howard, to which is appended an account of the Artificial Seasoning of Timber by S. Fitzgerald, illustrated; "Essays on the Surgery of the Temporal Bone," Sir Charles A. Ballance, with the assistance of Dr. C. D. Green, 2 vols., illustrated; "Space, Time, and Deity" (Gifford Lectures at Glasgow, 1916–18), Prof. S. Alexander, 2 vols.; "Implication and Linear Inference," Dr. B. Bosanquet; "Mind-Energy," Prof. H. Bergson, translated by Prof. H. Wildon Carr, in collaboration with the author; "The Idea of Progress: An Inquiry into its Origin and Growth," Prof. J. B. Bury; "Essays in Critical Realism: A Co-operative Study of the Problem of Knowledge," Profs. D. Drake, A. O. Lovejoy, J. B. Pratt, A. K. Rogers, G. Santayana, R. W. Sellars, and C. A. Strong; "A Critical History of Greek Philosophy," W. T. Stace; "Through Deserts and Oases of Central Asia," Miss Ella Sykes and Brig.-Gen. Sir Percy Sykes, illustrated; "The Handbook to Cyprus," H. C. Luke and D. J. Jardine, new edition; "The Ila-speaking Peoples of Northern Rhodesia," Rev. E. W. Smith and the late Capt. A. M. Dale, 2 vols., illustrated; "Among the Natives of the Loyalty Group," Mrs. E. Hadfield, illustrated; "England," edited by F. Muirhead (The Blue Guides); and "Highways and Byways in Northumbria," P. A. Graham, illustrated by Hugh Thomson. *The Open Court Co.* (Chicago and London) will publish shortly "A History of the Conceptions of Limits and Fluxions in Great Britain from Newton to Woodhouse," Prof. F. Cajori. It will form No. 5 of the Open Court Classics.

OUR ASTRONOMICAL COLUMN.

SPECTROSCOPIC DETERMINATION OF STELLAR PARALLAX.—Since this method of parallax determination was devised the number of stars of which the parallax has been measured trigonometrically has increased considerably. With the view of testing the accuracy of the curves used for deducing absolute magnitude from the relative strength of certain spectral lines, Messrs. W. S. Adams and G. Strömberg have made an exhaustive comparison between their spectroscopic parallaxes, which now number some 1500, and the parallaxes deduced from direct measures and proper motions; the results are given in Proc. Nat. Acad. Sci., July, 1919. The stars are divided into five spectral groups, A7 to F8, F9 to G8, G9 to K3, K4 to K9, and Ma to Md. The spectroscopic method has not yet been applied to types B_0 to A_6, as suitable spectral lines have not been found. The graphs show very satisfactory accordance, the weakest point being the fainter absolute magnitudes in the first group, where the spectroscopic determinations of distance are smaller than those measured directly. The last two groups indicate very clearly the division into giant and dwarf stars; this is also faintly indicated in the second and third groups, but not at all in the first.

The authors draw the satisfactory conclusion that "in this large amount of observational material hardly a single serious contradiction has been found between the spectroscopic and trigonometric results."

MINOR PLANETS.—Dr. F. Cohn gives his annual report on the orbits of recently discovered planets in *Astr. Nach.*, 5030. There are now 914 planets to which permanent numbers have been assigned, besides several hundreds which have been observed insufficiently; approximate orbits have been computed for about eighty of the latter. Two of the freshly numbered planets are of special interest—No. 898 for its high eccentricity, amounting nearly to 0·4, and No. 911, since it is a sixth member of the Trojan group, the mean motions of which are the same as that of Jupiter. Two others, Nos. 895 and 914, are notable for large inclinations, more than 25° in each case.

LUNAR PHOTOGRAPHY WITH THE 100-IN. REFLECTOR.—*Popular Astronomy* and Pubs. Astr. Soc. Pacific for December contain reproductions of some beautiful photographs taken with the new reflector at Mount Wilson by Mr. F. G. Pease. Silver prints have also been presented to the Royal Astronomical Society. The equivalent focus is 134 ft.; the scale is, therefore, very large, and a wonderful amount of fine detail is shown. Prof. Hale notes that the instrument is to be called the Hooker telescope, in memory of the donor of the optical parts. It is welcome news that its performance comes up to the highest expectations, and that the Mount Wilson conditions of seeing prove equal to standing this most severe test upon them. "The (radial) motions of faint stars in the heart of globular clusters and in the star-clouds of the Milky Way can be measured." Nebulium has been found in the variable star R Aquarii, and luminous clouds of calcium vapour are found to surround the star in Hind's variable nebula in Taurus. It is also possible to study the spectra of the faint companions of close double stars.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES.

AT the annual public meeting on December 22, M. Léon Guignard in the chair, the prizes awarded in 1919 were announced as follows:—

Mathematics.—The Bordin prize to Salomon Lefschetz; the Francœur prize to Georges Giraud, for his work on automorph functions.

Mechanics.—The Montyon prize to Albert Herdner, for his work on the construction and working of locomotives; the Poncelet prize to Gen. Prosper Charbonnier, for the whole of his work on ballistics.

Astronomy.—The Lalande prize to Vesto Melvin Slipher, for his work at the Lowell Observatory, especially his researches on nebulæ and star clusters; the Benjamin Valz prize to Félix Boquet, for his work at the Paris Observatory; the G. de Pontécoulant prize to Arthur Stanley Eddington, for his studies of stellar movements.

Geography.—The Gay prize to René Chudeau, for his explorations in Western Africa; the Tchihatchef prize to E. C. Abendanon, for his book entitled "Expédition de la Célèbes centrale."

Navigation.—The prize of 6000 francs between Yves Le Prieur and Georges Sugot; the Plumey prize between Georges Raclot (1500 francs), for his experimental researches on the longitudinal flexure of ships, Maurice Poincet (1500 francs), for his theoretical and experimental researches on the blades of steam turbines, and Alfred Schwartz (1000 francs), for his work as a whole.

Physics.—The Kastner-Boursault prize to Marius Latour, for his researches on electric motors; the Gaston Planté prize to Emile Brylinski, for his work in applied electricity; the Hébert prize to Raymond Jouaust, for his work on magnetism, electrical standards, photometry, and wireless telegraphy; the De Parville prize to Louis Décombe, for his work in various branches of physics; the Hughes prize to Henri Chaumat, for his work on the industrial production of ozone, the electrolytic reduction of indigo and other dyes, and other work in electrotechnics; the Pierson-Perrin prize to Georges Sagnac, for his work on the secondary X-rays, interference, and other optical phenomena; the Clément Félix foundation to Charles Féry, to enable him to continue his experiments on the production of a small dry accumulator.

Chemistry.—The Montyon prize (Unhealthy Trades) to Georges Rivat (2500 francs), for his work on the analysis and absorption of asphyxiating gases; an honourable mention to Arnold Lassieur (1500 francs), for his contribution to the identification of the substances contained in the German poison shells; an honourable mention (1000 francs) to Cyrille Toussaint, for his chemical studies connected with the war; the Jecker prize between Ernest Fourneau (5000 francs), for his services relating to the synthetical preparation of medicinal organic compounds, Louis Maillard (2500 francs), for the whole of his work in organic chemistry, and Marcel Sommelet (2500 francs), for his researches on the ether oxides, the homologues of benzyl chloride, alcohols, and aldehydes; the Cahours foundation divided equally between Georges Mignonac and Marcel Murat, for their work in organic chemistry; the Houzeau prize to René Locquin, for similar researches.

Mineralogy and Geology.—The Delesse prize to Frédéric Roman, for his geological and palæontological work; the Victor Roulin prize to Léonce Joleaud, for the whole of his work; the Joseph Labbé prize to Pierre Pruvost, for his studies on the Coal Measures of Northern France.

Botany.—The Montagne prize between Fernand Moreau (1000 francs) and Gabriel Arnaud (500 francs); the Jean Thore prize to Auguste Sartory, for his publications on cryptogamic botany; the De Coincy prize to C. Houard, for his work on the cecidology of European Phanerogams; the Jean de Rufz de Lavison prize to Raoul Combes, for his researches on the absorption of glucosides by plants and on plant pigments.

Anatomy and Zoology.—The Cuvier prize to J. Jolly, for his work in histology; the Savigny prize to Louis Boutan, for his botanical and zoological studies in the Red Sea and Indo-China.

Medicine and Surgery.—Montyon prizes to Michel Weinberg and Pierre Seguin (2500 francs), for their memoir on gas gangrene; Louis Martin and Auguste Pettit (2500 francs), for their memoir on ictero-hæmorrhagic spirochætosis; Henri Rouvillois, Guillaume Louis, Albert Pédeprade, and Antoine Basset (2500 francs), for their studies on war surgery. Honourable mentions (1500 francs) to Jean Fiolle and Jean Delmas, for their book on the discovery of the deeper vessels; to Alfred Boquet and L. Nègre, for their work on epizootic lymphangitis; and to H. Gougerot, for his work relating to venereal diseases. The Barbier prize to Albert Goris, for his work on the localisation of glucosides in plants and on the preparation of catgut for surgical purposes; the Bréant prize (arrears) to Paul Ravaut (3000 francs), for his researches on malaria, and to Lucien Camus (2000 francs), for his researches on infection and vaccinal immunity; the Godard prize to Albert Pézard, for his researches on the genital glands; the Chaussier prize between Albert Dustin (3000 francs), for his studies relating to neurology, embryology, and histology, Marcel Frois and Barthélemy Caubet (3000 francs), for a memoir on fatigue in industrial work, Adrien Grigaut (3000 francs), for his memoir on new chemical methods in pathology and their results, and Hector Marichelle (1000 francs), for his researches on the mode of production of speech sounds; the Mège prize (encouragement of 300 francs) to Jules Glover; the Bellion prize to the late Georges Demenÿ, for the whole of his work, and a very honourable mention to Humbert Boucher; the Baron Larrey prize to Camille Lian, for his memoir on the cardiac troubles of soldiers; the Argut prize to Robert Pierret, and a citation to Victor Raymond and Jacques Parisot, for their memoir on trench-foot.

Physiology.—The Montyon prize to Robert Lévy, for his work on the toxins of genital products of certain animals; the Lallemand prize to Léon Binet, for his monograph on trembling, and a very honourable citation to E. Couvreur and E. Duroux, for their work on nerve-lesions, and to André Léri, for his memoir on war-shock and emotions; the Philipeaux prize to Mme. Lucie Randoin-Fandard, for her researches on blood-sugar; the Fanny Emden prize to Léon Chevreuil, for his memoir on existence after death.

Statistics.—The Montyon prize to Arthur Chervin, for his book on Germany of to-morrow.

History and Philosophy of the Sciences.—The Binoux prize to the late René Larger, for his publications on the extinction of species by degenerescence and the theory of counter-evolution or degenerescence by pathological heredity.

Medals.—The Berthelot medal to Georges Rivat, Louis Maillard, Marcel Sommelet, and René Locquin.

General Prizes.—Grand prize of the physical sciences to Louis Roule, for his researches on the migrations of fishes; Petit d'Ormoy prize to Henri Lebesgue, for his mathematical works; the Estrade Delcros prize to H. Perrier de la Bathie, for his scientific work in Madagascar; the J. J. Berger prize between Paul Juillerat and Emile Gérards; the Saintour prize to Eugène Pagézy, for his anti-aircraft work; the H. de

Parville prize between Héloïs Ollivier (1500 francs), for his course of general physics, and Adrien Loir and H. Legangneux (1500 francs), for their work entitled "The Products of the Sea"; the Lonchampt prize to Camille Delezenne, for his work on the presence and *rôle* of zinc in animals; the Henry Wilde prize between Jean Rey (1000 francs), for his researches on projectors, and Adrien Bochet (1000 francs), for his mechanical and optical inventions; the Thorlet prize to Adolphe Richard, for his catalogue of scientific books in the libraries of Paris.

Special Foundations.—The Lannelongue foundation to Mme. Cusco and Mme. Ruck.

The Laplace prize to Robert Henri Le Besnerais, Maurice Victor Duruy, and the late Charles Marie Carcopino-Tusoli; the L. E. Rivot prize to Robert Le Besnerais and Maurice Duruy (each 750 francs), Louis Delmas and Henri Pagezy (each 500 francs), Joseph Fontaine and Albert Masselin (each 750 francs), Robert Besse and Henri Lang (each 500 francs).

Foundations for Scientific Researches.—The Gegner foundation to René Baire, for his work on the general theory of functions; the Charles Bouchard foundation to Jean Camus, for the continuation of his work on nerve reactions, the regeneration of nerves, and the effect of various poisons on the nerve-centres.

[*Note.*—As in former years, the Bonaparte and Loutreuil foundations have been omitted, and will be dealt with in a separate article.]

EDUCATIONAL CONFERENCES.

THE eighth annual Conference of Educational Associations was held at University College, London, on December 31–January 10. Three tendencies could be observed in the lengthy list of lectures and discussions arranged for this well-attended conference: the preparation of the citizen, testing for capacity, and care for the artistic side of life. The Master of Balliol took "The Education of the Citizen" as his topic before the Training College Association, while to the Assistant Mistresses' Association Mr. Evan Hughes lectured on "The Importance of a Wider Knowledge of Economic Principles." Under this head, too, came a discussion of continuation schools and their possibilities. Sir William Ashley, in presiding at a joint conference on this topic, emphasised the difficulty of forecasting the labour demand of different occupations, and of anticipating the place that skill would occupy within any one industry. Mr. Spurley Hey, Director of Education, Manchester, found his difficulties in the provision of buildings and teachers, and was critical of works schools; whilst Mr. Beresford Ingram was more distressed by the problem presented by the small employer. The Civic Education League also took up this question in a discussion on education and industry, which largely turned upon the problem of the works school, and, in conjunction with the Infant Welfare Association, arranged a course of twelve lectures dealing very thoroughly with the whole question of infant care and child nurture.

Eugenics entered into this course, but was more specifically treated by Dr. R. Douglas Laurie, who lectured on "Eugenics Education in the Training College," and at a later session on "Eugenics Education in the School," before the Eugenics Education Society. He would not allow the feeble-minded criminal to hand down his qualities, or the aggravated pauper to pass on his inherent pauperism; and the question of deaf-mutes and epileptics should be considered. The eugenic point of view should be part of the mental constitution of every normal citizen, and to this end he would have some measure of biological training given to every boy or girl. This should begin with Nature-study, develop into physiology, and then into hygiene, which should lead on to eugenics.

A correlative of such teaching was to be found in a brilliant lecture by Dr. Olive Wheeler to the Assistant Mistresses' Association on "New Views of Human Personality." Dr. Wheeler contrasted the mechanistic tendencies of the nineteenth century with those of a more idealistic character which were becoming current in the twentieth. This change she traced largely to the development of modern biology and psychology. The child was born with certain dynamic forces: the instincts as described by McDougall, the appetites as outlined by Drever. These powerful impulses needed expression; if repressed, they still existed in the realm of the unconscious, and continued to influence conduct. Attention was directed to Bergson's view that the essential difference between a living organism and a machine was the power of creation and the importance he attached to that modification in the "urge," or dynamic flux, which caused an organism to move in a specific direction.

The problem of testing capacity was first raised by Mr. G. F. Daniell, of the Kent Education Department, in opening the discussion on "The Selection of Elementary Children for Higher Forms of Education." Mr. Daniell favoured a preliminary examination in the elementary schools of pupils between ten and twelve years of age, by which some would be selected for a final examination, to consist of written tests in English and arithmetic. The teacher's report and the school record should be considered, and an interview arranged in at least all doubtful cases. Psychological tests he held to be useful and valuable in this connection, and he thought that careful inquiry did not support the view that the largely written character of the examination excluded from the secondary schools all who were gifted in artistic work and craftsmanship, though it would be well to include in the examination a test of such ability, could one be devised that was both satisfactory and easily applied.

The question of psychological tests was dealt with by Dr. P. B. Ballard in his lecture on "The Measurement of Practical Ability" before the Educational Handwork Association. Dr. Ballard's incidental exhibition of the well-known tapping machine for testing innate motor ability was largely reported in the Press, and equally misunderstood. The whole subject was treated more fully in his lecture on the following Monday to the British Psychological Society on "The Development of Mental Tests," one of the most successful and largely attended meetings of the conference. He pointed out that the history of mental testing was, in the main, an attempt to introduce mathematics into the solution of the problem of the selection of ability. The earliest attempts were in the direction of finding some physical correlate of mind, as in the phrenology of Gall, the physiognomy of Lavater, and the criminology of Lombroso. But neither such static measurements, nor the later applied dynamic measurements of motor response to stimulus, gave results that were valid beyond their own sphere. They had passed from the physical to the psycho-physical, and were now reaching out to the psychical tests. But success in securing standardised tests and measurements depended upon three mathematical conceptions: that of a definite scale for the measurement of intelligence first devised by Binet, much abused but much used; that of the law of normal distribution enunciated by Quetelet, but first applied to mental traits by Galton; and that of the doctrine of correlation, suggested also by Galton, but elaborated by Prof. Karl Pearson and by Prof. Spearman. The same subject received further treatment by Prof. John Adams in a lecture on "Tests of Intelligence" before the Association of University Women Teachers, wherein he pointed out the dependence of efficiency of intelligence upon its environment, and the well-marked distinction that tests had revealed between knowledge and capacity; educational attainments did not hide lack of intellectual ability.

Within the artistic sphere of the conference were embraced play, music, dancing, and the drama, all popular and suggestive topics. Prof. James Shelley gave a thoughtful lecture on "The Seriousness of Play" before the Froebel Society; Dr. Somervell treated of "The Place of Music in Education" before the Girls' School Music Union, as did Mr. Stewart Macpherson before the Association of Head Mistresses, before which also Mr. Burret Carpenter lectured on "The Place of Art in Education." Very popular, too, were the lecture, with demonstration, on "Folk Dancing" by Mr. Cecil Sharp before the English Folk Dance Society, and that on "Eurhythmics" by M. Jaques-Dalcroze, and held at the Lyceum Theatre; whilst the British Drama League drew a crowded house to hear Mr. Ben Greet's account of the great work being done in London in introducing the acted Shakespeare play to children from the elementary and secondary schools in school-time.

Altogether it was a very full conference, but those who attempted the whole course could only save themselves from "mental indigestion" by applying to the lectures Mr. Fisher's dictum about books given in his opening address. "Some books live to be skimmed; others claim to be studied minutely in whole or in part. The true reader discerns his proper food by intuition."

GEOGRAPHICAL ASSOCIATION.

The annual meetings of the Geographical Association were held in London on January 9–10. Sir C. P. Lucas, in his presidential address, opened out fresh lines of thought concerning islands as centres of preservation of human diversities and their relations to peninsulas, all in connection with the development and fate of empires and commonwealths. He suggested that the giving of self-government to British Colonies and Dominions might be due to home experience of diversities within the British Isles and of the need for giving each group opportunities of development in its own way.

Dr. R. N. Rudmose Brown emphasised the development of the coal export trade from Spitsbergen, and estimated that next year 250,000 tons of coal would be shipped. He referred to the extra-territorial rights of British, Swedish, and Russian estates within the new Norwegian dominion of Spitsbergen created by the Paris Conference.

The educational side was dealt with by Mr. T. W. F. Parkinson, who urged that the Board of Education should do more to encourage geography in the higher forms of secondary schools, and that more scholarships should be opened to students of geography. The discussion brought out references to the creation of a Geographical Tripos at Cambridge and to the full recognition of geography in the faculties both of arts and of science by the University of Wales, as well as to the new creation of an arts degree (Pass and Honours) at Leeds and London.

An important demonstration of the value of the kinema in geographical teaching was given to a large audience by Capt. C. E. Hodges. Mr. M. de Carle S. Salter, Superintendent of the British Rainfall Organisation, gave a very valuable original paper on rainfall as a geographic function.

SCIENCE MASTERS' ASSOCIATION.

The annual general meeting of the Science Masters' Association was held at the London Day Training College on January 6 and 7. The president (Mr. W. W. Vaughan, Master of Wellington College), in his address, directed attention to the importance of science as part of a liberal education. But the aim of scientific education must not be commercial prosperity. History taught that utilitarian science always degenerated. The object of education is the liberating of man's soul.

The following subjects were then discussed:—(1) The teaching of organic chemistry (Mr. W. J. Gale, King's College School, Wimbledon). (2) Biology in the school syllabus. Mr. F. W. Hodges (Cooper's School, Bow) urged the necessity of making biology an integral part of school science. Prof. Hickson (Manchester) supported this view, and contended that it was impossible to teach the science of life from plants only. (3) Laboratory management (Mr. H. Preston, Caistor Grammar School). (*a*) *The Training of Assistants.*—In order to obtain suitable boys, the occupation of laboratory assistant must not be allowed to remain such a blind-alley occupation as it is at present. Proper provision should be made to fit these boys for a career, and to provide suitable education for them. (*b*) *Cost of Apparatus.*—The high cost of apparatus is detrimental to the necessary expansion of science teaching at the present time. Mr. Preston considered that the cost was unnecessarily high in many cases, and indicated that science teachers were being exploited or else that British manufacturers were incapable of producing apparatus at a reasonable cost. As the result of this discussion a committee was appointed to inquire into the matter.

In the evening an interesting lecture was delivered by Dr. Crommelin on the British observations during the solar eclipse of May last. After giving a brief, but clear, outline of Einstein's theory and the experimental work which led up to it, Dr. Crommelin described the measurements of the deflection of light-rays passing close to the sun, as shown by the positions of star images on the photographic plates.

On January 7 the subjects discussed were as follows:—(1) Science teaching in the early stages. Major V. S. Bryant considered that science in preparatory schools should be part of the whole teaching, and not segregated. In the discussion the conclusions arrived at were:—To avoid so-called "practical measurement"; to stimulate the boys' interest, and that not less on the biological than on the mechanical side; to avoid restricting natural history to biology; and to give adequate attention to the teaching of English. (2) The divorce of laboratory and class-room courses (Sir Richard Gregory, and Mr. G. D. Dunkerley, Watford Grammar School). Sir Richard Gregory's paper was mainly a reaction against the idea that the only science teaching of value is that given in the laboratory. This view has led to the neglect of those sciences which do not lend themselves to experimental treatment, and hence the undue prominence given to physics and chemistry. The "science for all" courses of the S.M.A. are conceived in the new spirit of science teaching. Laboratory work should not merely be exercises in measurement, but also deal with subjects which cannot be treated in any other way. Laboratory work is intended to give an idea of scientific method; class-room courses should give a broad survey of scientific facts, principles, and achievement.

THE PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.

THE tenth annual exhibition of electrical, optical, and other physical apparatus, arranged by the Physical Society of London and the Optical Society, was held on January 7 and 8 at the Imperial College of Science, South Kensington. For the first time, we believe, the exhibition extended over two days. The extent of the exhibits was also greater, two floors of the physics department of the Imperial College being occupied in place of one, as in previous years, the last being 1913. To some extent this expansion was due to a special reason, namely, the inclusion of a supply of German instruments captured during the war, shown by permission of the Admiralty, the Air Ministry, and the War Office. The attendance was very satisfactory. The fact that the annual Conference of Educational Associations was meeting in London during the week allowed many teachers the opportunity to pay a visit, and we believe this was taken full advantage of.

There are two sides to an exhibition of this kind, the educational and the commercial, and the two react. The visitor is anxious to buy as well as to learn; the exhibiting firms are ready to learn as well as to sell. There is much intercourse and interchange of ideas, which may fructify later in the improvement of old instruments and in the devising of new.

Although business affairs are by no means stabilised as yet, the standard reached by the exhibits shows that a keen, progressive, and enterprising spirit is alive amongst makers of scientific appliances. It is not surprising to learn that a great exhibition of products of the British Empire, to be held in London in 1921, is already in hand.

Two discourses which attracted good attendances were given daily; one on "The Use of Light in the Transmission and Reproduction of Sound," by Prof. A. O. Rankine; the second on "Some Polarisation Experiments," by Prof. F. J. Cheshire. In the former was given an exposition of an application of the selenium cell, which suggests the possible supersession of the purely mechanical method of reproduction of speech and music by the gramophone.

A marked feature of the exhibition was the large number of demonstrations of apparatus in action. There is no doubt that this is widely appreciated, and that the effects in stimulating interest and inquiry are fully commensurate with the pains taken by the firms concerned. Amongst these may be mentioned the production of electrical oscillations by the triode thermionic tube, the indirect compensated illumination known as "Sheringham daylight," and Mr. Darling's simple device for indicating the quenching temperature in the hardening of steel. The model aeroplane cabin with its array of instruments *in situ* (shown by Hughes and Son) was also most instructive.

It is impossible in a brief survey to do justice to all the items of apparatus displayed, or to the firms who participated; only a few can be referred to. First, we would mention thermionic tubes. Few are unaware of the great use that was made of these instruments in the course of the war, and of the many purposes for which they can be employed; and one was naturally prepared to find, though not less grateful on finding, a fairly complete exhibition of various stages in the evolution of the diode, and especially of the triode, forms of tube. These were shown by the Marconi-Osram Co., the Edison-Swan Co., and H. W. Sullivan, the production of electrical oscillations by use of the triode tube being demonstrated.

The electrical CO_2 recorder (the Cambridge and Paul Instrument Co.) for the testing of flue-gases furnishes an interesting example of the application of physical principles in combination. The percentage of carbon dioxide in the flue-gases determines the thermal conductivity of the gas; this determines the rate of cooling of an immersed heated platinum wire; and this in turn determines the current in the galvanometer of an unbalanced Wheatstone bridge, of which the platinum wire constitutes one arm. This example recalls another instance of the application of indirect measurement, namely, the dionic (?) water-tester (Messrs. Evershed and Vignoles), where the electrical conductivity serves to indicate the extent of inorganic impurity present.

A collection of glasses by Chance Bros., though on a modest scale, was of great interest. It included the Crookes spectacle glasses, which protect the eye by cutting out the ultra-violet rays, and an ultra-violet glass, opaque to the visible spectrum, but transmissive of the ultra-violet. Demonstrations of their properties were made by the aid of a nichrome arc and a fluorescent screen of barium platinocyanide.

Amongst Hilger's instruments for refined optical measurement we may single out the vacuum spectrograph (shown by courtesy of Prof. Fowler), which permits of photographing the spectrum in the Schumann region.

Optical instruments of high quality were displayed by many firms, including Charles Baker, Hughes and Son, Bellingham and Stanley, Davidson and Co., Watts and Son, W. Ottway and Co., Penrose and Co., Watson and Sons, Newton and Co., and Rheinberg and Co. Exhibits of books by the Cambridge University Press, Macmillan and Co., and several other firms were much appreciated.

There is room, we think, for one criticism of the quality of the exhibits. We refer to the comparative absence of simple forms of apparatus. There is a great need, for teaching purposes in schools and colleges, of apparatus, made without elaboration, of an open type that will proclaim its principle at a glance. Dr. Searle's apparatus occurs to one as a good example of the type desired. Collaboration between teachers and manufacturers would serve to hasten a development that is urgently required, and we commend this field to the attention of both. D. O.

THE CHARTERS TOWERS GOLDFIELD.

THE Geological Survey of Queensland has published a very complete description of the Charters Towers goldfield by Mr. J. H. Reid (Publication No. 256). Although this was for long the most important goldfield in Queensland, and had, in fact, for many years the largest gold output of any of the individual goldfields in the whole of Australia, no full account of the geology of the field or of the nature of the ore deposits has yet been published, so that the issue of the present monograph is fully justified. Furthermore, had the issue of such a work been delayed much longer, it could never have been carried out effectually, as many of the mines are now closing down. The goldfield was discovered in 1871, and ten years later the gold production was close upon 75,000 oz. of gold bullion; in 1887 this output had doubled, reaching 151,500 oz.; and in 1899 the highest output, namely, 319,572 oz. of fine gold, was attained. From that time the production has been a steadily declining one, the drop since 1912 having been particularly rapid, until in 1916 the output was only 33,107 oz.

Unfortunately, it is only too clear from the report that this falling off is not a temporary phase, but is due to the very nature of the gold deposits themselves, and that the field is rapidly approaching exhaustion. It is shown that the principal country rock is a granodiorite of Lower Devonian or pre-Devonian age, traversed by numerous dioritic dykes and by well-marked systems of fault-fissures, the throw of the latter being generally inconsiderable. Within the zones of shattered rock accompanying these fissures veinlets of auriferous quartz have been deposited, undoubtedly, according to the author, by hydro-thermal agencies. The veins are, for the most part, narrow, ranging as a rule from a few inches to 5 ft. in thickness, anything more than 5 ft. being considered exceptionally large.

There are two main auriferous belts, both running north-east to south-west; the more northerly one, containing all the more famous lodes, such as the Day Dawn and the Brilliant, is about three miles long and three-quarters of a mile wide; the less important southerly belt is of about the same length, but never exceeds 200 yards in width. A small number of scattered mines have been worked outside these belts, but most of these are now closed down. The noteworthy feature of all the lodes is that, whilst the fissures persist in depth, the gold values do not, the mines as a whole showing progressive impoverishment in depth. To quote the author:—"It can be affirmed that pay shoots between the surface and the 1000-ft. level were richer than those between 1000-ft. and 2000-ft. levels, and that these were correspondingly richer than those found below 2000 ft."

THE NEW ZEALAND SCIENCE CONGRESS, 1919.

NEW ZEALAND occupies a unique and advantageous position for scientific work. Situated in the midst of the vast Pacific, she has splendid opportunities for the pursuit of the fascinating studies of oceanography and the meteorology and astronomy of the southern hemisphere. Innumerable problems in geography, geology, and physiography, of an entirely novel and supremely interesting kind, present themselves, not only in New Zealand itself, but also in the surrounding Pacific and further south in the mysteries of the Antarctic. In her flora and fauna and native races, in her varied mineral wealth, in her large reserves of water-power, both fluvial and tidal, there are endless opportunities for the man of science. In her political, social, and economic institutions she is bound to make valuable contributions to experimental sociology; and it is the experimental side that chiefly matters and stands most in need of encouragement in these days of nebulous theories and unsubstantial visions.

It is perhaps only natural that, in her present stage of development and in view of the smallness of her population, New Zealand should appear to limit her research outlook chiefly to matters of a practical and utilitarian nature. In such a purely agricultural community it is only to be expected that the biological sciences—applied botany and zoology—should occupy a predominant position, as is clearly evidenced by the election of a distinguished botanist as president of the New Zealand Institute and Science Congress, and also by an analysis of the contents of the first fifty volumes of the institute's Transactions. Such analysis discloses that, of the papers contributed, zoology claims 1143; botany, 654; geology, 503; anthropology, 204; physics (including astronomy and meteorology), 152; chemistry, 135; engineering, 76; mathematics, 40; economics, 37; history, 34; metaphysics, 22; medicine, 20; literature, 15; education and statistics, 12 each. It must be remembered, however, that many valuable contributions do not appear in the Transactions; some are published in scientific journals in Great Britain; the Geological Bulletins and the Palæontological Bulletins of the New Zealand Government absorb others. The *Polynesian Journal* takes most of the papers on anthropology.

In commenting on the predominance of the natural history papers, the president, Dr. Cockayne, pointed out that this is only to be expected in a new land with both flora and fauna so little investigated and containing so much that is endemic. Most of the papers are devoted to classification. "This must have been so; it is the natural evolutionary process in the history of biological research the world over. . . . As for chemistry and physics, which make but a poor showing in the work of the New Zealand Institute, little progress can be made in these sciences without well-equipped chemical and physical laboratories and men specially trained in such. Laboratories of this class are now attached to the various university colleges, and chemical and physical contributions—the work of trained students—are slowly but surely finding a place in the Transactions."

When it is remembered that the institute only receives the small sum of 500*l*. per annum as Government grant it is a matter for amazement that so much work has been accomplished. A levy of 200*l*. was made on the affiliated societies, which could ill afford it, but yet there are scarcely funds sufficient to publish the Transactions. Many papers of great value await publication, and much work of national interest awaits initiation. Government financial support and public sympathy are both badly needed, and it is hoped that the Science Congress, the first of its kind in New Zealand, will go far to supply these needs. The Government has, as a matter of fact, promised to do its utmost to place the institute on a firm financial footing, and has already made special grants for economic science.

The New Zealand Institute consists of a number of incorporated societies, namely, the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, the Otago Institute, the Hawke's Bay Philosophical Institute, the Poverty Bay Institute, the Manawatu Philosophical Society, the Wanganui Philosophical Society, and the Nelson Institute. The management of the New Zealand Institute is vested in a board of governors representative of the incorporated societies and of the Government, and this board meets annually in Wellington in January.

The Science Congress, organised by the institute this year and held in Canterbury, was the first of its kind in the Dominion, and owed its inception largely to proposals for the reform of the institute made by Dr. J. Allan Thomson in 1917. Dr. Thomson said: "In its relation to the public the New Zealand Institute should, but does not, hold a position analogous to that of the British Association for the Advancement of Science, the body which most keeps the public in touch with science, and from which most of the improvements in the State attitude to science have had their origin. The Australasian Institute for the Advancement of Science meets too seldom in New Zealand to be effective in this direction." The Congress was opened by the Governor-General of the Dominion, who, in his address, enumerated four important matters for investigation and study, namely, (1) public health and pandemic disease; (2) afforestation; (3) the mineral oil industry; and (4) fisheries. The Hon. G. W. Russell, Minister of Internal Affairs, urged the development of natural resources, especially hydro-electric power, and promised the institute adequate financial support. "The State must be prepared to foot the bill. I therefore urge the Science Congress to press upon the Government that without Governmental expenditure science cannot grow and expand; that scientists cannot live on air or on the hope of posthumous fame; and that therefore, if the Dominion is to develop by means of science, adequate funds must be provided for research, for the training of teachers and professors, for the equipment of laboratories and staffs, and for the creation of the scientific atmosphere of which I have spoken."

The president of the Congress (and of the New Zealand Institute), Dr. L. Cockayne, gave a brief historical account of the institute and described its immediate aims and aspirations. These are mostly agricultural at present, and in such a farming community nothing demands years of close study more than the soil itself. The world over, soil science, notwithstanding many books on the subject, is in its infancy. Chemical analysis of a soil, even with far better methods than those now available, is only one part of the question. The extremely difficult problems of soil-physics at once confront the investigator. Then there is the rich soil-flora and the rich soil-fauna. When more of a fundamental character is known as to the relation of soil-physics, soil-chemistry, and soil-biology to one another, then, said the president, undoubtedly new methods of soil-utilisation will be in sight. In the domain of anthropology Dr. Cockayne made the interesting suggestion that there is no need to confine one's investigations to primitive races, for amongst the settlers in a new land evolution in certain directions goes on apace. The question of dialect, for instance, among the white people of New Zealand would form a valuable study.

Although the presidential address was mostly biological, it is sufficiently evident, from an examination of the numerous and varied papers read, that other important branches of science are not to be overlooked by the institute. *Section* 1, *Biology and Agriculture*, had several papers of value and interest to the agriculturist, concluding with one by Sir James Wilson on "Agriculture's Debt to Science." *Section* 2, *Geology*, had papers on "The Older Gravels of North Canterbury," by R. Speight; "The Significant Features of Reef-bordered Coasts," by W. M. Davis; "Rough Ridge, Otago, and its Splintered Fault-scarp," by C. A. Cotton; "Natural Features of the Arthur's Pass Tunnel," by F. W. Hilgendorf and others; and "Geology of the Middle Clarence and Ure Valleys," by J. Allan Thomson. These and other papers will ultimately appear in the Transactions. Dr. Thomson also gave some interesting notes on the geology and palæontology of the Palliser Bay district, and a quantitative study of the silica-saturation of igneous rocks, suggesting a valuable means of comparing rock analyses. About a thousand such analyses have been calculated and plotted, and it is hoped to continue the work with the aid of a Government research grant.

Mr. E. K. Lomas dealt with some of the educational aspects of geography, and his opening remarks are well worth quoting: "Education, from one point of view, consists in bringing a mind into close touch with its environment through the senses. The more often the mind is roused to activity by excitations from the outside the more it develops. The special section of the environment in which we are particularly interested—I speak to a meeting of geologists—is that included under the term 'geology'; and the only means we have of introducing our subject into the schools is through the medium of geography, so that this subject should be an object of lively interest to all present. And there is no doubt about it, we shall have to take more interest in the subject for several reasons: (1) it is developing rapidly, (2) it is eminently suitable for educational purposes, (3) the present ignorance of geography is truly alarming and deplorable." If this be true of New Zealand, with its excellent educational system, it is still more applicable to this country. One of the most valuable papers in the geology section was "The Organisation and Functions of a State Geological Survey," by Mr. P. G. Morgan. This gave a brief account of most of the existing State geological surveys in the United Kingdom, Europe, India, Canada, the United States, Australia, and New Zealand, with suggestions for the organisation of such surveys in general and for New Zealand in particular.

In *Section* 3, *Chemistry, Physics, and Engineering*, Mr. D. M. Y. Sommerville described an improved planisphere and a slide rule for solving the quadratic equation. Dr. C. E. Adams, Government Astronomer, read a paper on "Tables of Mathematical Functions." Mr. Evan Parry, Government Electrical Engineer in New Zealand, said these tables constructed by Dr. Adams were of great value, for the ordinary tables of natural logarithms were not sufficiently minute for practical use in electrical work. Dr. Adams also gave another very interesting paper on "The Harmonic Analysis of Tidal Observations and the Prediction of Tides." No arithmetical approximations are used, so that a criterion is obtained with which to test the application of Fourier's series to tidal observations. The method of tide-prediction used in New Zealand is a graphic one, controlled by calculation, and is fully illustrated and described in the Survey Reports of the Lands and Survey Department for the years 1910–14. The results for Wellington and Auckland are published in the New Zealand Nautical Almanac by the Marine Department.

In his paper on "The Porosity of Porcelain," with special reference to high-pressure insulators for electric transmission lines, Mr. C. C. Farr said that the tests were made at the suggestion of the engineers of the Lake Coleridge electric supply system, who desired a method for determining whether the porcelain of the insulators was porous or not. The tests were carried out in the physical laboratory of Canterbury College by immersing specimens of porcelain in a fuchsin or red-ink coloured solution under a pressure of 2000 lb. per square inch, the solution being contained in a hole 3 in. in diameter and 6½ in. deep bored in a block of solid steel and covered with a steel cap 1 in. thick and a leather washer by means of eight bolts. Both glazed and unglazed porcelain was subjected to test, and it was concluded from the results that (1) density and porosity have little or no connection with each other, (2) porcelain can be made which shows no penetration after fifty hours' immersion under the pressure named, (3) porcelain is not always so made, and may contain a porous layer with abrupt edges in the mass of the substance. The experiments are being continued.

In a paper on "The Interference of Power Circuits with Telephone Circuits" Mr. E. Parry presented a mathematical treatment of the subject, as complete as possible, with the view of co-ordinating results of past experience and enabling effects to be predicted under given conditions, with special reference to the Lake Coleridge transmission lines. The New Zealand Public Works Department, together with the Post and Telegraph Department, has for some time been studying the influence of power circuits on telegraph and telephone circuits, since the wires for both services are supported on the same poles.

In Mr. E. E. Stark's paper on "The Effect of Low Power-factor from the Viewpoint of Electric Power Station Operators" it was suggested that the power stations using the alternating current system should charge the consumer for the total current taken, including both power-producing and wattless current—that is to say, the charge should be based on kilovolt amperes instead of kilowatts. If it is desired to equalise the rates without raising the price of electricity, an average power factor could be taken on a given system and a reduction made. Mr. H. Hill read a paper on "National Hydro-electric Schemes for New Zealand," in which he said it was difficult to understand the delay in formulating a national electric scheme for the Dominion. Mr. E. Parry's great North Island scheme should be put in hand at once, including the electrification of the East Coast railway. The people in the South Island also should insist on a national scheme.

Dr. Adams, in addition to his papers already noted, read others on (1) "Determination of the Position of the Moon by Photography," illustrated by photographs from the Lick Observatory. The very fine star images secured indicate the high efficiency of the Crossley reflector telescope, which was driven without any guiding, and the photographs prove that the position of the moon and terrestrial longitude can be determined with high precision. (2) "The Almucantar Method for Determination of Time and Latitude." (3) "A Nomogram for Transit Instrument Star Factors." Dr. Adams exhibited also some photographs on glass of the solar corona received by the Hector Observatory from Dr. W. W. Campbell, of the Lick Observatory in California. The photographs were taken by the Crocker Eclipse Expedition on June 8, 1918, at the total eclipse of the sun, with a 40-ft. camera pointed directly at the sun, and using 10 in. by 12 in. plates. The Lick Observatory had most remarkably good fortune at this eclipse: the sky had been completely cloudy all day, but cleared up in the neighbourhood of the sun one minute before totality, and this small portion of the sky remained clear until a few seconds after totality. The small region of unclouded sky containing the totally eclipsed sun seemed to be quite clear and was the bluest sky seen by the expedition.

Section 4, *General*, had papers on "Moriori Art," by Mr. H. D. Skinner, lecturer on ethnology at Otago University; "The Language of the Chatham Islands," by Archdeacon H. W. Williams; and "The Natural Laws of Poetry," by Mr. J. C. Andersen. The following papers, read in the General Section, should more properly have been included in Section 1, viz. "Afforestation in New Zealand," by Mr. W. H. Skinner; "Some Proposals with regard to Natural Afforestation in a New Zealand Mountain Area," by Mr. W. G. Morrison; and "Preservation of New Zealand Fauna," by Mr. E. G. Stead.

THE AFRICAN RIFT VALLEY.[1]

AFTER the discovery of Lake Rudolf in 1888, Suess showed that the Jordan, Dead Sea, and Red Sea fractures were not continued along the coast of Africa, but through the East African lake chain, the basins of which had been formed by the foundering of their floors between parallel faults. During an expedition to British East Africa in 1892–93 Prof. Gregory confirmed Suess's conclusions, with some modifications as to the age and origin of the Great Rift Valley, the formation of which he attributed to successive faulting during the great earth movements of the Kainozoic era.

The Rift Valley has been traced from northern Palestine to southern Africa. Its structure varies with its age and the nature of the country traversed. Thus the fault-scarps are better preserved along the Gulf of Akabah than in the older sections which enclose the Red Sea and the Gulf of Suez. The section in southern Abyssinia which connects the Red Sea with Lake Rudolf and the Rift Valley in British East Africa is locally irregular where intersected by the cross fractures that bound the sunk land of the Gulf of Aden. Across British East Africa the valley is a comparatively simple trench; its walls are often so steep that Sir John Bland-Sutton describes them as "as steep and abrupt as those of a grave," and for long the Uganda Railway worked its trains between the valley and plateau by a rope incline, and there is still no road for wheeled traffic from Nairobi to the floor of the Rift Valley.

[1] From a paper read before the Royal Geographical Society on January 5 by Prof. J. W. Gregory, F.R.S.

South of British East Africa it has been claimed that the Rift Valley comes to an end, only its western wall being continued as a fault-scarp. This arrangement occurs near Lake Mänyara, where the eastern side is a long, smooth slope which ends westward at the foot of the fault-scarp that bounds the Giant Cauldron Mountains. The structure may be explained as an extreme case of the asymmetry due to the different strengths of the rocks on the two walls. In southern British East Africa at Lage Magadi the western wall is a high, steep scarp, while the eastern side consists of a number of wide, flat steps due to parallel faults. At Lake Manyara, as the rocks on the eastern side are softer, the scarp has been dressed down to an even slope. This arrangement does not extend far; the eastern wall soon reappears, and, though Suess left a gap of 350 miles long between Lakes Manyara and Nyasa, the Rift Valley has now been traced across most of it.

That Nyasa is a Rift Valley basin has been proved by Andrews and Bailey. Its northern end is joined by the western branch, which includes Tanganyika, the Albert Nyanza, and the Upper White Nile. In the western branch the valley is in places irregular, as branches run off or the course is deflected along the grain of the country, to which that branch as a whole is oblique. South of the Zambezi the Rift Valley has been traced by Teale and Wilson, who have shown that a post-Eocene rift valley separates the Sheringoma plateau from the eastern front of Rhodesia. The long meridional section of the coast from Beira to Cape Corrientes appears to have been determined by the southernmost of the crustal movements of the Great Rift Valley.

The valley, therefore, extends from Lebanon to the Sabi River; its branches reach the mouth of the Gulf of Aden, and westward include the rift valleys of the Eastern Congo. Its length is about one-sixth of the circumference of the earth; hence it must have had some world-wide cause, the first clue to which is its age. The view that its history is geologically short commends itself by the freshness of its walls, by the legends of catastrophes, such as the destruction of Sodom and Gomorrah and the drowning of many villages on the formation of Tanganyika, having occurred along it during the time of man, and also by the fact that many of its faults are certainly recent. Nevertheless, the fuller evidence now available confirms the classification advanced in 1896, which attributed some of its lavas to the time of Chalk, and represented some of its faults as older than the uplift of the Alps. Some beds attributed to the Miocene on physiographical evidence are now proved of that date by the evidence of fossils. The rift valley of the Red Sea was certainly in existence by the Oligocene, and the southern end of the valley is shown to be of the same date by a fossil sea-urchin which has now been proved to be an East African species.

The history of the Rift Valley is largely dependent on the volcanic history of the country traversed. The first step in its formation was the uplift of a broad band of highlands extending from Palestine to Natal. The weakening of the support led to the collapse of the summit of this ridge. The sinking of the keystone caused volcanic eruptions along the adjacent fractures. The earliest of the great eruptions probably dates from the formation of the Arabian Sea and the breaking up of Gondwanaland, which originally included both India and Africa. These subsidences became more rapid about the end of the Chalk period, and led to volcanic eruptions on a colossal scale. On the eastern side of the foundered area were discharged the Deccan Traps, covering more than 200,000 square miles in India, and probably an equal area under the Indian Ocean. On the northern and western sides volcanic eruptions probably contemporary with the Deccan Traps formed the plateau-lavas of southern Arabia, Abyssinia, and the Kapite Plains in East Africa. These lava plains are older than the Rift Valley faults, and after them the East African arch fell in and initiated the Rift Valley; then followed eruptions from fewer vents building up higher volcanoes. They were followed by a lake period, the age of which is fixed by the remains of *Dinotherium Hobleyi* as Miocene.

That the whole volcanic history of British East Africa cannot be restricted to the post-Miocene is indicated by the evidence of Mount Kenya, since the glaciation of its valleys shows that they were in existence, the mountain had been deeply dissected before glacial times. It is incredible that the long volcanic history of the country, from the oldest plateau-lavas to the reduction of Kenya to its present form, should be restricted to only one period, the Pliocene.

If the first eruptions of the Rift Valley area were contemporary with the Deccan Traps, and therefore of the age of the Chalk, and the faulting lasted from the Oligocene to the Pliocene, the formation of the Rift Valley was connected with two great systems of earth movements, the foundering of the Indian Ocean and the uplift of the Alpine and Himalayan mountain systems. During the Mesozoic a slow deformation of the earth's crust caused the downward sagging of the North Polar regions and the buckling of the tropical and temperate zones by broad folds running east and west. Then elevation on lines trending north and south raised the East African highlands, while the collapse of the floor of the Indian Ocean caused widespread volcanic disturbances round the Arabian Sea. Later earth movements, which lasted for about the same time as the faulting of the Rift Valley, buckled the crust into the fold mountains of Europe and Asia. This corrugation was due to pressure, which in Europe was northward and in Asia southward. The reversal of direction may be explained by the difference in structure between Eur-Africa and Asia. Africa was a high plateau undergoing further uplift, while regional subsidence was taking place in and off northern Europe. The combined subsidence to north and uplift to south left Europe laterally unsupported on the north: the crust north of Africa was pressed northward, and buckled the country in front of it into fold mountain chains. In Asia the conditions were reversed; the massive plateau was to the north, and the sinking area was to the south in the Indian Ocean; so Asia was corrugated by a southward movement. The reversal from the European to the Asiatic direction occurred near the Sea of Azov and due north of the Rift Valley, which is the rift between the segment of the earth moving northward and that moving southward.

The structural contrast between Africa and America, due to the difference between the later mountain-forming movements, is explained by the fact that Africa is antipodal to the Pacific Ocean, and by the well-established principle that antipodal areas of the crust are subject to contrary conditions. While the Pacific was sinking, Africa was being upraised. The subsidence of the Pacific buckled its borders into the fold mountain chains of Western America, and those of which fragments can be traced from Japan to New Zealand. As Africa was being stretched by its uplift, and left unsupported on each side by the foundering of the adjacent oceans, it was rent by fractures between which the summit of its highlands fell in and formed the Great Rift Valley. "There may," says Sir George Adam Smith, "be something on the surface of another planet to match the Jordan Valley; there is nothing on this." That remark may be extended to the whole Rift Valley; for, in addition to the other unique features of Africa, its Rift Valley has no parallel elsewhere on the globe. The character of that valley may be explained by the special stresses in Africa due to its position antipodal to the great subsidence of the Pacific Ocean, while its course was determined by the wrench in the crust between the segment in which the pressure was northward against Europe and that pressing southward from the Asiatic highlands towards the infallen basin of the Indian Ocean.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

A JOINT discussion with Section F (Economic Science and Statistics) and the Subsection of Psychology on "The Influence of the Six-hour Day on Industrial Efficiency and Fatigue" was opened by Dr. H. M. Vernon. It has been suggested by Lord Leverhulme that two six-hour shifts may be more economical than one eight-hour shift, because the former would obtain twelve hours' use of expensive machinery instead of only eight hours. Examples were given of cases in which shortening of the hours of labour had increased the output, but in other cases the output had been decreased. The determining factor seems to be the amount of muscular effort put into the work. Heavy muscular work can be speeded up for shorter hours to produce a greater output, but where heavy labour is not involved the production falls with shorter hours.

Mr. P. Sargant Florence gave statistics from the United States which supported the concluding portion of Dr. Vernon's paper. He further pointed out that the average age of the working population should be taken into account as indicating whether the labour was too long or too heavy. Noise in factories is particularly fatiguing.

Prof. E. L. Collis advocated a reduction of working hours for the sake of health, but said that it must be done slowly. Unequal distribution of wealth is being remedied, but output must be increased.

Sir Hugh Bell pointed out the difference between various trades. Where the labour bill is only a small part of the cost of the manufactured article, it is easier to increase wages than when wages form the main portion of cost. He objected to legislation and uninformed interference, because agreement between employers and employees had reduced the hours of labour without the bad effects of legislative interference.

Miss C. Smith-Rossie advocated a wider educational system on the lines followed by Denmark, so that more interest can be aroused in the working people, thus eliminating fatigue.

Dr. H. H. Dale opened a discussion on "The *Rôle* of Capillaries in the Regulation of the Blood-flow." Previously the control of the blood-pressure had been considered to be brought about by the state of contraction of the arterioles, but it is now necessary to discuss whether the capillaries may or may not take some part in the regulation. Small doses of histamine cause a dilatation of capillaries if injected into the circulation, but fail to do so in a perfused organ unless both red-blood corpuscles and adrenaline are present in the perfusion solution. Large doses of histamine cause a condition like secondary shock. The blood accumulates mainly in the capillaries, so that, although the heart is beating vigorously, so little blood passes through the veins to reach the heart that the blood-pressure falls. Actual counting of capillaries by Krogh shows that during rest only a few capillaries contain blood. During activity many more open up, so that the volume of blood that can be accommodated in them is greatly increased.

The discussion was continued by Prof. W. M. Bayliss, Prof. E. H. Starling, Prof. A. D. Waller, and Prof. N. Noël Paton. The trend of the discussion was that the arterioles regulate the blood-supply to the larger areas, and that variation in the size of capillaries may allow more or less blood to accumulate in them, thus affecting both the local and general circulation.

Three papers on accessory food substances were read before the Section. Prof. W. D. Halliburton contrasted butter and margarine. Margarine can be made from various substances, but liquid oils must be hardened. The hardening process destroys fat-soluble vitamines, so that even if these are present at the outset they are absent from the finished article. Sophistication of food is dangerous because it may remove accessory food substances. Children should be given the butter and milk, as adults can better withstand the absence of fat-soluble vitamines.

Dr. E. M. Delf read a paper on the effect of heat on the antiscorbutic food substance. Heating rapidly destroys antiscorbutic substance, but orange-juice withstands heating better than most of the anti-scorbutic substances.

Miss A. J. Davey recorded the effect of preservatives on the antiscorbutic substance. Lemon-juice is a much more powerful antiscorbutic than lime-juice. Lemon-juice was preserved by metabisulphite or by its own rind-oil. The latter is more stable, and retains its antiscorbutic effect for more than a year without much deterioration.

Prof. A. D. Waller demonstrated the decrease in the electrical resistance of the hand that takes place when a disturbance occurs in the central nervous system. Coughing, burning, or even threatening to burn the opposite hand causes a decrease in electrical resistance. Some people are more imaginative and respond more to the threat than to the actual stimulus, whilst others are more phlegmatic, and give the greater response to the actual stimulus. Prof. Waller also demonstrated the effect of walking, running, and swimming on the output of carbon dioxide.

Dr. H. E. Roaf read a paper on the pathology of pellagra. Pellagra is due probably to the unsuitable nature of the protein in the diet. The symptoms point to an interference with the sympathetic nervous system. No previous record is known of distinctive pathological changes in pellagra. The sympathetic nervous system showed marked plasmolysis of its ganglion cells. It is possible that the sympathetic nervous system may be affected by diet through the adrenal medulla. It is, however, necessary to investigate the condition of the sympathetic nervous system in other diseases. Dr. Roaf also showed readings of climatic conditions made in Egypt and in Palestine. Heat loss and the effect of clothing on heat loss were shown by readings made with Prof. Leonard Hill's katathermometer. The protection by clothing from sun radiation was measured by sun-radiation thermometers.

BOTANY AT THE BRITISH ASSOCIATION.

THE influence of the great war was distinctly to be noted in the character of the papers presented at the first post-war meeting. The Botanical Section was fortunate in having a president so well able to review the actual and potential plant resources of our Empire, and to lay stress upon the pressing necessity for their scientific development. This note was struck again in the Forestry discussion, which took place jointly with the Agricultural Section. To this discussion Prof. A. Henry contributed a paper on the afforestation of water-catchment areas. He urged the planting of all suitable portions of gathering grounds (which probably vary in different cases from 10 per cent. to 70 per cent.), largely on account of the paramount importance of ensuring the purity of the water-supply, which can so adequately and profitably be done by this means. The scheme practically necessitates co-operation between State and corporation for the acquirement of the necessary land.

What may be regarded as a real war paper was furnished by Capt. H. Hamshaw Thomas, who gave an account of the desert flora of Western Egypt some twenty-five miles north-west of Cairo. The small rainfall, coupled with hot days and dewy nights, constitutes a set of conditions unfavourable to plant-life, so that, unlike the sandy, rocky desert of Eastern Egypt and Sinai, the Libyan Desert includes vast stretches totally devoid of vegetation. The pruning effect of the "khamseen" or sand-storms is very marked, and reduces the plants to a dwarfed, tufted habit.

Other floral and ecological papers included the flora of the district of the London Clay, by Mr. Horace W. Moncton, and the northern invasions of New Zealand, with special reference to Lord Howe Island, by Dr. J. C. Willis. Mr. Moncton pointed out that the flora of the London Clay in the Thames basin differs greatly from that on contiguous areas of different geological formation, and he illustrated his point from the sedges. In addition to the twenty-eight species characterising the London Clay, there are some twelve others recorded, which, however, "do not seem to occur where the London Clay forms the *actual* surface," since "a covering of gravel or sand too slight to mark on a geological map is sufficient to alter the flora."

Dr. Willis added to his well-known series of observations and conclusions concerning the origin of floras data with regard to that of New Zealand and Lord Howe Island, which led him to conclude that the New Zealand flora includes a western invasion, which probably "followed the ridge upon which stands Lord Howe Island." In consonance with his general position, Dr. Willis put forward the view that the endemics of Lord Howe Island are furnished by the larger (older) families and genera.

Considerable general as well as local interest was raised in connection with Col. Godfrey's paper on the orchids of Hants and Dorset, and the members of the section were privileged to see on their expedition to the New Forest one of the rare orchids mentioned, viz. *Malaxis paludosa*. The author enumerated a surprising number of natural hybrids occurring in the district.

As part of the joint discussion with the Zoological Section in the field of Genetics, Mr. W. Brierley and Dr. Ruggles Gates presented papers in which notable contributions to our concepts of species and the transmission of characters were put forward. Mr. Brierley treated of species in relation to his study of fungi, and claimed that it is the inner *physiological constitution* rather than the chance *morphological facies* which makes up the true species complex. It can be demonstrated that in certain fungi, at any rate, the morphological expression varies with every medium, *i.e.* with environment, and must rightly be regarded as a resultant of a comparatively fixed physiological constitution and a variable environment, *i.e.* of two sets of interacting physico-chemical factors.

In his paper on mutational *versus* recapitulatory characters Dr. Gates endeavoured to distinguish between new characters which result from nuclear changes in the germ-cell, which he classed as mutational and referred to as "a new Mendelian character," and new characters which result from "the impress of the environment," which he classed as recapitulatory and described as "gradually developed, involving adaptation to new conditions, and, if permanent, the principle of inheritance of acquired characters." He went on to say: "The theory of antithetic alternation of generations, which is widely held as regards archegoniate plants, implies a gradual lengthening in the sporophyte through the addition of cell-divisions to its subterminal stages. This can scarcely be supposed to have resulted from an alteration in the cell-unit."

Miss Saunders's paper on a graded series of forms in Matthiola added very important data bearing on the relation between continuous and discontinuous characters. She has traced the genetic origin of a perfectly continuous series of forms between the glabrous variety and the normal densely hairy plant. These were produced as the result of crossing the familiar glabrous variety with a rare half-hairy form. "The phenomenon is explicable on the supposition of multiple allelomorphs."

Dr. Scott, in a paper entitled "The Relation of the Seed-Plants to the Higher Cryptogams," discussed the prevailing view that the pteridosperms, and hence the spermophytes as a whole, are to be derived from some unknown group of ferns. Dr. Scott combated this view, and took the stand that "pteridosperms have always been distinct from any of the known phyla of vascular Cryptogams . . . parallel in important aspects to the ferns, but of unknown and remote origin." He adduced anatomical and geological evidence in support of his view.

Another morphological paper concerned itself with the vexed question of the nature and origin of the pith and inner endodermis in medullated ferns. Dr. McLean Thompson concluded from his extensive investigation of *Platyzoma microphylla* that it furnished very good proof of the intrastelar or potentially vascular nature of the pith in this form. Not merely does the basal protostele pass gradually into the medullated condition once in the development of the individual, as in many other forms, but in this species the protostelic structure appears again in later-formed regions.

In a paper entitled "Monocotyledonous Features of the Ranunculaceæ, with Special Reference to the Floral Structure," Dr. Salisbury reviewed the similarities met with in the two groups in relation to number of parts, *dédoublement*, meristic variation, apocarpy, nature of fruits, placentation, etc.

As the result of her extensive work on movable-cell inclusions or statoliths, Miss Prankerd has found that they may be (1) starch grains, (2) chloroplasts, or (3) crystals, and that the nucleus may move with these inclusions. Even when this is not so, the nucleus of the statocyte may be markedly differentiated from that of neighbouring cells.

Under the heading of "Mychorrhiza and the Ericaceæ," Dr. M. C. Rayne added to her former work new facts tending to establish obligate symbiosis in Vaccinium similar to that in Calluna, and raising the question of the possibility of nitrogen fixation by the fungus.

Prof. Priestley put forward a very important contribution to the theoretical consideration of the phenomenon of root-pressure, involving an ingenious use of the rapidly accumulating knowledge of the behaviour of a colloid gel in respect to its variability towards water. It is hoped that this important subject will come up again for discussion at the Cardiff meeting in 1920.

The formal meetings of the section were brought to a close by a semi-popular lecture of exceptional interest given by Prof. F. W. Oliver on Spartina and Poole Harbour.

E. N. T.

EDUCATION AT THE BRITISH ASSOCIATION.

AFTER the presidential address by Sir Napier Shaw the Section settled down to discuss a varied and interesting programme, which attracted large and appreciative audiences throughout the week. It was a great disappointment that Sir A. Quiller Couch was unable to be present himself, but his paper on the teaching of English admirably expressed a need now widely felt by thoughtful teachers that English should be the root of all learning for an English-speaking child; that until the age of fourteen or fifteen he should practise the language natural to his mind in addition to one other; that the plainest, most everyday speech should be clear, expressive, accurate, graceful whenever possible, and at any rate decent; that a child should learn to define and clarify in his mind the terms in which he thinks, to think in real English, not in jargon. Therefore, to attain this, teachers should aim through English in preference to any foreign language, alive or dead. English should not be treated as a special subject, but should be the basis of all others. He deprecated the inordinate amount of time given in the lower forms to linguistics and mathematics, since these are mainly ancillary, the former to literature and history, the latter to natural science; they are formal studies, studies in the abstract, and lacking the content of the other three, employing processes alien to a child's thought.

Mr. W. D. Eggar read a paper on the teaching of English in relation to school science, and claimed that the teaching of English was as much the concern of the science master as that of any other master—perhaps more so, as he is concerned with the live end of the language. He strongly urged that a broader and more intelligent study of English should take the place of much of the mathematical and linguistic work in preparatory schools.

Prof. H. E. Armstrong opened a discussion on "Method and Substance of Science Teaching" by criticising the Government report on the position of natural science in the educational system of Great Britain. This report he thought would prove of little value to teachers, and not likely to influence educational opinion to any degree. He looked upon it as a lost opportunity for examining and utilising experiments already tried. He combated the absurd statement made in Paragraph 43 of the report: that the heuristic method involves the rediscovery by the pupil in his school hours of all that he may fairly be expected to know. The method does, however, involve neither more nor less than learning the art of inquiry. The method employed must be disciplinary—the method of science; scientific outlook must be acquired if scientific knowledge is to be of any avail.

On the same topic Sir Richard Gregory, although advocating heuristic methods, thought that the substance of instruction suffered from concentration upon method, and that laboratory work should be supplemented by a broad general course of descriptive lessons given quite independently of the practical work. Dr. E H. Griffiths said he hesitated to accept this divorce of lecture and practical work. Mr. Mangham spoke of the neglect of biological science in education, and asked for a closer co-operation between the lecturers in various branches of science at the universities. Dr. Lilian Clarke gave some interesting details of a sound practical course of elementary science in girls' schools, showing how the spirit of inquiry can be aroused in botany as well as in chemistry. Her plea for more time should not go unheeded; for it is impossible to go far in such valuable work with only one to one and a half hours per week. Miss Shove discussed the necessity of a thorough course of elementary chemistry and physics preliminary to a botanical course.

A joint session was arranged with Section F, when a paper from Sir Herbert E. Morgan was read. The paper had for its theme the real need of the country for educated men in directing business affairs, men educated in the right way, with technical training added to sound general knowledge and broad views. Mr. C. R. Fay emphasised the value of university influence in business, and claimed that a central school for all branches of economic science at the university would co-ordinate effort and effect a rapid diffusion of new methods. Mr. H. N. Sullivan thought that young men entered business too early. Prof. Oldham described the work of the faculty of commerce in Dublin University. Sir Hugh Bell said that the bold step of appointing university men in railway business was a success, but that it was objected to by men whose promotion had thereby been affected.

A discussion on continuation schools was opened by Sir Robert Blair, who, speaking from the point of view of the largest urban district, suggested that for the first two years education should be general, and for the second two may have a technical or commercial bias derived from the occupation; that residence is the basis of obligation on the authority; that the required eight hours per week should be taken in two four-hour periods; that it would be inadvisable to divide the four-year period between two schools, one from fourteen to sixteen, the other from sixteen to eighteen; that schools may be mixed, not dual; that continuation schools will be ends in themselves and, for some, "stepping-stones" to higher things. Interest, he declared, is the key to the problem of instruction; the schools will be what the staff makes them. Extra class-room activities are no less important—libraries, clubs, games, and societies will attract the adolescent.

Mr. A. P. M. Fleming followed with a paper on works schools, in which he illustrated their advantages, such as the close correlation between the school work and the practical training in the works, the increased facilities for the selection for employment, promotion, systematic training, and for ensuring harmonious relations between the management and the worker. Mr. J. S. Rainer took a rather contrary view of works schools, and in a very able paper presented the W.E.A. point of view as being opposed to works schools. He contended that for efficiency and success these schools must be entirely independent of employers' control; for distrust of the employing interest, as being almost entirely personal and mercenary, would prevent such schools from giving suitable and adequate education. The subjects of study must be related to the interests of the pupil, and not determined by the needs of trades or industries. Mr. G. F. Daniell dealt with the problem in rural districts, and pointed out the need for transport facilities. He urged close relations with the village clubs and institutes, and thought that attendance could be arranged either for one day per week for forty weeks, or for a seasonal attendance. Mr. C. A. Buckmaster pleaded for full liberty to the teachers and for the provision of school societies and games, and thought that the content of the curriculum was secondary to the training of character. Lord Malmesbury advocated the gradual elimination of those unable to profit by the education provided out of public funds, but would encourage and spend as much as possible on the best boys and girls.

Dr. Vincent Naser, of Copenhagen, submitted proposals for an exchange of students between Denmark and Great Britain, and suggested the formation of bureaux of international information in connection with universities.

Sir Richard Gregory spoke on the educational value of the kinema—not to make learning easy, but to awaken interest and synthesise instruction. An exhibition of some instructive films was given by the Community Picture Bureau.

Bishop Welldon, in opening a discussion on training in citizenship, said that something must be done through co-operation or co-partnership to create a fellow-feeling between capital and labour, and that an enlightened patriotism as well as the dignity and history of the Empire should be taught.

Lt.-Gen. Sir Robert Baden-Powell made an eloquent appeal for the need of out-of-school training and environment as auxiliary to education for producing efficient human citizens. The wonderful success of the Boy Scout movement suggests that the most important duty of the schoolmaster is to discover what particular portion of his environment appeals most to each of his pupils, and to use that as the medium for inducing mental activity.

In a valuable paper on fundamental principles in education Prof. A. N. Whitehead claimed that all education is the development of genius, and showed that the true ultimate problem before the educator is how to impart knowledge so as to stimulate genius. He showed that language is essential, but argued that a child should not study a dead language until a modern literature has gripped the imagination; that classical learning is the superstructure of a literary education, and not the foundation.

Mr. F. S. Preston submitted a paper in which he emphasised the value of literary studies in the development of imagination and the moral faculties. A paper from Prof. Marcus Hartog on the function of examinations in education followed.

The final sitting of the Section was occupied with two excellent papers on the present position of private schools in the educational system, one by Mr. R. H. Hume, the president of the Private Schools Association, the other by Mr. Alex. Devine. These papers, and the discussion that followed, brought out the fact, little realised by many, that the number of children educated in private schools approaches in many places 50 per cent. of the school population.

Reports by special committees of the section were read and discussed, that on the free-place system by Mr. C. A. Buckmaster and Mr. D. P. Berridge, that on museums by Mr. Herbert Bolton, and that on the registration of schools by Lady Shaw—all embodying valuable information and suggestions for the educational reformer.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IN connection with the London County Council addresses to teachers on recent developments in science, Dr. W. Bateson will give a lecture on biology at King's College, Strand, W.C.2, on Saturday, January 24, at 11 a.m. The chair will be taken by Dr. S. Russell Wells, Vice-Chancellor of the University of London.

A WHITE Paper (Cd. 221, 1919) just issued sets forth the proposed text of the Order in Council by which, subject to the approval of Parliament, certain powers and duties in relation to public libraries, museums, and gymnasiums, formerly exercised by the Local Government Board and latterly by the Ministry of Health, are to be transferred to the Board of Education. This forms part of the proposal made by the Reconstruction Committee on Adult Education, to which, as we have previously recorded (NATURE, October 9, 1919), exception was taken by the museum officials and librarians. On the face of it, however, the proposed Order seems unobjectionable and, indeed, natural. The powers in question relate to the making of various by-laws and to the sales of buildings or land, and there can be no ground for supposing that they will be exercised in other than a liberal spirit conducive to the best ends of the institutions concerned. The questions of financial control, apportionment of rates, and general management do not seem to fall within the scope of this Order, and nothing is said in it about bringing museums and libraries under the control of the local education authorities. At the same time, the present step may be regarded as only the first of a contemplated series, and as, in any case, the necessary preliminary to those more fundamental changes concerning which opinions differ.

SOCIETIES AND ACADEMIES.

LONDON.

Faraday Society, December 15, 1919.—Prof. A. W. Porter, vice-president, in the chair.—A. G. **Tarrant**: The measurement of physical properties at high temperatures. An account is given of experiments made upon refractory materials with the view of measuring certain physical properties at high temperatures, particular attention being paid to thermal expansion, tensile strength, and thermal conductivity.—Lieut. W. A. **Macfadyen**: An aspect of electrolytic iron deposition. The experiments detailed were carried out in seeking the best conditions for obtaining thick, hard, adherent deposits of iron on steel-mechanism parts which had been machined too much or worn down in a few places, and thus rendered useless, so as to enable the scrapped parts to be replaced in use after treatment.—J. G. **Williams**: The electrolytic formation of perchlorate. It is pointed out that present practice in electrolytic preparation of perchlorate uses much higher temperature of liquor and current density than is given in text-books.—Prof. A. W. **Porter**: The vapour pressure of binary mixtures. In order to remove difficulties in connection with the proof of the Duhem-Margules formula for the vapour pressures of binary mixtures, a simplified proof is given which makes clear the extent of the usual approximations in each step of the proof.—Prof. E. D. **Campbell**: The solution theory of steel and the influence of changes in carbide concentration on the electrical resistivity. Baly's force-field theory is applied to the case of the solid solution of the non-ferrous elements in steel. The experimental portion of the paper describes a research on the influence of the decarburisation by means of hydrogen of a series of alloy steels on the electrical resistivity, when the metal is in both the annealed and hardened condition.—S. **Horiba**: Some relations between the solubilities of solutes and their molecular volumes.—Dr. E. J. **Hartung**: (1) An accurate method for the determination of vapour pressure. (2) Some properties of copper ferrocyanide.

PARIS.

Academy of Sciences, December 15, 1919.—M. Léon Guignard in the chair.—H. **Douvillé**: The annular Foraminiferæ (Cyclostègnes) of Orbigny. The annular development taken by Orbigny as a basis of classification is the result of a particular mode of growth, and is a secondary character.—G. **Bonnier**: Comparative culture of seedlings at high altitudes and in the plain. After experiments, lasting thirty or thirty-five years, low-level plants grown on the same soil at different altitudes acquire completely the form and structure of plants of the same species growing naturally at the higher altitude. Detailed examples are given.—E. **Ariès**: A new improvement of the equation of state of fluids.—V. **Grignard**, G. **Rivat**, and Ed. **Urbain**: The chloro-derivatives of methyl formate and carbonate.—G. **Friedel**: The calculation of the intensity of X-rays diffracted by crystals.—M. Louis Lumière was elected a member of the division of the applications of science to industry.—M. **Plancherel**: The method of integration of Ritz.—J. **Drach**: Determination of the first integrals of the differential equation of geodesic lines, rational with respect to the first differential of the unknown function.—Ed. **Fouché**: A characteristic equation for atmospheric air.—P. **Jolibois**: A new method of physico-chemical analysis of precipitates. Application to the study of the calcium phosphates.—A. **Recoura**: A new complex form of chromic sulphate.—A. **Kling**, D. **Florentin**, A. **Lassieur**, and E. **Schmutz**: The properties of the chloromethyl chloroformates.—M. **Godchot** and F. **Taboury**: Some new bicyclic ketones. Further applications of the reaction between ketones and calcium hydride.—L. **Bertrand** and A. **Lanquine**: The relations between chemical composition, microscopic structure, and the ceramic qualities of clays. The usual method of calculating the proportion of mica in clay from the chemical analyses can be shown by microscopic examination to be erroneous. The chemical composition of a clay is an insufficient guide to its ceramic properties.—R. **Anthony**: The determination of the lobulation of the kidney in mammals.—A. **Pézard**: Alimentary castration in cocks submitted to an exclusively carnivorous diet. A strictly carnivorous diet sets up a slow intoxication to which the genital glands are peculiarly sensitive. The latter are either atrophied or do not develop.—R. **Bayeux**: The urinary toxicity and its modifications by hypodermic injections of oxygen during a prolonged stay at the Mont Blanc Observatory.—F. **Bordas**: Milk contamination. Remarks on the importance of reducing infant mortality, with especial reference to tuberculosis produced by dirty milk.—P. **Achalme** and Mme. **Phisalix**: The preservation of vaccine.

BOOKS RECEIVED.

The Child's Unconscious Mind. By Dr. W. Lay. Pp. vii+329. (London: Kegan Paul and Co., Ltd.) 10s. net.

The Elements of Analytical Conics. By Dr. C. Davison. Pp. vii+238. (London: At the Cambridge University Press.) 10s. net.

A Geographical Bibliography of British Ornithology from the Earliest Times to the End of 1918. By W. H. Mullens, H. Kirke Swann, and Rev. F. C. R. Jourdain. Part ii. Pp. 97–192. (London: Witherby and Co.) 6s. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England (with Musical Illustrations).
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.
LONDON MATHEMATICAL SOCIETY, at 5.—Major P. A. MacMahon: The Divisors of Numbers.—H. Steinhaus: Fourier Coefficients of Bounded Functions.—S. P. Owen: The Lag of a Thermometer in a Medium whose Temperature is a Linear Function of the Time.
LINNEAN SOCIETY, at 5.—Dr. B. Daydon Jackson: Methods of Botanic Illustration during Four Centuries (Lantern Lecture).
ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Prof. E. W. Hope: Schemes and Methods in Tuberculosis Work.
CHEMICAL SOCIETY, at 8.—L. E. Hinkel and H. W. Cremer: The Condensation of Acetoacetic Ester with *p*-Dimethylaminobenzaldehyde and Ammonia.—G. S. Butler and H. B. Dunnicliff: The Action of Alcohol on the Sulphates of Sodium.—M. Nierenstein, C. W. Spiers, and, in part, the late K. C. R. Daniel: Guarana Tannin.—R. Lessing: Studies in the Composition of Coal: (1) The Behaviour of the Constituents of Banded Bituminous Coal on Coking; (2) The Mineral Constituents of Banded Bituminous Coal.—P. Ray and P. V. Sarkar: The Hydrazino-thiocyanates of certain Divalent Metals.

FRIDAY, JANUARY 16.

INSTITUTE OF AERONAUTICAL ENGINEERS (at the Holborn Hall), at 2.30.—Prof. G. H. Bryan: Presidential Address.
ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Dr. A. A. Gray: A Few Anatomical Details of the Anatomy of the Vestibule, not previously described.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—R. B. Dunwoody: The Economic Requirements for Inland Navigation Transport in the British Isles (Vernon Harcourt Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—J. H. Reyner: The Development of Automatic Telephony.
JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—B. E. D. Kilburn: Meteorology and Engineering.
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—C. Thurstan Holland: Lessons of the War.
SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.30.—Dr. P. Manson-Bahr and Others: Discussion on Bacillary Dysentery.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Sir James Dewar: Low Temperature Studies.

SATURDAY, JANUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. Noyes: The Anglo-American Bond of Literature.

MONDAY, JANUARY 19.

VICTORIA INSTITUTE (Committee Room B, Central Hall, Westminster), at 4.30.—Dr. A. T. Schofield: The Psychology of the Female Mind.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery; His Contributions to our Knowledge of the Heart and Blood Vessels (Hunterian Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—S. M. Hills and Others: Discussion on Functions of a Trade Journal.
SURVEYORS' INSTITUTION (Junior Meeting), at 7.—R. E. A. Dash: The Housing Question and how it is affected by Recent Regulation.
ARISTOTELIAN SOCIETY (at 74 Grosvenor Street), at 8.—Prof. J. A. Smith: The Philosophy of Giovanni Gentile.
ROYAL SOCIETY OF ARTS, at 8.—Capt. H. Hamshaw Thomas: Aircraft Photography in War and Peace (Cantor Lecture).
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt.-Col. J. Tilho: Tibesti to Darfur.

TUESDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. Sir John Cadman: Modern Development of the Miner's Safety Lamp.
ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—J. Barcroft and Others: Discussion on the Therapeutic Uses of Oxygen.
ROYAL STATISTICAL SOCIETY, at 5.15.—G. H. Knibbs: The Organisation of Imperial Statistics.
MINERALOGICAL SOCIETY, at 5.30.—Dr. E. S. Simpson: Gearksutite at Gingin, Western Australia.—C. E. Barrs: Fibroferrite from Cyprus.—Dr. G. T. Prior: The Classification of Meteorites.—A. F. Hallimond: On Torbernite.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—H. Moore: Spontaneous Ignition Temperatures of Liquid Fuels.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—T. H. B. Scott: Pictorial Suggestions.

WEDNESDAY, JANUARY 21.

ROYAL SOCIETY OF ARTS, at 4.30.—A. H. Powell: Ancient Cottages and Modern Requirements.
ROYAL METEOROLOGICAL SOCIETY (at the Royal Astronomical Society) (Annual General Meeting), at 5.—Sir Napier Shaw: Pioneers in the Science of Weather (Presidential Address).
ROYAL SOCIETY OF MEDICINE (Occasional Lecture), at 5.—Surg.-Comm. K. Digby Bell: The Position of the Medical Profession with regard to National Physical Education.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery: His Contributions to our Knowledge of the Lungs and Pleuræ (Hunterian Lecture).
GEOLOGICAL SOCIETY OF LONDON, at 5.30.
ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts), at 8.—A. P. Cole: Principles of Rigid Airship Construction.
ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 8.—J. E. Barnard: The Present Status of Microscopy (Presidential Address).

THURSDAY, JANUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England.
ROYAL SOCIETY, at 3.30 (Special General Meeting). At 4.30.—Prof. E. G. Coker and K. C. Chakko: The Stress-strain Properties of Nitro-cellulose and the Law of its Optical Behaviour.—S. Marsh: Alternating-Current-Electrolysis.—W. H. Eccles and J. H. Vincent: The Variations of Wave-length of the Oscillations Generated by the Three-Electrode Thermionic Tube due to Changes in Filament Current, Plate Voltage, Grid Voltage, or Coupling.—S. D. Carothers; Plane Strain. The Direct Determination of Stress.—F. Horton and Ann C Davies: An Investigation of the Effects of Electron Collisions with Platinum and with Hydrogen, to ascertain whether the Production of Ionisation from Platinum is due to Occluded Hydrogen.—L. Bairstow, R. H. Fowler, and D. R. Hartree.—The Pressure Distribution on the Head of a Shell moving at High Velocities.
INSTITUTION OF MINING AND METALLURGY (at the Geological Society), at 5.30.—W. Broadbridge: Froth Flotation: Its Commercial Application and its Influence on Modern Concentration and Smelting Practice.
INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Civil Engineers), at 6.—J. L. Thompson: Transformers for Electric Furnaces.

FRIDAY, JANUARY 23.

PHYSICAL SOCIETY OF LONDON (at the City and Guilds Technical College, Leonard Street), at 5.—Dr. J. H. Vincent: Maintained Oscillations in Triode Valve Circuits.—Dr. W. Eccles: Measurements of the Chief Parameters of Triode Valves.—F. W. Jordan: Measurement of Amplification of a Radio-frequency Amplifier.—F. E. Smith: The Measurement of Amplification given by Triode Amplifiers at Audible and at Radio Frequencies.—Hon. C. W. Stopford and C. R. Darling: Exhibition of a Method of Determining the Hardening Temperature of Steel.—C. R. Darling: Exhibition of a Thermal Cell of Constant Voltage.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery; His Contributions to our Knowledge of the Alimentary System (Hunterian Lecture).
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—E. M. Bergstrom: Recent Advances in Utilisation of Water Power.
ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. F. G. Crookshank: Principles of Epidemiology.—Dr. Cleland and Dr. Campbell: Epidemiology of Acute Encephalomyelitis.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Hon. Sir Charles Parsons: Researches at High Pressures and Temperatures.

SATURDAY, JANUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. Noyes: Aspects of Modern Poetry.
PHYSIOLOGICAL SOCIETY (at King's College), at 4.

CONTENTS.

PAGE

Surgery and Deformities 493
The Oil-hardening Industry. By E. F. A. 494
Political Science. By Rt. Rev. Bishop J. E. C. Welldon 494
American Books on Agriculture 495
Handbooks of Chemistry. By C. J. 497
Fresh-water Biology 498
Our Bookshelf 499
Letters to the Editor:—
Promotion of a Plumage Bill.—Prof. J. E. Duerden 499
Musical Drums with Harmonic Overtones. (*Illustrated.*)—Prof. C. V. Raman and Sivakali Kumar 500
Power from the Sun.—Alfred S. E. Ackermann 500
Triode Valves as Electric Amplifiers. (*Illustrated.*) By Prof. W. H. Eccles 501
Indian Geology. (*Illustrated.*) By T. H. D. L. . . 502
Meteorology in Three Dimensions. By Lt.-Col. E. Gold 505
Sir Thomas R. Fraser, F.R.S. By J. A. G. 505
Notes 506
Our Astronomical Column:—
Spectroscopic Determination of Stellar Parallax . . . 511
Minor Planets 511
Lunar Photography with the 100-in. Reflector . . . 511
Prize Awards of the Paris Academy of Sciences . . 512
Educational Conferences 513
The Physical and Optical Societies' Exhibition. By D. O. 514
The Charters Towers Goldfield 515
The New Zealand Science Congress, 1919 . . . 516
The African Rift Valley. By Prof. J. W. Gregory, F.R.S. 518
Physiology at the British Association 519
Botany at the British Association. By E. N. T. . 520
Education at the British Association 521
University and Educational Intelligence 523
Societies and Academies 523
Books Received 523
Diary of Societies 524

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THURSDAY, JANUARY 22, 1920.

WIND AND BAROMETRIC GRADIENT.

Manual of Meteorology. Part iv.: *The Relation of the Wind to the Distribution of Barometric Pressure.* By Sir Napier Shaw. Pp. xvi+166+3 plates. (Cambridge: At the University Press, 1919.) Price 12*s.* 6*d.* net.

THE other parts of this manual are not yet published, but Part iv. deals with the question of the extent to which the motion of the lower strata of the atmosphere can be inferred from the ordinary working chart prepared on receipt of the telegraphic information of the surface conditions by a meteorological office, a question of great importance to the aircraft service.

As the author informs us in the preface, many inquiries of this sort were addressed to his office in London during the war, and he sets out here the extent to which and the means whereby answers to such questions can be given.

The matter is a complicated and difficult one, but Sir Napier Shaw is to be congratulated on the mass of information he has brought together and on the clear way in which he has arranged it and correlated together the different parts, which are sometimes more or less contradictory.

In chaps. i. to iii. the relation of the surface wind to the isobars is set out. The principle that the motion of the air will be at right angles to the direction of the pressure gradient and have the velocity deduced from the gradient equation is accepted as a working hypothesis, and the reasons why the rule does not hold close to the surface are explained. The principle was set out by the author thus in 1913: "In the upper layers of the atmosphere the steady, horizontal motion of the air at any level is along the horizontal section of the isobaric surface at that level, and the velocity is inversely proportional to the separation of the isobaric lines in the level of the section." How far this principle holds is a fundamental question in meteorology. Admittedly, it only applies to first order terms, and the author, in chap. x., shows that there is a systematic departure from the rule near the centre of a travelling cyclone. On the other hand, if a meteorologist is asked to give the velocity and direction of the wind at 1500 ft. height at any given time and place, it has been found, in the absence of information from pilot balloons, that the best answer he can give is to quote the gradient wind as shown by an isobaric chart.

In chaps. iv. and v. the author discusses the increase of wind with height in the lower strata, and gives G. I. Taylor's theory of the diffusion of eddy motion and its effect on the wind and on the formation of thin sheets of low cloud. Taylor's formula takes the form $W/G=\cos\alpha-\sin\alpha$, where W denotes the actual surface wind, G the geostrophic wind, and α the angle between them. It will be noticed that this formula makes a value of α exceeding 45° impossible.

Chaps. vi. and vii. deal with the variations of the wind in the upper layers and their dependence on the form of the distribution of temperature. It is shown how the cessation of the lapse rate, *i.e.* the fall of temperature with height, in the stratosphere, and the higher temperature over the cyclonic area that is found above 10 km., produce the rapid falling off of the wind that is also shown by direct observation.

Chap. x. is perhaps the most suggestive in the book, and throws fresh light on the well-worn theme of the mechanics of a travelling cyclone. It is there shown that in what is called a normal cyclone there are three centres: the instantaneous or kinematic centre; the "tornado centre," which is the centre of the supposed rolling disc; and the dynamic centre, which is the centre shown by the isobars on the chart. This representation leads to a systematic difference between the true and the gradient wind in the parts that are near the centre, a difference that has been noticed, but was supposed to be accidental, on some working charts.

In chap. xi. Sir Napier Shaw discusses Rayleigh's and Aitken's papers on revolving fluid, and gives diagrams and reproductions of instrumental records relating to some noted storms of the last twenty years or so. Synoptic charts are reproduced which show a good agreement with the method of treatment in chap. x. The diagrams Figs. 5 and 6, on p. 154, are especially striking; they refer to the storm of September 10, 1903, at Holyhead, and show the velocity and direction of the wind on that occasion corrected for the known peculiarities of the exposure due to the local configuration.

In theoretical discussions of the mechanics of a cyclone, especially if there is much mathematical analysis, one is unavoidably compelled to make hard-and-fast suppositions, and the point arises as to what extent the real cyclone will submit to be bound by such suppositions. The author questions how far the "normal cyclone" of chap. x. is the real cyclone as shown on the charts, and one wonders how far Rayleigh's conclusions are vitiated by his leaving out the effect of the rotation of the earth. Doing so greatly simplifies the equations of motion, but it is the earth's rotation which ensures that every cyclone in the northern hemisphere without exception shall rotate in one direction only, and every cyclone in the southern hemisphere in the opposite direction. It must therefore be of supreme importance.

Every serious student of meteorology should obtain Part iv. of the manual and read it, and all will hope that the other parts may be published shortly.

W. H. DINES.

RESEARCHES ON FLUORESCENCE.

Researches in Physical Optics. Part ii. *Resonance Radiation and Resonance Spectra.* By Prof. R. W. Wood. (Publication No. 8 of the Ernest Kempton Adams Fund for Physical Research.) Pp. viii + 184 + x plates. (New York: Columbia University Press, 1919.)

THIS is the second instalment of a valuable re-publication of Prof. Wood's papers. The first half of the volume deals with the spectroscopic properties of iodine vapour, particularly the study of the fluorescent spectrum with high resolving power. The difficulty with this, as with most other modern optical experimenting, is lack of light, and the success attained in overcoming the obstacle by well-thought-out optical arrangements is very remarkable; but the complexity of the phenomena brought to light is such as may well make theoretical progress seem almost hopeless.

It has been possible to obtain monochromatic stimulation at one particular absorption line of the iodine spectrum by the ingenious but simple device of using the mercury vacuum arc as illuminant. If the arc is run at low-current density, one line only of the iodine spectrum is covered by the green mercury line. Even in this case the result is to stimulate not merely the line primarily excited, but also a series of doublet lines, extending along the spectrum on either side of the latter. Stokes's law of fluorescence is thus completely violated.

All this results from the stimulation of one line only of the iodine spectrum.

But this line is one of forty thousand, and it appears that we can scarcely rely on it as being typical, since the iodine lines are of many varieties, as shown by their minute structure and by the Zeeman effect and the magnetic rotatory properties.

No doubt what is wanted for this class of research is some means of obtaining intense monochromatic stimulation of great purity, and with its frequency under control over a wide range. Prof. Wood is able to do something in this direction by altering the current through the mercury arc, and thereby the width of the green mercury line; this makes it overlap several of the iodine lines, and the complexity of the phenomena is thus greatly increased. It is perhaps worthy of consideration whether the Doppler effect obtained by moving the source could be of service, but this method would probably be very difficult of execution, and the range that could be hoped for very far short of what is desired.

The second half of the volume deals with other phenomena of fluorescence in gases of a miscellaneous kind, but is marked throughout by the same fertility of resource in devising experimental methods. The re-emission of the mercury radiation at wave-length 2536 when cold mercury vapour is stimulated by this radiation is an observation of special importance; the question presses for answer how this resonance is related by the scattering of white light by gases when there is no resonance.

R.

SCIENTIFIC STUDY OF THE SUGAR GROUP.

The Simple Carbohydrates and the Glucosides. By Dr. E. Frankland Armstrong. Third edition. (Monographs on Biochemistry.) Pp. x + 239. (London: Longmans, Green, and Co., 1919.) Price 12*s.* net.

THE third edition of Dr. E. F. Armstrong's monograph is something more than a new and revised issue; it is, to all intents and purposes, a new book. Such a statement may not, on first inspection, seem to be well founded, as the general scheme adopted by the author in the earlier editions has been retained, and the subdivision of the material into chapters remains much as before. A comparative reading of the texts, however, shows that some of the changes introduced are fundamental, and a reader making his first acquaintance with the specialised chemistry of the carbohydrates through a study of the latest edition will thus acquire not only much new information, but also an entirely new perspective.

The seven years which have elapsed since the appearance of the second edition have been marked by considerable activity in sugar research, and the fact that Emil Fischer closed his career by once more directing the work of his school to this subject would almost in itself be sufficient to make a fresh edition necessary. Many novel and unexpected types of compounds have been isolated, and these are now fully described and classified under an improved nomenclature; but this alone does not explain the advances made in the present book.

Dr. Armstrong has been quick to realise that the recent recognition of the specially reactive forms of sugars which are regarded as ethylene-oxides has opened out many new fields of inquiry, and has made clear much that has hitherto been obscure. He has therefore introduced the new structural ideas at an early stage of his narrative, and keeps them continually before the reader, adding on the way many fresh suggestions and criticisms. His treatment of this difficult subject is extremely lucid, and the result is strikingly successful.

Although the book has been considerably expanded by the inclusion of much new experimental material, little need be said regarding the details of the subject-matter, as nothing of present or potential importance has been overlooked, and the enlargement of the various chapters is well balanced. The high standard of accuracy maintained throughout the text extends to the comprehensive bibliography, which is carefully classified according to the topics discussed—a plan which saves time when a rapid search through the original literature is necessary.

Monographs suitable for both the research worker and the advanced student play a part of ever-increasing importance in our scientific education, and the present book is a model of its kind. Considering the magnitude and the wide appeal of carbohydrate chemistry, it is no easy task to compress within narrow limits an accurate account of the most important features of the sugars, and at the same time to avoid the dangers of merely cataloguing compounds or of losing all style in telegraphic brevity. Dr. Armstrong has skilfully avoided these dangers, and has succeeded in making his narrative interesting without sacrificing any essentials, and that this has been possible is ample testimony to the excellence of the scheme upon which the original edition was planned. The leanings of the author, as a practical worker in this field, to the biological aspects of sugar chemistry are well known, but Dr. Armstrong is a firm believer in the value of structural study, and he therefore establishes constitutional principles before proceeding to descriptive details.

It is, then, on the elastic framework of structural chemistry that Dr. Armstrong has arranged the complex facts of sugar chemistry, and he has done so systematically, thoroughly, and with scholarly judgment. No point of view is neglected. The organic chemist is not allowed to forget that Nature is the great sugar laboratory, and that he must work in association with the biologist. On the other hand, the biochemist is forced to think in the exact terms of structure, and the lesson is probably necessary.

For several years the reviewer has been in a position to appreciate the merits of the earlier editions by observing the use made of them by graduates commencing research work on the sugars. The monograph has answered most successfully to this practical test, and as the latest edition is a distinct advance on its predecessors, students of the sugar group will have access to a thoroughly satisfactory book—a book written with the authority of the expert and conveying the stimulus of the enthusiast.

NUTRITION AND LONGEVITY.

(1) *The Newer Knowledge of Nutrition: The Use of Food for the Preservation of Vitality and Health.* By E. V. McCollum. Pp. ix+199. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 6*s*. 6*d*. net.

(2) *On Longevity and Means for the Prolongation of Life: Founded on a Lecture delivered before the Royal College of Physicians on December* 3, 1903. By Sir Hermann Weber. Edited by Dr. F. Parkes Weber. With a preface by Sir Clifford Allbutt. Fifth (enlarged) edition, revised and partly re-written. Pp. xxii+292. (London: Macmillan and Co., Ltd., 1919.) Price 12*s*. net.

(1) PROF. E. V. McCOLLUM sets forth in volume form the results of, and conclusions to be drawn from, his well-known researches on food accessory bodies, the discovery of which was initiated by Dr. Gowland Hopkins. These bodies, called "vitamines" by Funk, are now realised to be of the greatest importance to growth, health, and resistance to disease, the lack of them making the body susceptible to the rank growth of microbes.

Prof. McCollum inclines to doubt that scurvy is due to the lack of a water-soluble accessory body A, strong evidence for the existence of which has been adduced by the workers at the Lister Institute, Dr. Harden, Miss Chick, and others. He lays the greatest stress on the fat-soluble A accessory body, which is of supreme importance for growth, and is to be found in growing cells and in milk, eggs, and the germ of seeds (wheatberry, etc.), substances specially formed with growth principles in them. The miller removes the germ in the preparation of white flour, and, classed as offal, it goes to feed and promote the growth of pigs and chickens.

Dairy produce from cows fed on green leaves and the green leaf itself supply "fat-soluble A," and are thus the great protective foods, and every endeavour must be made to keep up the supply of these. Green vegetables must not be regarded as a luxury, but as a most essential part of the diet. The citizen is divorced from gardens and allotments, and the cost of transport makes a cheap supply of greenstuff prohibitive. Milk has become costly, and even when cheap was not much drunk by the children of the poorer classes. How many schools recognise the imperative needs of children for green vegetables, fruit, and abundance of milk?

The fatality of the recent epidemics of influenza may have been closely associated with deficiency of fat-soluble A in the diet, for there is none in the vegetable-oil margarine which has so largely replaced butter.

(2) The fifth edition of the late Sir Hermann Weber's book on longevity, edited by his son, Dr. Parkes Weber, is prefaced by Sir Clifford Allbutt by many wise and illuminating remarks. The motto of the author is no less old than true. "Work, moderation, and contentedness are the main sources of health, happiness, and long life." A great apostle for open-air exercise, he justly extols walking and climbing above all forms of exercise. He lived to ninety-seven himself, following the wise tenets which he lays down.

It is often asserted that longevity is an inborn quality, and the cases of men are cited who have attained old age and yet have been heavy eaters or drinkers. Inquiring into the manner of living and other antecedents of more than 100 persons living to between 86 and 102 years, Weber found that although most of these persons belonged to the well-to-do classes, and were not obliged to restrict themselves, there were not more than six amongst them who had more or less habitually indulged themselves by eating or drinking largely; many, on the contrary, were remarkable for great moderation. He records the cases of many middle-aged people with bad family histories and showing themselves signs of breaking up in health who, by his regimen of open-air exercise and great moderation in food and alcohol, were carried on in good health to eighty years or more, while their brothers and sisters, following no such regimen, died twenty years or so before them. The evidence Weber thus adduces seems strong enough to support his claim that great moderation in eating and drinking, and plenty of open-air exercise, can promote the duration of life of the middle-aged to a marked extent. The degenerations of the blood-vessels and other organs which hasten the end of life are primarily due to toxins absorbed from the bowels or from infections—*e.g.* rheumatic fever, syphilis, etc. A clean, healthy life keeps these away.

CHEESE- AND BUTTER-MAKING.

(1) *The Book of Cheese.* By Charles Thom and Prof. Walter W. Fisk. (Rural Text-book Series.) Pp. xvi+392. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 8*s.* net.

(2) *Practical Butter-making: Fourth Revision. A Treatise for Butter-makers and Students.* By C. W. Walker-Tisdale and Theodore R. Robinson. Pp. 143. (London: Headley Brothers, Publishers, Ltd., n.d.) Price 5*s.* 6*d.* net.

(1) THE greater interest which is being taken in the manufacture of cheese will assure a welcome for this volume. It is one of the well-known series edited by Prof. L. H. Bailey, and it thoroughly warrants its inclusion in the list.

Practical cheese-making has not had in this country the study it requires to have, and whilst a number of the standard cheeses have originated here it cannot be said that, apart from Prof. Lloyd's investigations in the making of Cheddar cheese, any serious attempt has been made to throw light upon the details of manufacture or to explain the causes of the failures which arise from time to time.

In this volume the authors deal systematically with the general method of cheese-making, and state in simple language the process of milk coagulation and the theories which have been advanced in explanation. A chapter is devoted to "starters," and it would be well if our dairy students could receive greater facilities for preparing and judging the cultures and noticing the effect upon the cheese of a bad starter. A clean acid starter has a great influence upon the texture and flavour of the cheese, as is well known, and a maker who works with a bad starter cannot hope to produce a first-class cheese. Inability to judge a good starter may mean the continuance of flavours and faults which would have disappeared had the proper type of starter been used.

Amongst the hard cheeses, chief place is naturally given to Cheddar, as this type is the one commonly made in America and Canada. The appliances suitable for a factory making Cheddar cheese are described, and the process of making the cheese is followed step by step. Various types of cheese made in different countries, but all prepared upon the Cheddar principle with greater or less modification, are reviewed.

The "Book of Cheese" has many other interesting chapters, one even upon the food value of cheese, the method of using it, and recipes for dishes in which cheese plays an important part.

Milk-testing by the Babcock method is described, and numerous other tests, such as Hart's test for casein, and the testing of cheese for fat by a modified Babcock method, are given. The accuracy of the latter test is questionable.

(2) Butter-making is somewhat under a cloud at the present time, owing to the impossibility of producing it commercially at a profitable price. The information given by the authors is, however, excellent, and the best up-to-date methods and appliances are described.

The extension of the practice of selling milk, and the facilities now afforded the farmer by the wholesale dealer or the condensing factory, have not encouraged the breeding of cows giving a high percentage of fat in the milk, and it is difficult to see how butter-making can for some time to come compete with cheese-making or milk-selling. Nevertheless, there will always be a good demand for high-class butter, and it is most necessary that the maker should produce an article of prime quality. This volume would not have reached a fourth revision unless it had met with success in previous editions, and both as a manual and a reference book it takes a very high place.

OUR BOOKSHELF.

Enjoying Life: and Other Literary Remains of W. N. P. Barbellion [B. F. Cummings]. Pp. xvi+246. (London: Chatto and Windus, 1919.) Price 6*s*. net.

THIS book is welcome because it raises a much pleasanter picture of its author than did the rather peevish "Journal" reviewed in these columns in July last. Some of the essays, excluded from the "Journal" for reasons of space, would have illuminated its shadows. One is called "Crying for the Moon," but Barbellion wanted to swallow the Universe. Even those of us who would be content with the World have to learn that it is too large an oyster. Life is a perpetual renunciation of the unattainable. Barbellion had yet to realise that the half is greater than the whole; his only limitations were those of a sickly body, and so he seemed to scorn those who restrained the appetite of the soul. Hence, in the diarist, an apparent poverty of human kindness. But in his outward relations, as Cummings, the defect is made good or hidden. There is sympathy as well as skill in his sketches of Spallanzani, Montagu, Rousseau, and Goldsmith of the "Animated Nature," and even for his colleagues, the Scarabees, he has a good word, for he has begun to realise that the driest museum entomologist may have beneath his dusty coat something of a Barbellion.

It is ungracious to criticise lapses in a posthumous publication, but "Sir Hercules Reed," "Museo di Stovia Naturale," and "Sir Francis Galten" might have been avoided.

The Manufacture of Chemicals by Electrolysis. By Arthur J. Hale. (A Treatise of Electrochemistry.) Pp. xi+80. (London: Constable and Co., Ltd., 1919.) Price 6*s*. net.

IN this monograph a brief account is given of the application of electrolysis to the preparation of chemical products. Most of the electrolytic preparations of which a description has been published are referred to, and references to the original publications are given throughout, so that the book is likely to prove a useful guide to the literature of the subject. The reader is, however, left to guess that certain groups of preparations, such as chlorine, sodium, and the alkalis, to which no reference at all is made either in the text or in the preface, are to be described in other monographs of the series. This probably accounts for the impression created on reading the text that the academic aspects of the subject have secured in this volume undue prominence as compared with its industrial applications. If, however, all the really productive processes have been reserved for other writers, and the author of the present volume has been left to cultivate only the more barren areas, he cannot be blamed for the unfruitfulness of so large a proportion of the preparations which he describes, and is rather to be congratulated on having given so good an account of the minor applications of electrolysis to chemical industry.

A Synoptical List of the Accipitres. (Diurnal Birds of Prey.) Parts i. and ii. By H. Kirke Swann. (London: John Wheldon and Co., 1919.) Price 4*s*. per part.

THE literature of an attractive Order of birds receives a notable addition in this work. It is now nearly half a century since the late Dr. Bowdler Sharpe's "Catalogue of the Accipitres," the latest complete work on the subject, appeared. During this long interval innumerable contributions have been made to the knowledge of the Order relating to the discovery of new species, the recognition of numerous racial forms, changes in nomenclature and classification, extension of geographical range, and much else. Thus a treatise, however modest, which might bring the subject down to date was a desideratum, and now, in a measure, has been supplied in a highly epitomised form by this synoptical list, which furnishes concise diagnostic characters of families, genera, species, and subspecies, and also an indication of the geographical range of each bird. For the species, however, it has been found impossible to deal with any but the plumage of adults, for the varied feather changes through which many species pass ere they assume the garb of maturity could only be satisfactorily described in an elaborate monograph on the Order; as yet there does not appear to be any signs of the advent of such a much needed work. Great care has been bestowed upon the preparation of this list—a task of no small difficulty—and it will be much appreciated by all who are engaged in systematic ornithological studies.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Gravitation and Light.

IN a recent letter (NATURE, December 25, p. 412) and elsewhere I have expressed doubt as to the security of the inferences regarding the influence of gravitation on the light from distant celestial bodies, which are advanced as tests of the Einstein formulation. A closer and less sceptical general scrutiny is possible. The difficulty was to recognise how a theory which professes to supersede an æther with its definite space and time, by concepts purely relativist, could manage to effect direct comparison, at a distance and without tracing transmission across the intervening space, of the radiations of a molecule at the sun and those of a molecule of the same substance at the earth. This body of doctrine seems, in fact, to consist of two chapters. A blind man could work out the purely relativist theory, which would indeed represent rather closely the process of groping from point to adjacent point in space and time by which he must acquire his own scheme of knowledge. But to compare his results with the world of experience a practical astronomer is needed, with very different equipment; he relies on the rays of light, in conformity with the optical theory that prescribes their function as messengers across space.

It thus appears to be necessary to examine directly what changes in the propagation of rays of light would arise under the modified gravitation, and, if possible, to bring out more explicitly and demonstratively the further postulate that is needed to reconcile them with the proposed test-relations. The postulate which is sufficient to sustain the optical predictions proves to be this: that all the way to the sun and throughout the solar system the formula for the element of fourfold length by which the nature of the space is determined does not contain explicitly that one co-ordinate which is more especially related to time, but involves only its differential. This is, of course, a reasonable assumption; but it is of an absolute type regulating the whole space, assumed to be thus settled in advance on the Newtonian plan, not of the relativist type which would profess only to explore it gradually from place to place as it arises.

But we can analyse further and more definitely. The new theory implies that if this quadratic formula characteristic of the space involved in its product terms the differential of that co-ordinate which stands closest to time, then the velocity of the rays of light in any direction at any place would be different according as they are travelling forward or backward. That could only mean that the co-ordinates define at such a locality a frame of reference which is itself in motion. But in motion with reference to what? The relativity of language is doubtless capable of supplying an answering formula; but it would only be wrapping up in abstractions the simple statement that when at any place the quadratic characteristic of the spacial extension involves the differential of the co-ordinate specially related to time in its product terms, then there is latent in it a specification of its own mode of change at that place with respect to uniform space-time. If no such products are contained, the space is not locally in motion, and we may say that the frame of reference is fixed in the æther. That is, the fourfold space-time frame in which we set the universe is everywhere deformed and awry, but it is then nowhere in movement relative to light; or, in graphic terms, the co-ordinate system would involve a fourfold curvilinear frame instead of a rectangular one when it is set in a uniform fivefold extension, but it is to be nowhere in movement when set in that higher auxiliary space. The physical properties of the rays of light can scarcely be invoked to obtain an astronomical test of results, by providing in their vibrations a universal scale of time, without becoming to the same degree a criterion of the relation to light of the whole construction; if they can settle universal time by optical vibrations, they can equally well be applied to settle absolute space in each locality. It comes to this, that radiation can be utilised to determine the space and time absolutely.

This point of view involves no destructive criticism of the substantial and brilliant mathematical theory, which, of course, ought to evolve correctly the consequences of the postulates that are put into it. But it does demur to the popular presentation which asserts that space and time and the æther have now been transcended. The outstanding problem, stripped to its essentials, was to find whether gravitation could be brought into line with radiation in this very arresting feature: that the time which is most appropriate by far for its analytical formulation is a changing local time mixed up definitely, though very slightly, with spacial relations. The value of the new theory is that it opened out a way by which this problem could be attacked, while previously no approach was in sight; and, still more important, that it has not improbably led to an answer, in the affirmative. This, of course, is a very remarkable consummation, comparable to Faraday's detection of an influence of magnetism on light, though more fundamental in that it relates to free space; it must promise substantial advance as regards the formulations on which we construct our ultimate plan of physical activity, either along its present lines or some other that would represent the result with equal approximation. But beyond that the extreme relativist developments, where they are not metaphysical dogmatics, are a very interesting extrapolation towards the possible or probable physical formulation of a universe in which bodies are moving thousands of times as fast as the stars are found to move in our own.

Reference may be made to forthcoming Proceedings of the Cambridge Philosophical Society and Monthly Notices of the Royal Astronomical Society.

Cambridge, January 17. JOSEPH LARMOR.

The Outlook of British Technical Optics.

THE symposium and general discussion on "The Microscope: Its Design, Construction, and Applications," held in the rooms of the Royal Society at Burlington House on January 14, under the auspices of the Faraday, Royal Microscopical, Optical, and Photomicrographic Societies, in co-operation with the Optical Committee of the British Science Guild, with Sir Robert Hadfield, president of the Faraday Society, in the chair, was a landmark in the history of British optics. Whether judged by the number, value, and variety of the exhibits and the papers contributed, or by the number of people who attended, the symposium was a success.

At the present time the microscope possesses a unique interest for those concerned with British optical industries. It demands greater technical knowledge and skill in its designer and producer than any other optical instrument, and the demand for it, both actually and potentially, for work of the most far-reaching importance is so great that it may fairly be said to be the keystone in the arch of an industry which has already been recognised as one of such vital national importance as to constrain the Government to treat it as a "key industry." But there is no royal road to success even in manufacture and commerce. If this country is ever to stand in the forefront as a producer of microscopes for the world's needs the position to-day must be boldly and courageously faced. The lessons of the war must not be forgotten. We shiver yet when we remember the single thread upon which the production of optical munitions depended in this country. Our glass-makers, beaten by their foreign rivals, receiving neither help, encouragement, nor even recognition from the Government, had been content to continue their patriotic efforts to maintain the industry, on the urgent representations of a few far-seeing scientific men, until long after those efforts held out any promise of pecuniary reward. That danger, happily, has passed, and the complete solution of the optical glass problem is now only a question of time. Many of the glasses now produced in this country compare favourably with the best of those of our foreign rivals. The varieties available are limited, but the leeway is being rapidly made up.

It is often stated that the late supremacy of the Germans in optical production was the direct and necessary result of the glass-making labours of Abbe and Schott completed in the year 1886. This is not a correct statement of the case. The fact is that, when Abbe and Schott broke down the barriers to optical progress imposed by the limited varieties of glass available, Germany had in reserve a small army of scientific workers, equipped with the necessary technical knowledge and skill, ready to fill the breach and carry on the work of utilising the new glasses in the invention of new optical systems and in the improvement of old. But the world moves quickly, and inventions and discoveries, however valuable intrinsically, are likely to remain barren unless a country has a sufficient number of men equipped with the necessary knowledge to exploit them instantly and to the full. Indeed, it is only such men that can appreciate the value of inventions and discoveries. The necessity for a broad and generous scheme of national education in optical matters thus becomes apparent. When the users of optical instruments are sufficiently educated to be able to distinguish and appraise good designs and work, makers will be encouraged to meet their demands. In the absence of such education the faddist has his day, and the maker concerns himself too often in meeting the demands of fashion.

It is satisfactory to know, then, that, so far as this country is concerned, a great deal has already been done to foster optical education. The establishment of the Technical Optics Committee, which includes representatives of the British Optical Instrument Makers' Association, the War Office, the Admiralty, the National Physical Laboratory, the London County Council, the Royal Society, and the Imperial College of Science, is in itself sufficient evidence that the question has been taken up with great thoroughness. The establishment of a department of optical engineering and applied optics at the Imperial College will ensure a supply of capable and well-educated young men for the needs of the industry generally. Prof. Conrady is doing yeoman service in the establishment of an English school of optical designers and computers, the need for which was so acutely felt during the war. The outlook, then, so far as education is concerned, is decidedly promising. Indeed, in some important respects the scheme of education here is already in advance of that of any other country.

When we turn, however, to the purely engineering side—the production of the microscope as a mechanical instrument—the outlook is not so satisfactory. At the present time the Government is pledged to afford protection to the optical industries. This will probably be done by a continuation of the licensing system, which has for the moment been suspended because of Mr. Justice Sankey's decision, but there is little doubt that the system will be reimposed, either by the reversal of that decision or by legislative enactment. Now the public at the present time, with just cause, are very suspicious of anything in the nature of Protection. During the past few years Protection has so often resulted in unscrupulous profiteering at the expense of the community that the public may well be excused for looking with suspicion upon any proposal to continue the system. In the case of the microscope, for example, there is little doubt that at the back of the minds of many people there is a fear that Protection will be taken advantage of by manufacturers to foist upon the market inferior goods at greater prices than could be obtained in a free market. But the symposium has proved conclusively that this danger, in the case of microscopes at any rate, is a very small one. One or two important makers exhibited new models, designed for mass production, which showed clearly how thoroughly and seriously the problem had been taken up. Microscope production in this country is now a young, vigorous, and promising organism, which, in the course of a year or two, will probably be able to stand up and fight its way in the world without artificial support.

The real difficulty at the present moment lies in the fact that efficient production means mass production, and mass production means large enterprises carried on with large capital. Everyone is agreed that production by the old methods, requiring the employment of a large proportion of highly skilled craftsmen—the artistic method—must be replaced by machine methods. Efficient and successful production in the case of the microscope involves, as it does in so many other cases, specialisation, standardisation, and the use of repetition machinery attended by unskilled labour to produce interchangeable parts, the whole of the activities being supervised and directed by the highest technical knowledge and skill. But this involves the speculative investment of capital. The maker, on the other hand, who can ensure a moderate success with little risk by carrying on producing operations on a small scale to meet the immediate needs of the country is under a great temptation to do so rather than risk everything in an attempt to secure large profits by mass production. The present position, therefore, is a serious one for the trade generally. If the mass production of optical instruments is necessary to the success of the industry and to the realisation of the end and aims of the Government, then it is very unlikely that that success will be achieved by Protection alone. Some much more substantial assistance must be given, and this assistance is not likely to be given by private enterprise.

An interesting fact brought out by the papers and discussions at the symposium was the urgent demand for greater resolving power in the microscope. This matter was particularly dealt with by Mr. J. E. Barnard, who showed a very interesting series of slides taken with the ultra-violet microscope to demonstrate the greater resolution obtainable with the shorter wave-length light. The metallographers, on the other hand, in some cases appeared to be insisting upon large magnifications without always clearly recognising that these do not involve greater resolution. The half wave-length limit to resolution, first advanced in effect by Fraunhofer, cannot substantially, at any rate, be evaded, and this fact must be clearly recognised.

F. CHESHIRE.

Imperial College, South Kensington.

Power from the Sun.

WITH reference to Mr. A. S. E. Ackermann's letter in NATURE of January 15, in which he states that, in putting the possible efficiency of obtaining power from the sun with the heat engine at less than 2 per cent., I have used too low a figure, I may point out that, whereas Mr. Ackermann's figure of 4·32 per cent. was a maximum obtained presumably under specially favourable conditions, and as I understand in Egypt, in suggesting a figure of less than 2 per cent. I was referring to what could be expected "in this latitude and in this climate"—that is to say, in England, and also as an average during the hours of daylight throughout the whole year.

For the purpose of my argument, and in comparison with the very much higher efficiencies that are theoretically possible if the radiation can be directly utilised without first turning it to heat, with the consequent avoidance of the second law of thermodynamics, I do not think that the difference between 2 and 4 per cent. is of much importance; but, even so, I should be surprised to learn that Mr. Ackermann would expect to obtain an efficiency of even 2 per cent. anywhere in England throughout the year.

A. A. CAMPBELL SWINTON.

66 Victoria Street, S.W.1, January 17.

Sedimentation of Blood Corpuscles.

I HAVE noticed lately that if oxalated or defibrinated blood is put to stand in narrow tubes, the corpuscles sediment a good deal faster if the tube is inclined than when it is vertical. Thus with tubes about 2·7 mm. internal diameter there were, after 20 hours, 4, 23, 35, and 42 per cent. of clear serum with tubes inclined at 0°, 22½°, 45°, and 67½° respectively. In another rough experiment with tubes of different diameters, all filled to a height of 40 mm. with diluted blood, after 5 hours there were the following proportions of clear serum:—

mm. diam.	Vertical Per cent.	11¼° Per cent.	22½° Per cent.	33¾° Per cent.
2·7	6	20	29	51
8	5	10	15	21
14	4	5	9	12

The phenomenon seems to depend on the *vertical* height of the columns of blood, and it occurs to me that the slight Brownian movement of the lower corpuscles may interfere with the sedimentation of those above. But I should be glad if someone would tell me the explanation: the phenomenon is perhaps well known in some other form. A. E. BOYCOTT.

Medical School, University College Hospital, W.C.

The Einstein Theory and Spectral Displacement.

ONE of the "crucial phenomena" in connection with the Einstein theory is the displacement of the spectral lines towards the red when the emitting atom is in a position where the gravitational potential is large.

In the case of the sun this displacement is so small that its existence is a matter of doubt. But the amount of the displacement varies as the mass of the sun or star concerned, divided by its radius, and in the case of giant stars, such as Canopus, Arcturus, or Antares, should give a result corresponding to a recession of many hundreds, if not thousands, of kilometres per second, whereas, in fact, these stars show no abnormal radial velocities.

It may be pointed out that the effect varies as the product of the area and density, factors as to which the magnitude and spectrum of a star enable astronomers to make a fair approximation, at any rate as to minimum values.

These facts must, of course, have been considered by the supporters of the theory, and I think that an explanation would be interesting and useful.

H. FLETCHER MOULTON.

11 King's Bench Walk, Temple, E.C.

MR. FLETCHER MOULTON is quite correct in stating that the shift of the spectral lines varies as mass/radius, but his expectation of spectral shifts measured by hundreds or thousands of kilometres per second does not appear to be justified. All the evidence available, deduced from visual binaries, Algol variables, and spectroscopic binaries, points to the conclusion that the masses of the stars vary between much narrower limits than their brightness. We have no clear evidence of any star having a mass so great as forty times that of the sun; moreover, the most massive stars known to us are apparently in a much more diffused state than the sun, so that the ratio of spectral shifts is much less than that of masses.

We cannot use individual stars to test the Einstein effect, for we do not know the radial motion independently of the spectroscope, as we do in the case of the sun. All that we can do is to take the mean of a large number of spectra and see whether there is a systematic shift towards the red; such a shift does exist, and the difficulty is rather that it is too large than too small to ascribe wholly to the Einstein effect. Thus Campbell ("Stellar Motions," p. 199) says: "Of Type II. stars (that is, F5 to M), 371 have positive velocities and 352 negative. Of Type I. stars (that is, O to F4), 215 have positive velocities and 122 negative." Subdividing further, he gives the following mean velocities of recession in km. per second: B to B9, 4·93; A, 0·18; A2 to F8, 0·60; G to M, 0·91. Dr. de Sitter, taking the average mass and density of a B star as 10 and 1/10 respectively, finds 1·4 for the Einstein effect, about one-third of the observed quantity.

We do not know the character of the atmospheric circulation in the stars; this, as well as pressure effects, may well have some influence on the mean results. Taking the stars as a whole, it must be admitted that their verdict, though by no means conclusive, is, so far as it goes, in favour of Einstein.

ANDREW C. D. CROMMELIN.

Use of a Prismatic Binocular for Viewing Near Objects.

A FEW years ago, with a view to the observation of close objects out of doors, I procured some glass adapter lenses for use on the object glass of the half of a prism binocular (×12) which I carried about with me. Finding, however, that this method involved the use of several glass adapters, and that with it I had to know the exact distance of my objective, I prevailed on an optician—after lengthy argument, he deeming the experiment impracticable—to remove the eyepiece and refit it for use with a long screw thread. The result was most satisfactory; by this device I can draw out the eyepiece and adjust it to the proper distance for any observation down to four feet off. This device is also very useful for indoor work, such as observation on the occupants of an aquarium.

The device may be useful to other observers, who will find that the necessary alteration can be easily made. D. WILSON BARKER.

Flimwell.

THE NITROGEN PROBLEM.[1]

I.

THE Nitrogen Products Committee was appointed in June, 1916, as a Committee of the Advisory Panel of the Munitions Inventions Department with the following terms of reference:—

To consider the relative advantages for this country and for the Empire of the various methods for the fixation of atmospheric nitrogen, from the point of view of both war and peace purposes; to ascertain their relative costs, and to advise on proposals relevant thereto.

To examine into the supply of the raw materials required and into the utilisation of the by-products obtained. Since some of the processes depend on the provision of supplies of cheap power, to ascertain how this can best be obtained.

To consider what steps can be taken to conserve and increase the national resources in nitrogen-bearing compounds, and to limit their wastage.

To carry out the experimental work necessary to arrive at definite conclusions as to the practicability and efficiency of such processes as may appear to the Committee to be of value, and to advise as to starting operations on an industrial scale.

It will be seen that the terms of reference are pretty wide, and the Committee, as is stated, have, moreover, interpreted them "in a liberal manner." The inquiry accordingly has resulted practically into a detailed examination of the nitrogen problem in its relation to the military, agricultural, and industrial requirements of the United Kingdom and other parts of the British Empire. The Committee submitted an interim report in February, 1917. As the conclusions and recommendations of that report are closely connected with the final conclusions and recommendations of the Committee, they are incorporated in the present report. The final report, with its appendices, charts, and diagrams, is a somewhat formidable document of upwards of 350 pages, the report itself occupying no fewer than 137 pages. It has been somewhat loosely constructed, and there is a certain amount of recapitulation, which was, perhaps, inevitable when regard is had to the many points of view the subject presents. But of its great value there can be no doubt. Considering the difficulty and complexity of the inquiry, it cannot be said to have been unduly protracted, and, as the result of the 106 sittings of the Committee and its Sub-Committees, we have now presented to us the most complete and comprehensive statement of the problem, as it affects this country, which has yet appeared.

The report will doubtless receive the most serious study, for it deals with matters of the gravest importance—the world's production of food, our industrial supremacy, and our national security. Indeed, its appeal is so wide, and the whole question affects so many interests, that there is a fear that no immediate action will come of it, on the principle that what is everybody's business is nobody's business. It is pre-eminently a national question, and demands the consideration of statesmen. But in the present condition of the political and industrial atmosphere we cannot hope that it will receive this. The State will wait upon private enterprise, and private enterprise will wait upon the State, each trusting, like Mr. Micawber, that "something may turn up" to avert the main conclusions to which the report inevitably points. But in view of the menace which will come from a resuscitated Germany, it would be nothing less than criminal folly to neglect the warning which the evidence now summarised conveys. Our chemical manufacturers and our producers of fertilisers must be brought to realise that synthetic nitrogen products have come to say. The days of the Chile nitrate industry are apparently numbered. If we accept the estimates of the Committee, retort nitric acid cannot, even in this country, be produced so cheaply as the synthetic product, and synthetic fertilisers are serious competitors with the natural nitrate and by-product sulphate of ammonia.

It would be impossible in the space at disposal to deal in detail with the many points and issues raised by the Committee's inquiry, and set out at length in the report. We must content ourselves, therefore, with a summary statement of the principal conclusions at which it has arrived.

With respect to the world's demand and production of nitrogen compounds before the war, it is shown that the world's consumption in 1913 was almost double what it was in 1903. The demand up to this time was practically wholly met by Chile nitrate and by-product ammonia, the nitrogen fixation processes contributing only a small, but still growing, proportion, notwithstanding their notable development during the years 1903–13. Up to 1914 the market price of combined nitrogen was governed by that of Chile nitrate, and was characterised by a general upward tendency, showing that the supply was not in excess of the demand. At the same time, synthetic nitrogen products could be placed upon the market at prices which competed favourably with ammonia nitrogen and nitrate nitrogen. That these fixation industries were in a healthy condition was shown by the fact that they had expanded more than 150 per cent. during the period, 1903–13, or more than double the expansion during the same interval of the Chile nitrate industry.

The war has profoundly modified the relative position of the natural and synthetic nitrogen industries. Before the end of 1914 the productive capacity of the nitrogen fixation installations represented 10 per cent. of the world's supply of combined nitrogen; at the present time it is about 28 per cent. The post-war production of ammonium sulphate, both synthetic and by-product,

[1] "Ministry of Munitions of War. Munitions Inventions Department. Nitrogen Products Committee. Final Report." Pp. vi+357. (London: H.M. Stationery Office, 1919). Cmd. 482. Price 4s. net.

is calculated to amount to 39 per cent. of the world's supplies of combined nitrogen, Chile nitrate accounting for about 41 per cent. War developments are now challenging the supremacy of the Chilean industry. The market price of the synthetic products, and of ammonium sulphate, bids fair to govern that of Chile nitrate instead of following it as hitherto. The Committee estimates that the post-war supply of fixed nitrogen potentially available is likely to show an increase of from 30 to 40 per cent. upon the pre-war production, or to be of the order of a million metric tons per annum. It is, however, of opinion that this amount is not greater than would have been the case under normal conditions, to judge from the pre-war rate of growth in consumption. But it is significant that this increase is almost wholly due to the development of synthetic processes. There would seem to be no fear that over-production will be a serious factor in the post-war situation.

As regards the uses of nitrogen products prior to the war, at least 70 per cent. of the world's total supplies of nitrate and ammonia nitrogen was utilised in agriculture. Owing to their comparatively limited employment in this country, and the somewhat conflicting experience of our experiment stations, which, as the evidence presented to the Committee shows, have scarcely given sufficient study to the question, there is no absolute proof, as yet, that synthetic fertilisers are wholly suited to the particular circumstances of this country. The Committee, however, has no doubt as to their utility, and specifically makes mention of the value of nitrate of lime, as now manufactured, and of calcium cyanamide when free from dicyanodiamide, in which opinion it would seem to be supported by the Board of Agriculture.

Dr. E. J. Russell, of the Rothamsted Experimental Station, in a recent paper published in the Journal of the Society of Chemical Industry, states that the results of all published field trials show that the three fertilisers—nitrate of soda, sulphate of ammonia, and cyanamide—when compared on the basis of equal nitrogen content have the following values:—

Nitric nitrogen	100
Ammoniacal nitrogen	97
Cyanamide nitrogen	90

But, he adds, these include cases where the cyanamide nitrogen could have had no proper chance of acting. Cyanamide, he points out, presents the characteristic that it is not at once available for plants, but has to undergo change in the soil whereby ammonia is formed, which afterwards nitrifies. The whole value of the material, therefore, depends on the rate at which the change proceeds. In some soils it goes on rapidly, and here cyanamide is very effective. In others, however, it proceeds more slowly. The production of the ammonia would appear to take place in two stages, the first being purely chemical, and the second bacterial; further, the agent producing the chemical change is not always present in sufficient quantity in the soil. Under better advice, such as is now obtainable, the farmer could be warned beforehand, and the use of cyanamide kept to those numerous cases where it can decompose rapidly and act well. In these circumstances the value of cyanamide nitrogen might rise well above 90, and, what is more important, the risk of failure might be considerably reduced.

Of course, the war made imperative calls upon the nitrogen industries, and these, notwithstanding their expansion, were quite unable to cope with the demands for both explosives and fertilisers. The needs of agriculture were consequently largely set aside, to the great detriment of the world's food supply. The effect has been the almost universal recognition of the vital importance of nitrogenous fertilisers. The difficulties of obtaining them and the consequences which have followed from the shortage have together furnished an object-lesson which the world will not soon forget. The Committee learns that the visible demand for nitrogenous fertilisers is everywhere considerably in excess of the pre-war consumption.

With respect to the relative costs of synthetic and non-synthetic processes, the Committee concludes that under favourable conditions in regard to the cost of power and of raw materials, the nitrogen fixation and allied processes, speaking broadly, stand at a very considerable advantage as compared with non-synthetic methods. It ought to be stated, however, that all its estimates are based upon pre-war prices and factory costs, and it by no means follows that the price of coal and of water-power will advance *pari passu*. A waterfall does not "down tools" like a miner, nor does it attend football matches and go on strike for any or no cause in particular. But still, fallible as the basis may possibly be under present or prospective conditions, the comparison of costs is instructive and significant. The average market price of a metric ton of combined nitrogen in the United Kingdom during 1911–13 was 67*l.* and 66*l.* in the forms of Chile nitrate and ammonium sulphate respectively. The synthetic processes can produce a metric ton of available combined nitrogen at a cost, at the factory, of from 20*l.* to 30*l.* These processes can produce a metric ton of concentrated nitric acid (93 to 96 per cent.) at about half the cost of retort (Chile nitrate) nitric acid. Nitric acid can be produced by the oxidation process from by-product ammonia, even at its highest pre-war price, cheaper than by the old process.

It may, however, be doubted whether any of the synthetic processes, with the possible exception of the arc process in very favourable circumstances, can produce a nitrate fertiliser that would compete with Chile nitrate under conditions that the Chilean industry might be willing to adopt. Whilst improvements in the method of absorbing and recovering the oxides of nitrogen in the arc process are certain to occur, it must not be forgotten that the capital expenditure needed in installing this process is high, and bears a large proportion to the market value of the annual production.

It follows, therefore, from these conclusions that the industrial demand for nitric acid in the future will probably be met by means of synthetic processes. It is conceivable that the marketing of large quantities of synthetic sulphate of ammonia and cyanamide, made in Germany, will influence the future price of combined nitrogen, and may even control it. The Committee thinks that the producers of combined nitrogen may eventually have to face a competitive price of 7*l.* or 8*l.* per metric ton for ammonium sulphate, and 6*l.* or 7*l.* per metric ton for cyanamide. The by-product ammonia industry in this country may thus be seriously menaced. It can scarcely recoup itself by raising the price of the other by-products to any serious extent, and considering the relation of combined nitrogen to the food of the country, public opinion, whilst willing to tolerate, up to a certain extent, the protection of "key" industries, would strongly resent any action which seriously interfered with the productive capacity of the land.

(*To be continued.*)

THE MICROSCOPY OF METALS.

AT the very successful symposium on the microscope organised by the Faraday Society on January 14 in the rooms of the Royal Society, about one-half of the papers presented dealt with the microscopical examination of metals, a striking indication of the importance which this branch of microscopy has now acquired. It was therefore appropriate that the president, himself a distinguished worker in this field, should deal historically with the development of micro-metallography, as well as contributing an original paper to the discussion. Sir Robert Hadfield's introductory address surveyed the history of microscopical invention, and was illustrated by portraits of some of the pioneers in the art—Jansen, Lipperhey, Leeuwenhoek, Sorby, and Dallinger. We were reminded of the fact that, so far back as 1665, Robert Hooke described in his "Micrographia" the appearance of the point of a needle and the edge of a razor, and his faithful drawings of these two objects, revealing most accurately the features which could be observed under a low magnification, are reproduced in the paper. The next instance of the application of the microscope to the examination of metals is that by Réaumur, whose work on steel, published in 1722, contains many drawings of the magnified fractures of iron and steel bars. Such a method, however, gave little information, and did not lead to any further development. In 1808 Widmanstätten studied the structure of meteoric irons by polishing a plane section and heating until the constituents became differentially coloured by oxidation, thus introducing the method now familiar as "heat-tinting." The structure of these irons is so coarse that magnification is unnecessary, but the method gave hints to later workers, of whom Sorby is the chief. The work of Sorby, in view of its great importance, was dealt with by the president in a separate note.

Henry Clifton Sorby, one of those amateur scientific investigators who have contributed so wonderfully to the progress of science in this country, was led to devise the modern method of microscopic petrography by seeing sections of bone, teeth, etc., rendered transparent by affixing one surface to glass and then grinding down to an extreme thinness, as practised by the botanist Williamson. Sorby treated rocks in the same way, and in 1849 he prepared the first rock slice

FIG. 1.—Magnification 600. 12 mm. Achromat.

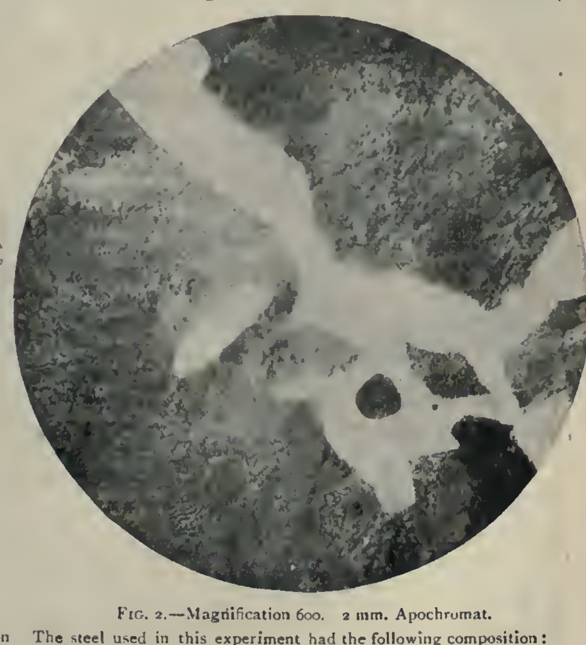

FIG. 2.—Magnification 600. 2 mm. Apochromat.

Photomicrographs showing the effect of magnification without resolution The steel used in this experiment had the following composition: C 0·48, Si 0·17, S 0·029, P 0·034, Mn 1·00 per cent.

ever made. By 1851 he had become expert in the new process, and was able to publish his observations of the microscopic structure of limestones. In 1857 he presented to the Geological Society his famous paper on the fluid inclusions in quartz crystals, in which he ventured to draw

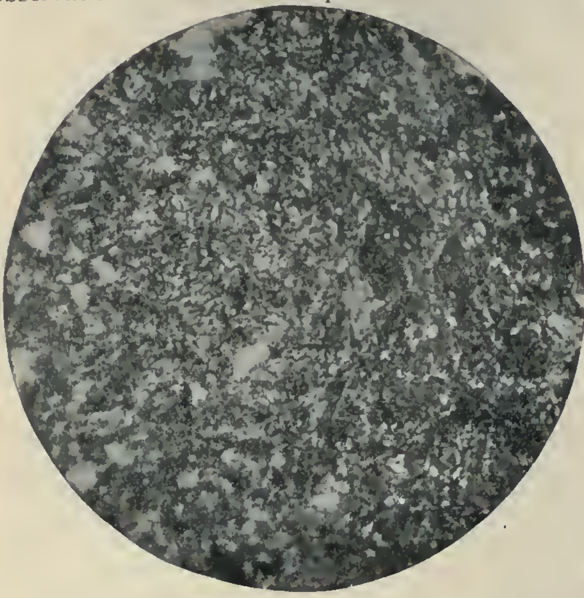

FIG. 3.—Magnification 100.

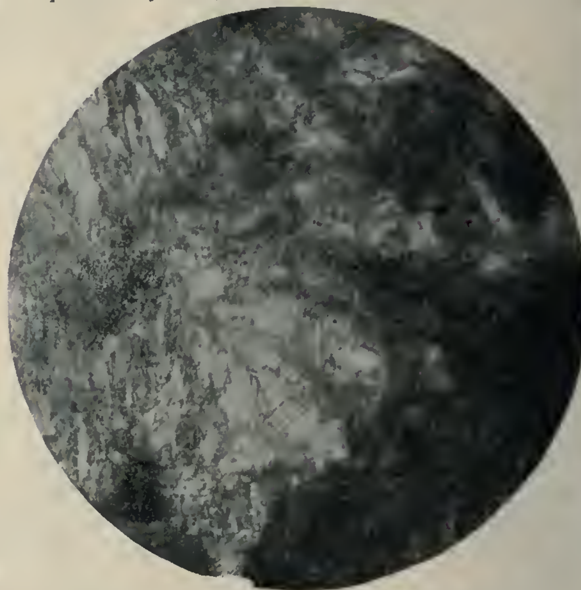

FIG. 4 Magnification 1500.

FIG. 5.—Magnification 5000.
2 mm. Apochromat. Structure of fine lamellar and sorbitic pearlite. The steel used in this experiment had the following composition: C 0·84, Si 0·30, Mn 0·45, Cr 1·12, Ni 0·12 per cent.

conclusions as to the conditions under which rocks had been formed in Nature from the examination of the minute quantities of liquid enclosed in the microscopic cavities in crystals. The paper was received without enthusiasm, and even with ridicule, so absurd did it seem to study geological problems on the minute scale of the microscope. Nevertheless, Sorby's conclusions came to be accepted by all geologists, and his paper is now accepted as one of the classics of the science. In 1863 he turned his attention to iron and steel, being led to their study by an examination of meteorites. Just as he had fused masses of silicates artificially in an attempt to solve some of the problems connected with igneous rocks, so he proposed to use the information to be derived from artificial masses of iron and steel for the explanation of the characteristics of meteoric irons. He exhibited sections of iron and steel, and photographs taken from them, at Sheffield and also at the Bath meeting of the British Association in 1864, and even these early photographs, taken, of course, at low magnifications, leave little to be desired in regard to sharpness and beauty. A collection of Sorby's original polished and etched sections of metals is carefully preserved by the University of Sheffield, and was lent on the occasion of the symposium.

Sorby's discovery aroused little interest, and when, in 1877, Prof. Martens, of Berlin, soon followed by Osmond and by Le Chatelier in Paris, began the study of metals with the aid of the microscope, the work of their predecessor had been forgotten. By this time, however, a general interest in the subject had been awakened, and Sorby's important papers in the Journal of the Iron and Steel Institute in 1886 and 1887 met with a more appreciative audience. By employing higher magnifications, Sorby was able to show that the "pearly constituent" of steel, as he had called one of its principal constituents, owing to the mother-of-pearl lustre often exhibited by it, was in reality an aggregate of parallel plates of a soft and a hard material. This discovery placed the metallography of steel on a firm basis, and prepared the way for the complete explanation of its structure when thermal methods were added to those of the microscope. Great as were the services of other investigators, it is to Sorby that we owe, without question, our modern metallographic methods.

Sorby laid great stress on the extension of our knowledge by the use of higher magnifying powers, so well illustrated by his own discovery of the true nature of pearlite. Most metallographic work is done at magnifications not exceeding 500 diameters, but excellent results have been obtained by some workers with magnifications of 1000 and even of 1500 diameters. The minuteness of many metallic structures, especially those of hardened and tempered steels, has made many metallographers wish for a means of applying much higher magnifications. Since the discovery of new detail depends, not on the magnifying power, but on the resolving power of the microscope, it is necessary to increase the latter. This may be effected either by increasing the numerical aperture of the objective, or by shortening the wave-length of the light used for illumination. The numerical aperture can be increased beyond its present maximum only by the use of other materials than glass, a plan which is likely to be adopted at some future time, whilst the use of ultra-violet light, the magnificent results of which in bacteriology were shown at the meeting by Mr. J. E. Barnard, has so far given disappointing results with metals.

A valuable contribution to the study of highly magnified metal sections was made by the third paper under notice, that by Sir Robert Hadfield and Mr. T. G. Elliot. The numerous and very beautiful plates illustrate both the advantages of high magnifications and the pitfalls which have to be avoided if success is to be obtained. For example, a field containing ferrite and pearlite is shown in three photographs, all taken at a magnification of 600 diameters, but with objectives of different resolving power. With a 12-mm. objective, the pearlite is structureless (Fig. 1), and only when a 2-mm. apochromat is used is its minute lamination fully revealed (Fig. 2). Another pearlite has its structure revealed at 1500 diam. (Fig. 4), but becomes much clearer at 5000 (Fig. 5), using the same objective. No further advantage is shown at 8000 diam. The effect of narrowing the aperture too much is shown by the apparent broadening of the cementite lamellæ in the pearlite, the true breadth being seen very clearly when the iris diaphragm is opened sufficiently. The photographs, all of which are remarkably good, may be said to be most successful in the case of pearlitic structures. The structure of martensite at 5000 diam. is not so clearly seen as at a much lower magnification, whilst the minutely granular structures of troostite and sorbite evidently call for a higher resolving power rather than for mere enlargement to indicate their true nature. The paper will serve a most useful purpose in directing attention to the nature of the problem, and perhaps attracting skilled optical workers and physicists to its solution.

C. H. D.

REPORT OF THE CALCUTTA UNIVERSITY COMMISSION.[1]

AT first sight a report in five volumes, each of upwards of four hundred pages, on the Calcutta University Commission would appear somewhat portentous; but anyone alive to the importance of university education in India who makes a study of these volumes will be quickly reconciled to their length and number. For it may be fairly claimed that they contain scarcely a sentence which one would desire to see omitted. The whole report of the Commission, including evidence and appendices, comprises no fewer than thirteen volumes, but we are here concerned only with the first five. Vols. i., ii., and iii. contain a very masterly analysis of the present conditions of education obtaining in Bengal, and vols. iv. and v. the actual recommendations of the Commission.

Although this report ostensibly deals only with education in Bengal, the greater part of it naturally has bearing on our educational systems throughout India. The whole report is a model of style, and bears testimony to the infinite pains and care taken by its editors. The names of the members of the Commission were a sufficient guarantee of its thoroughness and accuracy. The review of the present conditions of education in Bengal constitutes in itself one of the most valuable documents for the student of British rule in India. Reports, annual and quinquennial, have been issued in quantity from the various secretariats in India, but we know of nothing to compare for thoroughness and instructiveness with the chapters under review.

It is, of course, impossible for us in this place to do more than refer briefly to one or two of

[1] Reports of the Calcutta University Commission, 1917–19. (Calcutta Superintendent Government Printing, India, 1919.) Prices: Vol. i., Part i. 3s.; Vol. ii., Part i., 3s. 6d.; Vol. iii., Part i., 1s. 6d.; Vol. iv., Part ii., 2s 6d.; Vol. v., Part ii., 2s.

the many important topics dealt with, but before discussing any of these we may mention that the key to the reforms recommended by the Commissioners is the establishment of a Board of Secondary and Intermediate Education. The object they have in view is to secure the admission of students to the university who are duly prepared for higher studies, and the exclusion of those who are not. Under existing conditions an enormous number of candidates are sent up for the matriculation examination who are totally unfit to enter on university studies.

There are, of course, a number of excellent high schools in Bengal, and especially in Calcutta, but there are a fai greater number of inferior schools. Their inferiority is due in a great measure to the low standard of the teaching staff. English, for example, is often taught by an Indian on a poor salary, who is not really qualified to teach it. As the time approaches for the matriculation examination, a test examination is held in each school, and on the result of that test candidates are allowed to go in for the university examination. A percentage of marks is demanded of students who are allowed to proceed, but the test varies very much from school to school, and owing to the solicitations of parents and other causes there is a tendency to show great leniency, for so important is the prestige attaching to higher English education that to have failed in the matriculation is already regarded as an achievement. All Anglo-Indians are familiar with the claims that are supposed to attach to a man who has failed in the B.A., his value in the marriage-market being far greater than that of a man who has not sat for the B.A. at all.

The main problems, therefore, which the Commission set itself to solve were: (1) how to improve the higher classes of the secondary schools, and (2) how to secure the admission only of qualified students to university courses. Having convinced themselves of the impossibility of exercising full control of all the secondary schools in the province, which would involve an extensive inspectorate and interference with many private enterprises, the Commissioners came to the conclusion that control could be exercised at the stage now represented by the intermediate stage at universities, and they therefore suggest the establishment of intermediate colleges, which should be either attached to selected high schools or organised as distinct institutions. These colleges should be under the immediate control of the Board of Secondary and Intermediate Education, the constitution of which is representative of all classes. The intermediate colleges should afford instruction not only for the ordinary degree courses of the university in arts and science, but also for the medical, engineering, and teaching professions, and for careers in agriculture, commerce, and industry. There should be two secondary-school examinations: the first, approximately corresponding to the present matriculation, to be taken at the end of the high-school stage, at the normal age of sixteen, or, in special cases, at the age of fifteen, and to be known as the high-school examination; the second, approximately corresponding to the present intermediate, but much more varied in its range, to be taken at the end of the intermediate college course, at the normal age of eighteen, and to be known as the intermediate college examination. Success in this examination should constitute the normal test of admission to university courses.

The constitution of the board is, of course, a very important matter. It is to consist of from fifteen to eighteen members, with power to appoint outside members to sub-committees. The president of the board should be a salaried official appointed by Government, of high status. This board will naturally take a good deal of responsibility out of the hands of the universities, which will, however, be represented on it by seven members, for they will define the curricula, not only of the intermediate colleges, but, as naturally follows, also of the high schools; and they will further conduct the two secondary-school examinations which we have mentioned above. This board will also, of course, relieve the Director of Public Instruction of much detail work, without, however, reducing in any way the importance of his department.

Such is the Commission's proposal for improving the system. The Commissioners have also gone very thoroughly into the all-important question of improving the teaching staffs, which is chiefly a matter of finance. In this connection they have made several important proposals, of which the three following are the most important: (1) That facilities should be given for the interchange of teachers between privately managed schools and Government schools; (2) that teachers in Government schools and colleges should be placed upon a professional rather than a service basis; (3) that a superannuation fund should be instituted to replace the existing pension system for future recruits to the profession. This last suggestion, which is based upon the federated superannuation scheme which has been adopted in the home universities, should do much to encourage recruiting for the Bengal educational service.

One of the most difficult subjects with which the Commission has had to deal was the question of the medium of instruction to be used in secondary schools. Although, as is natural, there is a general desire among Indians that their children should be educated on a bilingual basis, there is an overwhelming mass of opinion in favour of English as the chief medium from the intermediate stage upwards. The difficulty is to decide at what stage to begin to use English as a medium, and for what subjects. The Commission is of opinion that the vernacular should be used for instruction throughout secondary schools for all subjects other than English and mathematics. It was convinced that the use of English in secondary schools as a medium is excessive. The Commissioners are, however, "emphatically of opinion that there is something unsound in a system of education which leaves a young man, at the conclusion of his course, unable to speak or write his own mother tongue fluently and correctly."

There is, we are aware, an ever-increasing desire on the part of Indians to see the vernaculars encouraged and developed; for a long time Englishmen also have aimed at fostering the development of vernacular literatures, and post-graduate research in the vernaculars is already a recognised branch of study. But it is, we feel, important to keep distinct the two objects in view, namely, (1) to provide the best education for schoolboys, and (2) to cultivate the vernacular languages.

Space will not permit us to discuss at any length the cognate subject of the teaching of English, but it may fairly be claimed that hitherto university instruction in English has been conducted on unpractical lines. Textual analysis of seventeenth-century literature on the part of students who have not mastered the modern idiom tends to unintelligent cram. What is wanted is the more rapid perusal of standard modern works. Nothing can be more pitiable than to see a class of Indian students taking down verbatim notes (always in English) from a lecturer on such a book as "Samson Agonistes." This is not the way to learn English for practical purposes, which is the main object of all except those who take English as a subject for their degree. It is satisfactory to note that the Sanskrit College and the Madrasahs have received ample treatment by the Commission, and are to be placed on a better footing.

We have not space to deal now with the important proposals of the Commission in regard to the organisation of the University of Dacca, the reorganisation of the University of Calcutta, and their many recommendations in regard to examinations, women's education, medical education, agricultural education, engineering and technological education, and Oriental studies. We can only congratulate the Commissioners on the admirable report they have produced, and express a hope that their main proposal, the Board of Secondary and Intermediate Education, may become before long a practical reality.

E. DENISON ROSS.

NOTES.

ONE of the most useful functions that can be performed in these days of minute specialisation of scientific research is the promotion of meetings at which workers in various fields can discuss subjects of common interest. Since Sir Robert Hadfield became president of the Faraday Society in 1914, fifteen such discussions have been held, the last, of which an account is given elsewhere in this issue, being in the meeting-room of the Royal Society on January 14, in association with the Royal Microscopical Society, the Optical Society, and the Photomicrographic Society. Sir Robert Hadfield and the secretary of the Faraday Society, Mr. F. S. Spiers, are to be heartily congratulated upon the great interest taken in this discussion, the subject of which was "The Microscope: Its Design, Construction, and Applications," and the exhibition of instruments connected with it. There were meetings in the afternoon and evening, and on both occasions it is scarcely too much to say that as many people were unable to find places in the meeting-room as those who filled it to the doors. With characteristic generosity Sir Robert Hadfield entertained a large company to dinner at the Ritz Hotel between the two meetings. The whole session was most successful and encouraging to all who are interested in the advance of British optical science, both theoretical and applied. By organising such joint meetings the Faraday Society is indeed promoting the best interests of both science and industry, and doing what might be undertaken even more appropriately by the Royal Society itself.

AN interesting pamphlet on the work of Faraday and the Faraday Society was prepared by Sir Robert Hadfield in connection with the joint discussion on the microscope held on Wednesday, January 14. It appears that the Faraday Society was chiefly responsible for the appointment of a special Nitrogen Products Committee by the Munitions Inventions Department, and this Committee was, in turn, instrumental in establishing a research department, which provided much valuable information for the practical consideration of sources of nitrogen supply when the submarine campaign made the subject a matter of national concern. One of the members of the council of the society, Dr. J. A. Harker, was entrusted with the direction of this work, and the final report of the Nitrogen Products Committee, which has just been published (Cmd. 482, 4s. net), is a most substantial survey of the position of supplies of nitrogen compounds and the practical problems involved in the establishment of processes for nitrogen fixation in this country. Referring in the pamphlet to his own particular lines of work, Sir Robert Hadfield mentions that Faraday, in his experiments on alloys of iron with other elements carried out in 1821 and 1822, was the pioneer of the great technical advances which have been made in alloy steels during the past thirty years. It was Sir Robert's own discovery and invention of manganese steel in 1882 which led others to explore the rich field first entered by Faraday, and has resulted in the production of chromium steel, silicon steel, nickel steel, tungsten steel, and many other types.

THE recent death of Dr. John Wilson, lecturer in agriculture and rural economy in the University of St. Andrews, robs the University and science of a keen and brilliant agricultural biologist. Dr. Wilson was one of the few who regarded agriculture as a sister science of biology rather than as a branch of chemistry, and his work on the improvement of farm crops has borne excellent fruit. Whilst demonstrator in zoology he devoted considerable attention to the development of the common mussel, and published an elaborately illustrated memoir on the subject, but his name will be more permanently associated with his successful investigations on the improvement of such plants as the potato, turnip, and oat. He raised an enormous number of new varieties. Amongst those of the potato were many of exceedingly fine quality and disease-resisting properties, and they have been taken up by growers all over the country. His most successful varieties in this connection were perhaps Templar, Bishop, and Rector. Dr. Wilson's experimental work on oats was equally successful, and he was hoping shortly to place on record a full account of his investigations. Many other plants at different times claimed his attention with equally interesting results. Handicapped by lack of means and assistance, he never spared himself. His unflagging enthusiasm and remarkable energy deserved better and more liberal support, and had it been forthcoming there is not the slightest doubt that the nation would have greatly benefited by his researches.

FATHER JOHANN NEPOMUK STRASSMAIER, S.J., the distinguished Assyriologist, who died on January 11 at the Jesuits' Church, Mount Street, London, W., was born in Bavaria in 1846. Soon after the beginning of Bismarck's *Kulturkampf* against the Catholic Church in Germany, Strassmaier left his native land in 1872 and came to England, where he remained for the rest of his life. From his early youth he had been deeply interested in Oriental studies, and in London his attention was soon directed to the numerous Babylonian tablets in the British Museum, which had not yet been interpreted and translated, and among which were many astronomical texts. Strassmaier was fortunate enough to become associated with Father Epping, S.J., who undertook the necessary calculations and the scientific discussion of the texts interpreted by Strassmaier. The first results of their labours were published in a book, "Astronomisches aus Babylon" (1889), which was followed by several papers in the *Zeitschrift für Assyriologie*. They showed clearly that the astronomers of Babylon during the two or three centuries before Hipparchus (if not earlier) possessed a considerable amount of accurate knowledge of the motions of the sun, moon, and planets. Epping died about 1895, but some years later his work was taken up by Father Kugler, who published his "Babylonische Mondrechnung" in 1900, and began to issue his great work, "Sternkunde und Sterndienst in Babel," in 1907. Kugler repeatedly bore testimony to the great patience and skill of Strassmaier in deciphering many text, which but for him might have remained unread for ever, as they were gradually deteriorating owing to damp and other climatic influences.

THE Lord President of the Council has approved the appointment of Col. Sir Frederic Nathan, K.B.E., late R.A., to be Power Alcohol Investigation Officer under the Fuel Research Board of the Department of Scientific and Industrial Research. The appointment of the Power Alcohol Investigation Officer has been made as a result of the consideration given by the Committee of Council for Scientific and Industrial Research to the report of the Interdepartmental Committee on the Production and Utilisation of Alcohol for Power and Traction Purposes, which recommended the establishment of a small permanent organisation under the Department of Scientific and Industrial Research to continue investigations into these problems. The Fuel Research Board proposes to begin by bringing the work already being done as regards both the production and the utilisation of alcohol into proper focus. Sir Frederic Nathan, who before the war was Superintendent of the Royal Gunpowder Factory at Waltham Abbey, and later works manager of Messrs. Nobel's Explosives Factory, Ardeer, was the officer in control of alcohol under the Ministry of Munitions during the war, and chairman of the Production Section of the Interdepartmental Committee referred to above. Prof. Pierce Purcell, who was Secretary of the Irish Peat Inquiry Committee, has also been appointed to act as Peat Investigation Officer under the Fuel Research Board. The duties of the Peat Investigation Officer will be to keep the Board informed of all progress in connection with research into the utilisation of peat, to continue and extend experiments on the mechanical cutting and winning of peat, and to make arrangements for careful tests of the use of peat as a fuel under boilers.

PROF. R. T. LEIPER, reader in helminthology in the University of London, has been awarded the Straits Settlement gold medal by the Senate of the University of Glasgow. The medal was founded some years ago by Scottish medical practitioners in the Malay States, and is given periodically to a graduate in medicine of the Scottish universities for a thesis on a subject of tropical medicine.

THE council of the British Medical Association is prepared to consider an award of the Middlemore prize (value 50*l.*) and an illuminated certificate for the best essay on "Perimetry (inclusive of Scotometry): Its Methods and its Value to the Ophthalmic Surgeon." The competing essays must reach the Medical Secretary of the Association, 429 Strand, W.C.2, on or before April 30 next.

MR. C. T. KINGZETT writes to suggest that airmen rising to great altitudes should carry bottles of water which, by being emptied at such heights, could then be sealed, and would enable samples of the air there to be secured for purposes of analysis. The late M. Teisserenc de Bort obtained specimens in this way and had them analysed, but found no difference from normal air. His specimens were obtained from registering balloons beyond the reach of any manned balloon or aeroplane. Glaisher no doubt also obtained air from the highest points he reached in his ascents about 1862.

THE death of Mr. Alexander Izat on January 2 is announced in *Engineering* for January 16. Mr. Izat joined the Indian Public Works Department in 1863, and had much to do with the development of the Indian railways. For several years he was on the Legislative Council of the Lieutenant-Governor of the United Provinces; he was made a Companion of the Indian Empire in 1898, and served for several years as a member of council of the Institution of Civil Engineers. At the time of his death he was in his seventy-sixth year.

WE learn with regret that Prof. George Macloskie, professor of biology, Princeton University, U.S.A., died on January 4 in the eighty-fifth year of his age. Prof. Macloskie was born at Castledawson, Ireland,

and educated at Queen's University, Belfast, from which he received degrees in both law and theology. During his student days he was twice a gold medallist of the college. He was called to Princeton in 1875, during the administration of President McCosh. Since 1907 Prof. Macloskie had been professor emeritus of biology in Princeton University. He is best known for his work on the flora of Patagonia.

THE *Times* of January 21 contains the following announcement with reference to the Dartmoor hydro-electric supply scheme:—"In deference to the opposition from the Duchy of Cornwall and the Devon County Council, the promoters have decided to drop that part of the Hydro-electric Bill by which they sought to utilise Dartmoor water for generating electricity. They will modify the Bill to restrict their powers to erecting overhead mains for supplying to consumers such surplus power beyond the requirements of their proposed copper-refining industry in mid-Devon, which they produce from lignite beds they intend to develop."

STRONG earthquakes continue to be felt in Mexico. At La Fragua, in the State of Puebla, shocks have been almost continuous since the great earthquake of January 3. At Coatzlan, another shock occurred on January 9, by which the destruction of the town was completed. San Joaquin, a village of 3000 inhabitants in the State of Vera Cruz, was destroyed by an earthquake on the morning of January 12. On January 8 the volcano of San Miguel, 35 miles north-east of Cordoba, broke into eruption; streams of lava flowed down the south-east side of the mountain, destroying villages and ranches.

ACCORDING to the Bulletin of the Science Division of the Royal Academy of Belgium for March, 1919, at the meeting on March 1 it was decided:—(1) To break off relations and exchange of publications with the scientific societies of Germany, Austria, Hungary, and Turkey. (2) To employ only booksellers to procure such publications as shall be considered strictly necessary, whatever be the additional cost involved. (3) Not to send any publication to the men of science of the above nations. (4) To decline and return to the societies or authors of the above countries any publications sent to the academy.

AN interesting interview with Prof. Einstein appeared in the *Daily Chronicle* of January 15. A German by birth, Prof. Einstein went to Switzerland in his early youth, where he became naturalised. For some years he was professor of physics at the Federal Polytechnikum in Zürich, and for a short time also at the University of Prague. Shortly before the outbreak of war he was "called" to the University of Berlin, where he is still working, being at the same time director of the Kaiser Wilhelm Institute for Physical Research. Now little more than forty years of age, this eminent man of science conceived the outlines of the theory of relativity at the early age of eighteen, and presented his special theory to the scientific world at the age of twenty-seven. Prof. Einstein regards Prof. Lorentz (Leyden) as his "co-operator" in the special theory of relativity. He points out that, far from vitiating the results of Newton, the theory of relativity rather enhances the greatness of this genius. Though these new ideas will not overthrow the general conceptions of mankind, they will leave their impress on men's thinking in the philosophical and allied sciences.

FOR some years there has been a vigorous Phytopathological Society in the United States, and recently a Canadian branch of this has been formed, the first annual meeting being held in Ontario. Dr. A. H. R. Buller, formerly of Birmingham University, and now professor of botany in the University of Manitoba, was elected president for 1920. Dr. E. C. Stakman, of Minnesota, was the guest of the society, and gave an account of the very valuable investigations which he and his colleagues have carried out into the races of cereal rust fungi and their bearing on the problems of immunity and susceptibility to disease. Among the attractive list of papers presented to the meeting, those of Mr. J. E. Howitt on "Leaf-roll and Mosaic of Potatoes" and of Mr. Paul A. Murphy on "Diseases of Potatoes which Cause the Running Out of Seed" may be mentioned. Both are welcome additions to our very meagre knowledge of extremely obscure subjects of primary importance. There is in this country no society devoting itself exclusively to phytopathology, and perhaps this is well, for we possess already more than enough small specialised organisations running a precarious separate existence. The need is not for increase in their number, but for some kind of amalgamation or federation of those now existent. The study of diseased crops is merely one branch of applied biology, and this subject is excellently catered for by the Association of Economic Biologists, which performs valuable work in synthesising all the many aspects of investigation which centre round the economic utilisation of plants.

POWELL's classification and map of the linguistic families of America allotted twenty-two families, or parts of families, to California. This classification has hitherto been generally accepted. But in recent years the study of these dialects has been fully investigated by Messrs. R. B. Dixon and A. L. Kroeber; the results of their work being now published in the University of California Publications in American Archæology and Ethnology (vol. xviii., No. 3, September, 1919). It has now become possible to regroup these dialects into seven main groups. The most important of these are the Penutian in the north-western region and the Uto-Aztekan to the south-west. The remaining language-groups form a sort of fringe round the two greater groups, the most important being the Hokon, and of less extent the Algonkin, Athabaskan, Yokian, and Lutuamian. Full grammatical details on which this new classification is based are given by Messrs. Dixon and Kroeber.

MR. J. W. GOWEN has made (*Genetics*, May, 1919) a biometrical study of the phenomenon of heredity known as crossing-over, basing his conclusions on extensive data derived from the behaviour of the Mendelian factors in the third chromosome of *Drosophila melanogaster*. It is shown that double crossing-over is an extremely variable phenomenon. The reduplication hypothesis is regarded as definitely disproved, and all detailed interpretations are based upon the structure of the chromosomes. Crossing-over between two fixed points on a chromosome is found to be highly variable. It is also found that a change in genes between two fixed points in the third chromosome slightly disturbs the ratios of crossing-over between those points. Biometric analysis shows that the results are all in harmony with the hypothesis that the factors are represented by particles arranged along the chromosomes. A cross-over in one region of the chromosome is more likely to be accompanied by a cross-over 25–35 units away than elsewhere.

Vol. ix. of the *Bulletin Statistique* has just been published by the International Council for Fishery Investigations. Particular interest attaches to this report, as it deals with the year 1913, the last of a long series during which there has been a continuous, progressive development of the sea-fishing industry in North European countries, and vol. ix. is likely to remain a standard of comparison of two periods, in the interval between which many conditions will be found greatly to have changed. The council has in preparation a Bulletin describing the effect of the war upon the fisheries, and this, it is hoped, will soon be ready. Several changes have been made in the arrangement of the present volume; the use of two languages has been dropped, and the results are now published only in English. There are many useful diagrams. A feature of exceedingly great interest, the estimation of the capital employed industrially, in factories, curing works, etc., in 1913, as well as in the vessels, might be included in the next volume as a help to the understanding of the great change in economic conditions that is now taking place.

The Tôhoku Imperial University, Sendai, Japan, continues to publish beautifully illustrated memoirs on fossils in the geological series of its Science Reports. In the latest part received (vol. v., No. 1), Mr. I. Hayasaka describes the microscopical structure of three Permian species of the remarkable sponge Amblysiphonella from Japan and China. Prof. H. Yabe also illustrates in three fine plates the microscopical structure of a Tertiary foraminiferal limestone from Borneo.

The United States Geological Survey has published Professional Papers Nos. 112 and 120, dealing respectively with Cretaceous plant-remains from Tennessee, Mississippi, Alabama, and Georgia, and Cretaceous fish-scales from various American localities. The plant-remains, described by Dr. E. W. Berry, are chiefly leaves of dicotyledons, and represent a lowland coast flora. The sudden appearance of dicotyledons as the dominant plants in Middle Cretaceous times is still a mystery, and Dr. Berry thinks this modern flora may have originated in the Arctic regions. The description of the fish-scales by Prof. T. D. A. Cockerell is a bold attempt to use fragmentary fossils in stratigraphical geology.

Part iii. of vol. iv. of the Records of the Geological Survey of India, which has just reached us, contains a review of the mineral production of India during 1918. Upon the whole the position is satisfactory, most of the important minerals showing an increased production. Thus the coal output rose from 18,212,918 to 20,721,543 tons; it is worth noting that the most substantial increases are shown in the important coalfields of Jharia and Raniganj, which produced respectively 52·85 per cent. and 30·74 per cent. of the total Indian output. The output of iron ore, too, increased, namely, from 413,273 to 492,484 tons, most of which was smelted in the works of the Tata Iron and Steel Co. and the Bengal Iron and Steel Co.; the latter produced also 12,114 tons of ferro-manganese during the year under review. There was a large increase in the production of chromite, mainly through the development of some recent discoveries in the State of Mysore. The output of manganese ore, on the other hand, fell from 591,000 to 518,000 tons, the falling off being probably caused by the difficulties of procuring the necessary shipping facilities. The Bawdwin mine in the Northern Shan States again shows an increase of output, namely, 19,074 tons of lead and 1,970,614 oz. of silver, as against 16,962 tons of lead and 1,580,557 oz. of silver. Gold, on the other hand, declined somewhat, namely, from 574,293 oz. to 536,118 oz. The falling off under this head has, of course, a far less effect upon the prosperity of India than has the increase noted under such minerals as coal and iron, which contribute essentially to the industrial development of the country.

The oscillations in the luminosity of incandescent electric lamps illuminated by alternating currents forms the subject of a short report by Dr. Luigino Fabaro in the *Atti dei Lincei* (xxviii. (1), 7, 8). The phenomena had been previously studied by Prof. Corbino, and the present experiments refer mainly to certain recent types of lamp. Diagrams are drawn showing the relation between the fluctuations of intensity and those of the electromotive force, and, at the same time, the difference of phase between the luminosity and the exciting electromotive force. These are in conformity with the theory that the effect can be reduced by increasing the mass of the filament.

From the Laboratorio di Ottica pratica e Meccanica di Precisione we have received the first numbers of a new periodical, *Rivista d'Ottica e Meccanica di Precisione*. Hitherto Italy has not had a technical periodical on the lines of the German *Zeitschrift für Instrumentenkunde*, and the new journal is a modest attempt to fill the want. Like other countries, Italy has made great progress in the construction of optical and other scientific instruments during the war, and the need for a medium in which matters of interest to practical optical workers can be discussed is now being felt. The November–December number contains articles on Galileo and the pendulum clock, the application of interference methods over simple observations with the naked eye, the first instalment of a paper by P. G. Nutting on "Dispersion

Formulæ for Optical Glass," and a description of the focimeter of the Royal Precision Laboratory, as well as a selection of abstracts from foreign periodicals.

IN an article entitled "The Æther *versus* Relativity" in the January issue of the *Fortnightly Review* Sir Oliver Lodge contends that as the current ideas that the æther is an infinitely extended uniform medium as a whole at rest, and that absolute motion is to be measured with respect to this æther, are simple and straightforward, they should be retained so long as no clear proof that they are false is forthcoming. The new theories express the facts of experience in other terms, but they attribute the property of wave-transmission to geometrical space free from any medium, and are, in consequence, repugnant to those "with a competent faculty for rational philosophising." Sir Oliver Lodge urges the desirability of comparing the speeds of light along and against a strong magnetic field as a promising means of determining the density of the æther. Such a result would entirely discredit the theory of relativity as a statement of real fact.

A REPORT on the general theory of blade-screws, forming Report No. 9 of the American National Advisory Committee for Aeronautics, has been drawn up by Mr. George de Bothezat, of Dayton, Ohio (Washington: Government Printing Office, 1919). In a problem like the present, in which the conditions are far too complex to admit of an exact hydrodynamical solution, any theory necessarily involves assumptions which at best are only approximate. The author applies elemental methods, first, to the slip stream, and, secondly, to the region surrounding a blade element, and, in common with many previous investigations, neglect of the effects of radial motion is one of the assumptions made in a first approximation. The theory appears to constitute an advance on previous investigations, especially in the matter of a detailed examination of the elements of fluid, and the author is very careful in stating the assumptions on which the work is based, and the justification for which will necessarily depend on comparison of the results with those of experiment. An appendix deals with the geometry of screw-blade drawing. The method appears to neglect compressibility, and will therefore be applicable to air-screws of which the tip velocity does not come too near the velocity of sound.

AN important paper on radio-transmission and reception by Mr. J. H. Dellinger has been published by the Bureau of Standards, Washington. The difficulty experienced by practically every man of science in understanding the ordinary radio theory is in mastering the proof of the formula which gives the magnetic force at a distance from the sending antenna in terms of the wave-length of the radiation. He objects to accepting it without proof, and he has not time to puzzle out the intricate theory given by Hertz. Mr. Dellinger gives a rough proof of this formula based on well-known laws. This formula being accepted, the rest of radio theory follows very simply. The formula has been tested in practice many times, and found accurate within a small percentage of error. The author makes a theoretical comparison of the relative values of antennæ and closed coils for sending and receiving purposes, and it is shown how the limitations of each follow directly from theory. Although the theory is sufficiently accurate to be a great help in the design of radio stations, yet the necessity for further research, both experimental and theoretical, is urgent, and a long list of such researches is suggested. To everyone desiring a knowledge of the practical theory of radio communication this paper can be recommended.

THE lot of the inventor is always hard unless he is exceptionally placed, and combines commercial with inventive ability. *Engineering* for January 9 points out two ways in which it is becoming increasingly difficult. Experiment is becoming much more costly, and at the same time the protection afforded by the patent laws becomes less and less. Nevertheless, the essential importance of invention from the national point of view is now recognised, and research laboratories are being set up which are to afford every facility for experiment. The success of this movement depends upon getting the inventors into the laboratories, and upon their doing their best work when they are there. But we find that men entering these laboratories are being required to sign away all rights of every kind to any invention they may make. They are to rely solely upon a reward at the discretion of the firm. Our contemporary suggests that a research laboratory should be an independent organisation, financed by the parent firm, but receiving royalties on a liberal scale to be divided among its members by agreement among themselves, and also hints that it may be useless to put forward such a scheme. Apart from the fact that the British business man feels that he is less and less "master in his own house," there is the other point which appeals to research workers, viz. victimisation; he may find himself no longer required in the laboratory, and, after his discharge, may look in vain for his share of the royalties.

Engineering for January 9 contains an article on works management by Mr. F. C. Van Dyke, which will be found to give a very clear discussion of the principles involved. There is a growing tendency to demand that the works manager should be a college-trained engineer, but it is essential that he should have the same practical and varied engineering experience as is required from the self-made man; whatever may have been his initial training, however, mere opportunity without fitness will not produce the successful works manager. The requirements as regards his principles and education may be summarised as consisting essentially of organisation, foresight, co-ordination, supervision or control, and diplomacy. A works manager should recognise that, notwithstanding scientific effort and research, the efficiency given by plant and machines is regulated by human effort, wasteful by instinct, and that to obtain the reduction of such waste it will be necessary to save lost efforts, so that the recovery of waste may add new resources to the community. He must also understand that science in industry will generally be resented by the average worker. Owing to the workers' insufficient knowledge of the economics ruling industry, he believes that the extra profit thereby derived passes to the employer without relative advantage to the worker, and that the efficiency of employees penalises others by unemployment; hence scientific improvements must be introduced with foresight and tact.

AMONG forthcoming books we notice the following: "Wireless Telegraphy, with Special Reference to the Quenched-spark System," B. Leggett; "Aeronautical Engineers," Major A. Graham Clark; "Theory and Practice of Aeroplane Design," S. T. G. Andrews and S. F. Benson; "Physical Chemistry of the Metals," R. Schenk, translated by R. S. Dean; "Manufacture and Uses of Alloy Steels," H. D. Hibbard; and "Mathematics for Engineers," W. N. Rose, vol. ii. (*Chapman and Hall, Ltd.*); "The Principles of Anatomy as Seen in the Hand," Prof. F. Wood-Jones, illustrated; "A Text-book of Organic Chemistry," E. de Barry Barnett, illustrated; and "Laboratory Manual of Elementary Colloid Chemistry," E. Hatschek, illustrated (*J. and A. Churchill*); "Coal Economy: For Steam Users, Engineers, Enginemen, Boiler Firemen, etc.," W. H. Casmey, and "The Mineralogy of the Rarer Metals," Cahen and Wootton, second edition (*C. Griffin and Co., Ltd.*).

THE new list of announcements of *Mr. John Murray* contains many books of scientific interest, *e.g.* "Science and Life: Aberdeen Addresses," Prof. F. Soddy; "Springtime, and Other Essays," Sir Francis Darwin, illustrated (this week); "Splendours of the Sky," Isabel M. Lewis, illustrated; "Conifers and their Characteristics," C. Coltman-Rogers, illustrated; "Life of Sir William White, K.C.B., F.R.S.," F. Manning, illustrated; "New Light on Ser Marco Polo," Prof. H. Cordier (a supplement to Sir Henry Yule's "The Book of Ser Marco Polo"); "The Shibboleths of Tuberculosis," Dr. M. Paterson; "Wild Life in Canada," Capt. A. Buchanan, illustrated; "The Heron of Castle Creek, and Other Sketches of Bird Life," A. W. Rees, with a memoir of the author by J. K. Hudson, illustrated; volumes dealing respectively with Hides and Skins, Rice, and Oil Seed (in the Imperial Institute Reports on Indian Raw Materials), and "Tungsten Ores," R. H. Rastall and W. H. Wilcockson (in the Imperial Institute Monographs on Mineral Resources); also new editions of "The Interpretation of Radium and the Structure of the Atom," Prof. F. Soddy, illustrated; "Microscopy: The Construction, Theory, and Use of the Microscope," E. J. Spitta, illustrated; "Hydrographical Surveying," the late Rear-Admiral Sir W. J. L. Wharton, revised, etc., by Admiral Sir Mostyn Field; "The Soil," Sir A. D. Hall; and "The Small Farm and its Management," J. Long.

OUR ASTRONOMICAL COLUMN.

LARGE FIREBALL ON JANUARY 16.—In the evening twilight of January 16, at 4h. 50m., a fireball was observed from London and other places in the Eastern Counties. It gave a brilliant flash and left a luminous trail which assumed curious forms during fully 5½ minutes. The observations already received of this object are not sufficiently exact or numerous to allow the real path to be trustworthily determined, but the meteor probably had a radiant in Cygnus at about $290° + 53°$, and was situated over Lincolnshire. We hope to give more details next week.

In recent years January has proved itself a month in which fireballs are notably abundant. In 1895, on January 16, three large fireballs were observed, and the period from January 12 to 17 seems to have been unusually productive of these brilliant objects.

PROF. W. H. PICKERING'S LUNAR STUDIES.—Prof. W. H. Pickering has for many years made careful studies of various regions of the moon during the whole period of their illumination by the sun. He has traced several cases of notable changes of relative illumination of adjacent regions, some growing brighter, others darkening, as the sun rises higher. *Popular Astronomy* for November contains a number of drawings and photographs of the crater Eratosthenes. The author suggests that the white regions are snow, and the dark regions some low form of vegetation. He imagines that a limited amount of water may remain in certain regions, being held in the soil by capillary attraction. It seems, however, that the phenomena might be otherwise explained by neighbouring regions being formed of different kinds of rock, or even by their being of different degrees of smoothness. Observations of occultations made on the dark limb show with certainty that no refraction occurs exceeding $1''$; those made on the bright limb are less precise, but even there the greatest admissible refraction is some $4''$. Comparing this with the $68'$ of a tangential ray in our atmosphere, we see how exceedingly rare any lunar atmosphere must be. The suggestion of vegetation is perhaps not absolutely impossible, but presents grave difficulties.

With regard to the suggestion made in a publication of the Smithsonian Institution, Washington, D.C., of a rocket to reach the moon, irresistibly recalling the well-known romance of Jules Verne, it seems clear that the propulsive effect of the escaping gases must be trifling beyond the atmosphere. A velocity of seven miles per second would therefore be required at the limits of the atmosphere, and considerably more evidence is needed before this can be admitted as attainable.

THE SOLAR ECLIPSE OF MAY 29, 1919.—The January number of *Conquest* contains an article by Mr. C. R. Davidson, one of the observers of the eclipse at Sobral, Brazil. It is illustrated by many views of the locality, eclipse camp, and instruments, and gives a clear statement of the problem which the expedition was sent to solve, and of the successful result. A deflection of light amounting to $1{\cdot}98''$ at the sun's limb was indicated by the measures, which is close to the value $1{\cdot}75''$ predicted by Einstein. Photography of the corona and prominences was not part of the aims of the expedition; indeed, the author points out that if the observers could have dispensed with these they would gladly have done so, since they veiled some stars near the sun that would have been very useful. However, a good record of the corona was obtained. Its shape is a blend between maximum and minimum types; it would conform more closely to the latter, save for a large streamer at the South Pole. Mr. Davidson and Mr. Woodman directed attention, at the meeting of the R.A.S. on January 9, to the advisability of repeating the observations, with still greater refinement, at the eclipse of September, 1922. They exhibited a model of a simple form of equatorial mounting, suitable for low latitudes, which would obviate the necessity for employing cœlostats. These are admirably adapted for physical researches, but have some defects in a case where extreme precision of position is required.

SYMPOSIUM ON THE MICROSCOPE.

THE symposium and general discussion on the microscope, held on January 14 by the Faraday Society, the Royal Microscopical Society, the Optical Society, and the Photomicrographic Society, in conjunction with the Optical Committee of the British Science Guild, attracted a very large audience, which the meeting-room of the Royal Society proved quite inadequate to accommodate. The objects of the symposium, as stated by Sir Robert Hadfield in his introductory address, were:—

(*a*) Improvement in the technique of the microscope itself, including its manufacture.

(*b*) Improvement in lenses, including eyepieces and objectives of high power.

(*c*) Improved application of the microscope for research in ferrous and non-ferrous metallurgy.

With such extensive ground to be covered it is not surprising that the programme of papers presented was much longer than could possibly be read during the meeting. Many of these were of great interest, and, as the majority were in type before the meeting, the aims of the symposium might perhaps have been more fully achieved had these been taken as read and the time thus saved utilised for discussion. It will only be possible in the space available for this article to record a few of the more salient points brought forward at the meeting.

Sir Robert Hadfield, who was in the chair, opened the afternoon session by giving a brief history of the microscope and its applications in metallurgy down to the present day. In addition, he contributed papers on the Faraday Society and on the work of Sorby, a bibliography of the chief literature relating to the microscope, and a series of photomicrographs of steel and iron sections at magnifications ranging from 9 up to 8000 diameters. He was followed by the presidents of the various participating societies, by microscope manufacturers, and by other prominent workers, who each dealt with some special aspect of microscopy. Prof. Cheshire indicated the importance of microscope production as a measure of the standing of the optical industry of any country. Other speakers touched on ground which was to a considerable extent traversed by many other contributors. On one subject, at any rate, all the speakers were agreed—the necessity for proper training in the use of the microscope, whether for visual or photographic use. This will be clearly realised by those who note how frequently those with extensive experience in microscopical research refer to the importance of securing proper conditions of illumination. The absence of proper courses in this subject was compared by Sir Herbert Jackson with the very thorough courses now available in spectroscopy. That instruction is needed in our universities in the use of the microscope and in the interpretation of the effect seen—nay, more, in the proper appreciation of optical theory itself—was proved beyond any doubt to the meeting.

Compared with the unanimity on the need for education, there were very marked divergences in the views expressed by nearly all the speakers on detailed matters. Consider, for instance, the desirability of obtaining increased magnification with greater resolving power. Many of the most experienced metallurgists who expressed their views anticipated that any considerable increase in resolving power would be likely to afford clues to some of those problems which to-day are most baffling in the production of metals with specific properties. It is suggested, for instance, that with improvements in the resolving power the mysterious alterations in the mechanical properties of metals brought about by cold working would be explained. The papers abound with examples of the valuable information that has been derived from past increases of aperture; nevertheless, some workers are satisfied that further advantage in this direction is not to be expected, and it is even suggested that the N.A. of objectives has already been increased too greatly.

The same extent of disagreement was shown in discussing the relative merits of British and German stands and lenses. For some purposes, at any rate, very experienced workers give decided preference to the English stand, though this is said to be less convenient for metallurgical work. No stand now made, it was said, is sufficiently rigid to enable the microscope to be changed from the vertical to the horizontal position without disturbing the relative adjustment of the specimen and the optical system. Modern designers were recommended to study Powell's model of 1841 as an admirable example of what is required. One important criticism was to the effect that the materials employed by the British makers were too soft, particularly for such working parts as the racks and pinions, with the result that after a few years all the movements were too loose. In this respect German instruments had been found more satisfactory by some workers, though this was not the experience of all.

As regards objectives, it was not denied that the best home-made products were fully as good as those made abroad, but it was contended that this standard of excellence was reached in a smaller proportion of the objectives produced than in the foreign lenses. The importance of a highly trained test-room staff was emphasised in this connection. It may be noted as a point of interest, mentioned by Mr. F. Twyman, that good objectives have been found to show differences of phase in the emergent wave-front of about one wave-length.

During the meeting it was announced that one or two makers would shortly place upon the market new designs of objectives made from English glasses. It is satisfactory to learn that the different varieties of glass required for these objectives have been produced in this country. To determine how these glasses compare with the German lenses of Zeiss, a committee of expert microscopists was appointed to investigate and issue a report. In view of what was said regarding the general standard reached, it would be as well if this proposal were carried a step further, and it became customary for manufacturers to issue with their objectives a certificate issued, say, by the National Physical Laboratory. If the required standard for a certificate were maintained at a reasonable level, with due regard to periodical improvements, such a system should go far to remove the impression that it is *necessary* to go to Germany for a thoroughly good objective.

There are many other points to which attention might be directed, but for these reference must be made to the printed papers. The apparent lack of enterprise on the part of the manufacturer since the war has, however, been fully explained. He has been busy for the first time in making arrangements for the mass production of microscopes by modern machine methods. This is of the first importance, for in the past few years nearly all the microscopes required for biological work—and this covers possibly as much as 90 per cent. of all microscopes made—have been imported. The hand-made English instrument could not possibly compete either in price or in quality with the machine-made article. Should it be possible to regain a large share of this trade while retaining the best features of the more expensive and elaborate models, the future position of the industry in this country will be assured. It is to be hoped that this development will not be hindered, as was suggested, by lack of capital.

Perhaps the most significant and satisfactory feature of the symposium is that it should have been possible to attract for a meeting which extended from 2.30 to 10.15 so large an audience for the discussion of the microscope and its applications to industry. It is more than doubtful if such interest could have been aroused before the war. The optical industry of the country, it is clear, will not fail to establish itself on a secure footing for want of a market. If the home products reach the necessary standard of perfection and keep abreast of the advances which scientific achievement in whatever field renders possible, the reward is certain. This, we are convinced, needs much more systematic investigation in advance of immediate requirements than has been undertaken in the past, greater readiness to be guided by scientific principles rather than by tradition, and not least the design of instruments with special reference to the accuracy obtainable in the various manufacturing operations by the best machine tools. It is a hopeless enterprise with one scientific adviser to attempt to compete with another firm of similar size which employs twenty such advisers. At present such assistance is difficult to obtain. It devolves upon our universities, no less than upon our manufacturers, to consider where they stand, and to do their part towards the country's well-being by making optics a living subject rather than resting satisfied with the knowledge of a hundred years ago. Research on their part and on that of other institutions is necessary; the field is wide. We look to them for that interest which we have every right to expect.

The afternoon session was preceded by an exhibition of microscopes and auxiliary apparatus. The historical collection of microscopes from the South Kensington Museum was of special interest. New models of microscopes attracted much attention. Messrs. Beck and Swift exhibited models fitted with the changing device they have adopted, and some exhibits by Messrs. W. Watson and Sons were greatly admired. Many other exhibits of much interest were shown, but for particulars of these reference must be made to the catalogue specially prepared for the occasion.

The publication of the proceedings of the symposium will be awaited with interest. We trust that all the papers will be collected into a single volume, and be available as a separate publication for all who have special interests in microscopy.

CONSTRUCTION AND USE OF MICROSCOPES.[1]

A CONSIDERATION of the microscope resolves itself of necessity into two parts, the mechanical and the optical. From the mechanical point of view there are two designs in general use, those referred to as the Continental and the English form of microscope. In the Continental type it has usually been customary to have what is known as the horseshoe foot, mainly, I imagine, because of its ease of construction by mechanical engineering methods; whereas the English design of microscope, which has hitherto been mainly made by hand, is of a more steady type, and the points of support are so distributed as to give more stability to the instrument in any position.

The essential parts of the instrument are a coarse adjustment, to give the body tube a quick motion in the direction of the optic axis, and a fine adjustment, which gives it a much slower motion in the same direction. The tube is adjustable in length, to enable correction to be made for varying thicknesses of cover-glass, although a large number of workers appear to regard it as a ready method of obtaining greater or less magnification, with disastrous effects on the resulting image.

There is only one fixed part of a microscope for biological purposes, and that is the stage. But metallographers require that the stage shall also be adjustable in the direction of the optic axis. The body tube itself should be made so that it can be closed to a length of 140 mm., including any objective-changing device that may be on the nose-piece; and it should be possible to lengthen it to at least 200 mm. or 250 mm. if long-tube objectives are used.

All these adjustments are in the direction of the optic axis of the instrument. Two others are usually provided which are at right angles to this direction—that is, a mechanical stage for actuating the object, and in certain of the best-class instruments an arrangement for centring the sub-stage condenser to the axis of the objective.

While there are many points which might be raised on the mechanical side, there are only one or two that I have time to mention. The main point about most microscopes appears to be that they are unstable. I have a considerable number in my own possession, but I do not think I have one even now which, if I centre an object on the stage with the instrument in a vertical position, still maintains its centration accurately if the instrument is put into the horizontal. The probability is, therefore, that there are few microscopes made at the present time that exactly fulfil the conditions necessary for high-class photomicrographic work or for observational microscopic work of an exacting order. I trust, however, that an instrument exhibited at this symposium will embody the necessary improvements to rectify this matter.

Some misapprehension appears to me also to exist as to the relative purpose of the coarse and the fine adjustments. The coarse adjustment appears to me to be one which should be sufficiently well made, and with which the user is sufficiently expert, to enable him to bring into view any object, whether it is being observed with a low- or a high-power objective. The fine adjustment is then used for accurate focussing and for getting a conception of the object in depth. In biological work, at any rate, this is very rarely the state of affairs as carried out. In using an oil-immersion objective, for instance, a common method is to immerse the objective, and then to lower it so that it all but touches the top surface of the cover-glass. The objective is then raised by means of the fine adjustment until the object comes into view. While this may act fairly well with very thin cover-glasses, it is a haphazard method when cover-glasses of varying thicknesses are used. It should be realised that when microscope-users are sufficiently educated they will be able to tell how far they are from the actual image by the appearance of the light in the field of view—that is, if the object is illuminated with reasonable accuracy.

Mechanical stages also appear to need some consideration. The stages which will on actuation cause no shift of the object other than in the direction intended, or any alteration of focus, are rare. Further, those in which the screws project for a considerable distance, with the result that any slight jar or knock causes them to be displaced, and, it may be, actually bent, are objectionable when used under laboratory conditions.

There is, I think, much to be said for the type of stage which has either co-axial milled heads on a vertical axis, or, if inconvenient to make, milled heads which are on separate axes. This method of con-

[1] Opening paper of a discussion on "The Microscope: Its Design, Construction, and Applications," organised by the Faraday Society and held at the Royal Society on January 14. By J. E. Barnard, president of the Royal Microscopical Society.

struction of necessity results in a much stiffer and more stable stage. There is, in fact, a general lack of stability going through nearly all parts of a microscope. But it is significant that, even so long ago as the beginning of last century, the instrument as then designed had much greater attention paid to this point. The microscope an illustration of which I show on the screen is, to my mind, an embodiment of a principle that should receive attention. So soon as English makers are in a position to consider the production of an instrument of a special type, it is my intention to have one made. In this the general principle is that all the optical parts are carried on a bar which is, in effect, an optical bench, and that this is strutted in such a way as to give stiffness to the instrument as a whole. The only effort that I am aware of that has been made in this direction is in the microscope designed by Dr. Rosenhain, particularly for metallography, but which is adaptable for ordinary work. This instrument, to my mind, is such an improvement on any other type of stand that I am at a loss to understand why metallographers have not more generally taken it up. It might appear that I am exaggerating the importance of stability in the stand, but it should be realised that any lack of centration in the optical parts, or of alignment in the optic axes of these parts, results in more serious deterioration of the resulting microscopic image than any other single factor. The optical parts of a microscope are the objective, for obtaining the primary magnified image of the object; the ocular, for further enlarging that image and transmitting it to the eye; and the sub-stage condenser, for illuminating the object with a larger or smaller cone of light. The limitations of time will prevent me from doing more than refer very briefly to some properties of the optical parts.

It is generally assumed that magnification is the primary function of an objective, but in point of fact the main point is not magnification, but resolution. By resolution is meant the power the objective has of separating and forming correct images of fine detail. The theory known as the Abbe diffraction theory is the one on which modern optical calculations are based; and it is safe to say that it was never more fully accepted than at the present time, and never rested on a surer basis. There has been much discussion in this country of that theory, and probably a good deal of misconception has arisen from its inapt designation, for the term "diffraction theory" is perhaps somewhat unfortunate. I cannot do better than quote the late Lord Rayleigh in reference to this matter. He said: "The special theory initiated by Prof. Abbe is usually called the diffraction theory, a nomenclature against which it is necessary to protest. Whatever may be the view taken, any theory of resolving power of optical instruments must be a diffraction theory in a certain sense, so that the name is not distinctive. Diffraction is more naturally regarded as the obstacle to fine definition, and not, as with some exponents of Prof. Abbe's theory, the machinery by which good definition is brought about." This very clearly and accurately sums up the position. The Abbe theory tells us that there are two main factors determining resolution; that is, the numerical aperture of the objective used and the wave-length of the light. Numerical aperture is determined for us by the optician, and it is well known that, with an oil-immersion objective, a numerical aperture of 1·4 is at the present time the practical limit. Metallographers are in a somewhat stronger position, as a monobromide of naphthalene immersion objective was, and presumably still is, made by Zeiss which had a numerical aperture of 1·6. This represents the absolute limit at the present time, and there is no indication that numerical aperture will be increased in this sense by present methods.

The other factor governing resolution is the wave-length of light, and in this connection it must be borne in mind that to resolve a regularly marked structure the distance between the markings must be more than half a wave-length. Under ordinary conditions of illumination we cannot go very far in the direction of increased resolution unless we resort to an illuminant such as a mercury vapour lamp which is rich in blue and violet radiations. There is much room for investigation in this direction, as the ideal illuminant for microscopic work has yet to be found. But I do not know of any one that approaches so nearly to it as the one I have mentioned, the mercury vapour lamp. It suffers only from one disadvantage that I can see, and that is that the differentiation due to staining is not so clearly brought out as when ordinary light is used. But as staining is itself an artificial process, and is simply done to differentiate structures, it only means a certain amount of education to enable us to appreciate the differences even under the light from this lamp. The only stains which it does not show quite well, or rather in which the colour-tint is altered, are those in which red predominates. Any other colour is shown perfectly and in proper gradation. The advantages of this illuminant are that it is even and uniform. It has a fairly large area, and can be used, therefore, for any class of work. Its intensity can be varied within considerable limits by having a resistance in series, so that the current density is altered to suit the particular work under observation. Further, it is possible, by interposing neutral screens, to vary the light intensity if the electrical method is inconvenient. Owing to its possessing practically no red radiations its mean wave-length is shorter, and by using suitable screens light which is truly monochromatic, yellow, green, blue, or violet, can be obtained at will. These lamps are made both in glass and quartz, but the quartz ones are preferable, because they admit of the use of heavier currents with greater luminosity; and, further, they have a much longer life. I have exhibited two of these lamps, because I regard them as far in advance of any other form of light available to the microscopist at the present time, whether he is a biologist or a metallographer.

The whole subject of illumination needs investigation also, because there is, I think, little doubt that a modification in the intensity of the illumination of any particular object enables us to use a larger light-cone than we could do in ordinary circumstances —that is, variation of the intensity is an alternative to the use of the iris diaphragm in the sub-stage of the microscope. But it is in the direction of using invisible radiations in the ultra-violet, or, it may be, radiations which are still shorter than the ultra-violet, that developments in microscopic work are, in my opinion, likely to occur.

There are two other points worth mention, which I trust may be dealt with more fully in succeeding papers. One is that, while the resolution limits are so inflexible, that does not by any means apply to mere visibility. By illuminating small particles by means of an annular cone of rays—that is, what is ordinarily known as dark-ground illumination—or by illuminating them at right angles to the optic axis of the microscope—what is known as the ultra-microscopic method—particles of a very much smaller order of size can be made visible. But we cannot tell anything about their form, nor can we accurately tell their size. We are only conscious of their mere existence.

Another point to remember is that magnification is definitely limited to something like 750 diameters with microscopes under ordinary conditions if we want to get the best optical effect. We may, as a matter of convenience, have still higher magnifications, because it is not given to everybody to appreciate fine detail unless an image is somewhat enlarged. But it must be appreciated that any increase beyond 750 or 800 diameters does not result in our seeing anything more. It simply allows us to see the object on a somewhat larger scale. We may, therefore, summarise as follows: An object which is much smaller in size than the resolution limit can be rendered visible provided the light with which it is illuminated is of sufficient intensity and sufficiently different in refractive index from the medium in which it lies. To resolve a series of equidistant points or lines in an object, their distance apart must exceed half a wave-length of light in the medium in which the object is immersed. Johnstone Stoney has shown that a pair of lines or objects can be separated when their distance apart is rather smaller than the resolution limit required for a number of points or lines in a row. But it should be borne in mind even here that the resolution limits apply if a clear standard of definition is required. An isolated object or pair of objects are not so well defined if they exceed the resolution limits as laid down for recurring structures. It cannot be too fully appreciated that illumination is the keynote of all sound microscopic work, and this applies whether the illumination is by means of visible radiation under ordinary conditions of work, or whether it is in experimental work in which the use of invisible radiations are concerned.

There is much room for research in this direction, and it is to be hoped that this is one of the points which will be seriously taken up. Apart from any question of research, the education of the user is perhaps of vital importance. It is of little use for opticians to make great efforts to turn out a satisfactory instrument if the user is incapable of taking advantage of the quality of the optical or other parts. I trust, therefore, that this symposium will give an impetus in this direction, and that it will help microscope-users to realise how much remains to be done.

MICROSCOPICAL OPTICS.[1]

In the opening paragraphs attention is directed to the methods of treating the aberrations on the principle of equal optical paths (A. E. C., Monthly Notices of R.A.S., January and March, 1904, and April, 1905) and to the author's recent determination of the actual light distribution at and near the focus in the presence of aberration (Monthly Notices, June, 1919). The sine-condition is also discussed.

The origin and effects of the secondary spectrum are then dealt with, and the paper proceeds:

The attempts to produce varieties of *glass* free from this secondary spectrum have been unsuccessful so far as the microscope is concerned, for the existing crowns and flints with proportional dispersion have so little difference in dispersive power that an impracticable number of lenses would have to be used to secure the desired effect. We therefore still depend on the material the value of which for this purpose was discovered by Abbe, the natural mineral fluorite, used instead of crown glass in combination with heavy crown glasses or very *light* flint glasses in place of ordinary *dense* flint glass. It was by the use of fluorite that Abbe produced the apochromatic objectives, and fluorite of good optical quality must be used to this day to secure the result. Apart from the difficulty of finding this material, there is no obstacle to the designing by exact calculation of apochromatic objectives.

I now come to a defect of nearly all microscope objectives, and especially of highly corrected ones, which is well known to all practical microscopists, namely, the pronounced curvature of the field, invariably in the sense of requiring a shortening of the distance from object to lens in order to obtain a sharp focus in the outer parts of the field of view. The general theory of the primary aberrations of oblique pencils shows that any lens system when freed from astigmatism will have the curvature of field defined by the Petzval theorem, and that in the presence of astigmatism the two focal lines which then represent the strongest concentration of the light always lie both on the same side of the Petzval curve and at distances from it which are in the approximate ratio of three to one. When the astigmatism is undercorrected the natural curvature of the field defined by the Petzval equation becomes aggravated, whilst overcorrected astigmatism tends to flatten the field, and is deliberately introduced for this purpose in ordinary photographic objectives. The presence of considerable amounts of astigmatism, of course, renders really sharp marginal images impossible in either case, so that its absence, or, better still, a modest amount of overcorrected astigmatism, must be regarded as the ideal in microscope objectives. Unfortunately, this desirable state cannot be reached in the existing types of objectives. The binary low-power objectives up to the ordinary 1 in. and ⅔ in. come nearest to it, and are, therefore, justly liked by microscopists for all work for which they are sufficiently powerful. In the ordinary ternary objectives of the ⅙-in. type, with approximately plano-convex components, the curvature of the field is also of reasonably moderate amount. But it is a general experience that highly corrected objectives are very much worse as regards curvature of field. In the light of my most recent work on the general theory of lenses (Monthly Notices, November, 1919), this curious and objectionable peculiarity is easily explained, and becomes revealed as a *necessary* consequence of high spherical and chromatic correction if the usual number of components is adhered to. In the Lister and Amici types of ordinary objectives, which are fairly satisfactory as regards curvature of the field, the front lens is of such a form as to produce strong outward coma, and there is in the back lens or lenses a corresponding amount of inward coma.

The simple extensions of Seidel's theory, given in the paper last referred to, show that this is the state of affairs which tends to diminish undercorrected astigmatism, or even to reverse it into the more desirable overcorrected form. High correction of the zonal spherical aberration, and to a still greater extent complete removal of the spherical variation of chromatic correction, necessitate a more or less complete reversal of the coma effects in front and back components. In other words, with the usual types of objectives reductions of curvature and apochromatic or semi-apochromatic correction are completely antagonistic and incompatible; what benefits one correction is detrimental to the other. Fortunately, the extended theory also indicates a way out of this dilemma. It appears fairly certain that by building the objective itself on the lines required by the apochromatic condition, but leaving it spherically undercorrected, perhaps also chromatically overcorrected to a moderate extent, and with a considerable amount of outward coma (this is the most important), and by correcting these residuals in a *widely separated* additional back lens, it will be possible to combine moderate curvature of field with apochromatic perfection, and thus to remove the worst outstanding defect of the best objectives.

[1] From a paper by Prof. A. E. Conrady presented at a discussion on "The Microscope: Its Design, Construction, and Applications," organised by the Faraday Society at the Royal Society on January 14.

Condensers for the proper well-regulated *illumination* of microscopic objects are identical in optical design with objectives, the only difference being that the light passes through in the reverse direction, and that a lower degree of correction is sufficient not only on theoretical, but also on practical grounds, for nearly always condensers are used in conjunction with the "plane" mirror, which invariably is very far from optical perfection, and so introduces irregular aberrations of unknown magnitude and kind, and, moreover, the light from the condenser has to pass through the slide on which the object is placed. This slide is practically little better than window-glass so far as optical quality and perfection of surfaces are concerned, and the great variation in thickness is another source of imperfection, especially with dry condensers of high N.A.

Moderate amounts of residual aberrations in condensers can always be effectively neutralised by using a sufficiently large source of light of uniform brightness or by magnifying the source by a sufficiently well-corrected "bull's-eye," if the source of light is naturally small.

A great and very serious defect in the construction of nearly all condensers of the present day, with the exception of the modest Abbe condenser of two simple uncorrected lenses, is that the iris and the ring for dark-ground stops are placed too far from the back lens instead of being close to the anterior focal plane of the condenser. It is easily shown that such a remote iris-opening or dark-ground stop produces decidedly oblique illumination of the extra-axial points of the object. With direct light this leads to an undesirable variation in the type of image and in resolving power in different parts of the field. With dark-ground illumination the result is even more serious, for it is then necessary to use a far larger central stop to secure a dark background over the whole field than would suffice if the stop were placed close to the anterior focal plane of the condenser; such an unnecessarily large stop is highly objectionable, because it reduces the visibility of the coarser structures in the object.

The increasingly bad position of the iris in the condensers of higher power and shorter focal length supplies practically the whole explanation of the universal experience that high-power condensers will not work satisfactorily with low-power objectives, especially for dark-ground illumination.

The great thickness of the mechanical stage in English stands of the highest quality is the chief *reason* why the iris and "turn-out ring" of high-power condensers have to be mounted so far below the back lens, and a profound modification of the design of the stage with the view of making the part projecting over the condenser as thin as possible therefore appears to be the most desirable improvement of microscope stands from the optical designer's point of view.

As regards the *actual making of microscope objectives*, it must be borne in mind that the excellence of a computed lens system may be completely swamped by comparatively slight imperfections of workmanship, and that high accuracy in this respect is therefore of the utmost importance. In lenses of high N.A. computation shows that a departure from the prescribed radii and thicknesses by a fraction of a thousandth of an inch may lead to a notable loss of perfection, and the polished surfaces must also be truly spherical within less than half a wave-length of light. These limits can be easily observed if modern methods of gauging and measuring are adopted, and if all surfaces are polished to accurately made and conscientiously used test-plates. The tools and methods employed in really *manufacturing* lenses on this system were shown by Messrs. W. Watson and Sons, Ltd., at the exhibition at King's College in January, 1917, and will be found described and illustrated in the record of that exhibition.

In old English practice the component lenses of microscope objectives and condensers used to be fixed in their cells by cement of the sealing-wax type. Many old lenses which are still found in perfect adjustment fifty or more years after being mounted demonstrate that the cement may hold the lenses in correct position almost indefinitely; but other experiences, especially with lenses used in tropical countries, suggest that shifting may occur, and it is therefore strongly to be urged that all microscope lenses should be held between metallic shoulders at both ends by being bevelled into their cells, care being naturally required to avoid pressure and distortion through too tight a fit.

A point on which users of objectives err to their own detriment is an excess of faith in numerical aperture. I have heard microscopists boast of possessing an objective, say, of 1·43 N.A., whereas somebody else had one of barely 1·40; and a careful test would show that whilst the 1·43 was an indifferent lens, the 1·40 was excellent. The fancied advantage of 2 per cent., then, is really a disadvantage of perhaps 25 per cent. or more.

One of the few disservices which Abbe did to microscopy was the pushing of the N.A. of dry lenses to 0·95, and to a less extent the increase of that of oil lenses to 1·40. The extreme marginal zone of the apochromatic dry objectives of 0·95 N.A. is particularly badly corrected, so much so that the lenses will only bear a solid illuminating cone of about 0·65 N.A. even on the Abbe test-plate, and that with annular light bringing only the marginal zone into action correction-collar and tube-length combined do not allow of reaching a point of good spherical correction. There is no doubt that Abbe's own earlier dictum still holds, to the effect that beyond about 0·85 N.A. the higher aberrations become unmanageable unless the free working distance is reduced to a very few thousandths of an inch. A carefully computed objective of 0·85 N.A. will bear a full illuminating cone on suitable objects, and can thus realise its fullest resolving power. An objective of 0·95 with a condenser of 0·65 has the resolving power of the mean, or of 0·80 N.A., and is thus actually inferior, except for freak resolutions, with extremely oblique light. Oil objectives of more than 1·30, or at most 1·35, N.A. are also of very doubtful added value.

In closing this section I will once more quote without comment an anecdote of Fraunhofer, who received a complaint that a telescope supplied by him, although giving magnificent images, displayed certain fine scratches when examined with a magnifying-glass! The reply sent by Fraunhofer is reported to have been: "We have constructed the telescope to be looked through, not to be looked at."

A few sentences may perhaps be added as to the prospects for further improvements of microscopic performances. I have stated earlier in this paper that there is a bright ray of hope with regard to diminishing the curvature of field without loss of definition.

Advances in numerical aperture offer very little attraction. Abbe, in my opinion, carried the N.A. too far rather than not far enough, and I am not aware that any notable discovery has been achieved with the few monobromide immersion objectives of N.A. 1·60 which he designed.

The use of a shorter wave-length, *i.e.* ultra-violet light, is a little more promising. There would be none but technical difficulties to the construction of lenses suitable for this work. But as only very few microscopists would be likely to go to the trouble of working in invisible light and of passing through a long apprenticeship in mastering the difficulties, apparatus of this description would necessarily be extremely costly, as the whole expense of designing and of constructing special tools would fall on a small number of outfits, or possibly on only a single one. And there would still be the grave drawback that the vast majority of objects would be opaque to extreme ultra-violet rays, and yield only black-and-white outline pictures.

The so-called ultra-microscope does not represent any advance in *resolving* power at all, but most decidedly the reverse. It is highly valuable for the detection of very minute particles and of their movements, which it achieves simply by intense dark-ground illumination, but the structure of the particles remains unrevealed, and only that would amount to an advance in resolving power. The seeing of these minute particles is, in fact, of precisely the same kind as the seeing of stars subtending less than 0·001 second of arc at night with the naked eye, the resolving power of which is of the order of 60 seconds.

PARIS ACADEMY OF SCIENCES.

BONAPARTE AND LOUTREUIL FOUNDATIONS.

Of the 72,500 francs placed at the disposal of the Academy by Prince Bonaparte, it is proposed to allocate 30,000 francs as follows:—

5000 francs to Charles Alluaud, travelling naturalist to the National Natural History Museum, for a geological and botanical expedition in the Moroccan Grand Atlas Chain.

2000 francs to A. Boutaric, for the construction of an apparatus for recording nocturnal radiation.

1000 francs to Emile Brumpt, for continuing his work on parasitic hæmoglobinuria or piroplasmos of cattle.

3000 francs to E. Fauré-Fremiet, for undertaking a series of studies on histogenesis and certain surgical applications.

3000 francs to A. Guilliermond, for pursuing his researches on lower organisms and on mitochondria.

3000 francs to Joseph Martinet, for continuing his researches on the isatins capable of serving as raw material for the synthesis of indigo colouring matters.

3000 francs to A. Vayssières, for the continuation of his researches of the marine molluscs, family Cypræideæ.

10,000 francs to the Fédération française des Sociétés de Sciences naturelles, for the publication of a fauna of France.

The committee appointed to allocate the Loutreuil foundations recommend the following grants:—

(1) To establishments named by the founder:

10,000 francs to the National Museum of Natural History, for the reorganisation of its library.

7500 francs to the Paris Observatory, at the request of the Central Council of the Observatories, for purchasing an instrument.

(2) Grants applied for direct:

6000 francs to the Société Géologique du Nord, to enable it to take up work interrupted by the war.

10,000 francs to l'Ecole des hautes études industrielles et commerciales de Lille, for restoring the material of its chemical laboratory.

20,000 francs to the Observatory of Ksara (near Beyrout). This laboratory was practically destroyed by the Turks and Germans. The grant is towards its restoration.

8000 francs to Henri Deslandres, for the study of the radial movements of the solar vapours and the thickness of the gaseous atmosphere of the sun.

7500 francs to Maurice Hamy, to carry out certain improvements in astronomical apparatus of precision.

3500 francs to Félix Boquet, for the publication of Kepler tables.

1000 francs to G. Raymond, for the continuation of his actinometric experiments.

10,000 francs to Charles Marie, for exceptional expenses connected with the publication of the "Tables annuelles de constants et données numériques de chimie, de physique et de technologie."

10,000 francs to the Fédération française des Sociétés de Sciences naturelles, for the publication of a French fauna.

2000 francs to P. Lesne, for his researches on the insects of peat-bogs.

2000 francs to A. Paillot, for his researches on the microbial diseases of insects.

2000 francs to Just Aumiot, for the methodical study of the varieties of potato.

5000 francs to Albert Peyron and Gabriel Petit, for the experimental study of cancer in the larger mammals.

3000 francs to Th. Nogier, for completing the installation of the radio-physiological laboratory of the Bacteriological Institute of Lyons.

THE MATHEMATICAL ASSOCIATION.

The annual meeting of the Mathematical Association was held in the London Day Training College, Southampton Row, on January 7 and 8, under the presidency of Prof. E. T. Whittaker. At the advanced section on the evening of January 7 the president gave a lecture on "A Survey of the Numerical Methods of Solving Equations." He described in some detail "iterative processes" for approximating to the roots and graphical methods of circumscribing the regions on the Argand plane, in which the various roots lay. The Lobachefsky-Graeffe method of approximating to the roots of equations and power series was described in considerable detail. In the animated discussion to which this lecture gave rise it was clearly seen that a wider knowledge of practical computative processes is a desideratum in all branches of mathematical work, which has been practically neglected hitherto in the schools and universities. It was also felt that such practical numerical work was the best possible introduction to the formal study of function theory, many of the ideas underlying which are usually presented in an entirely abstract way, whereas they present themselves naturally and of necessity in less general forms in the science of computation.

Next day, at the general section, Mr. C. Godfrey, of the Royal Naval College, Osborne, surveyed the whole question of the modern teaching of geometry in schools. He strongly favoured a preliminary course of practical instrumental work, to be followed by a more formal course in which "logic" is not too prominent. He advocated the entire postponement of a really rigorous course of abstract geometry until the post-school stage. Prof. T. P. Nunn strongly supported the general tenor of Mr. Godfrey's views, and urged the earlier teaching of "ratio and proportion" as a practical instrument for solving many problems, such as map-drawing, villa construction, etc.

Prof. E. H. Neville, of University College, Reading, next read a paper on "Convention and Duplexity in Elementary Mathematics," in which he protested against the usual "positive-sign" convention with regard to vectors. Miss H. M. Cook dealt with "The Place of Common Logarithms in Mathematical Training," and Prof. W. P. Milne strongly urged the necessity of making both logarithms and numerical trigonometry compulsory for the university matriculation, because the work of the intermediate classes in the universities was being seriously hampered by the lack of such knowledge on the part of a large number of the students. Prof. Whittaker gave a most interesting paper on "Some Mathematical Problems awaiting Solution," which suggested themselves chiefly in computative work, such as the question of the convergence of certain approximative processes in the case of a large number of simultaneous equations. Mr. R. C. Fawdry opened a discussion on the teaching of mechanics to beginners, and said that, after many years' experience, he still could not decide whether to teach statics or dynamics first. A vigorous protest was entered by Dr. S. Brodetsky, Prof. W. P. Milne, and Mr. A. W. Siddons against the practice that had just arisen of teaching "pure mathematics" in the new advanced courses in secondary schools, thereby promoting undue specialisation at a young age and losing entirely the outlook which a combined course of pure and applied mathematics can supply.

The meetings were extremely well attended and very enthusiastic. WILLIAM P. MILNE.

INDUSTRIAL RESEARCH ASSOCIATIONS.

THE Department of Scientific and Industrial Research has just issued the following list of research associations which have been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research, and have received licences from the Board of Trade under section 20 of the Companies (Consolidation) Act of 1908:—

British Boot, Shoe, and Allied Trades Research Association, Technical School, Abington Square, Northampton. *Secretary:* Mr. John Blakeman.

British Cotton Industry Research Association, 108 Deansgate, Manchester. *Secretary:* Miss B. Thomas.

British Empire Sugar Research Association, Evelyn House, 62 Oxford Street, London, W.1. *Secretary:* Mr. W. H. Giffard.

British Iron Manufacturers Research Association, Atlantic Chambers, Brazennose Street, Manchester. *Secretary:* Mr. H. S. Knowles.

British Motor and Allied Manufacturers Research Association, 39 St. James's Street, London, S.W.1. *Secretary:* Mr. Horace Wyatt.

British Photographic Research Association, Sicilian House, Southampton Row, London, W.C.1. *Secretary:* Mr. Arthur C. Brookes.

British Portland Cement Research Association, 6 Lloyd's Avenue, London, E.C.3. *Secretary:* Mr. S. G. S. Panisset.

British Research Association for the Woollen and Worsted Industries, Bond Place Chambers, Leeds. *Secretary:* Mr. Arnold Frobisher.

British Scientific Instrument Research Association, 26 Russell Square, W.C.1. *Secretary:* Mr. J. W. Williamson.

British Rubber and Tyre Manufacturers Research Association, c/o Messrs. W. B. Peat and Co., 11 Ironmonger Lane, E.C.2.

The Linen Industry Research Association, 3 Bedford Street, Belfast. *Secretary:* Miss M. K. E. Allen.

Glass Research Association, 7 Seamore Place, W.1. *Secretary:* Mr. E. Quine.

British Cocoa, Chocolate, Sugar Confectionery, and Jam Trades Research Association, 9 Queen Street Place, E.C.4. *Secretary:* Mr. R. M. Leonard.

Schemes for the establishment of research associations in the following industries have reached an advanced state of development:—

Research Associations Approved by the Department but not yet Licensed by the Board of Trade.—British Music Industries Research Association, British Refractory Materials Research Association, British Non-Ferrous Metals Research Association, and Scottish Shale Oil Research Association.

Proposed Research Associations the Memorandum and Articles of Association of which are under Consideration.—British Launderers Research Association, British Electrical and Allied Industries Research Association, and British Aircraft Research Association.

Industrial Organisations Engaged in Preparing Memorandum and Articles of Association.—Silk Manufacturers, Leather Trades, and Master Bakers and Confectioners.

In addition to the industries included above, certain others are engaged in the preliminary consideration of schemes for forming research associations.

THE ORGANISATION OF IMPERIAL STATISTICS.[1]

POINTING out that it was almost emphasising the obvious to say that any great nation should be thoroughly informed as to its numerical, its social, and its economic drift, the author directed attention to the fact that this had been recently recognised in a petition to his Majesty's Government so late as November 1 last. It was also emphasised by the calling together of a Conference of the Statisticians of the Empire, under the ægis of the British Government. In view of the position of the British Empire in world affairs, it was but little short of amazing that an Imperial Bureau of Census and Statistics was not long ago established. A bureau, to be really Imperial, must recognise the community of interest of all parts of the Empire. It was not something to be created mainly for the purposes of the United Kingdom, but something which would meet equally well the purposes of each part of the Empire. For this reason the needs of the autonomous Dominions must be quite as carefully considered as those of the United Kingdom itself, and it was implied in the paper that any part of the Empire which could not at present meet the common requirements of the whole must be prepared to do so. The interest would be general only in so far as it was Imperial.

In order to overcome departmental frictions and to secure the sympathy and co-operation of all public departments, it was suggested that a Central Statistical Commission should be created, the president of which would, of course, be the Director of the Bureau of Statistics. Such a Commission would be a body of expert advisers, and could make its departments helpful. The scope of an Imperial Statistical Bureau, both as to administrative procedure and as to subject-matter to be dealt with, was outlined, as was also the question of compilation and publication.

To attempt to organise an Imperial Bureau of Statistics with a small and humbly qualified staff would foredoom it to failure, said the author. In its higher professional section it must necessarily have experts in statistical theory, in the technique of the collection and compilation of statistical data, in pure and applied mathematics, in the languages which are important in the statistical field, in statistical editor-

[1] Abstract of a Paper presented to the Royal Statistical Society on Tuesday, January 20, by G. H. Knibbs, Statistician of the Commonwealth of Australia.

ship, in draughtsmanship and graphical representation, and in the interpretation and explanation of statistical results. In this last field the Director himself would, of course, be the expert *par excellence*, and not a mere administrator. It was also pointed out that to put the whole of the work in the hands of a mere administrator would lead to failure. The staff would, of course, include persons who specially studied demography, trade, production, finance, labour and industrial affairs, shipping, railways, tramways, and transport and communication.

In concluding, the author said that if the United Kingdom, by appropriate effort, were to supplement the efforts of some of the autonomous Dominions, it would be possible to build up a statistical edifice for the whole British Empire which, in meeting the needs of a great people—with its reactions upon the human race—would constitute the bureau a sort of *temple expiatoire* for our remissness in the past. The keynote of the whole paper was that an important duty has been left unfulfilled, and that we must not go on neglecting it, for such a work is needed by publicists and statesmen, and for the general purposes of intelligent criticism and intelligent government.

ITALIAN PAPERS ON RELATIVITY.

DR. ATTILIO PALATINI, of the University of Padova, Italy, dedicates a special paper (*Ac. d. Lincei*, April, 1919), entitled "Traiettorie dinamiche dei sistemi olonomi con tre gradi di libertà," to the investigation of what may shortly be called irreversible systems, *i.e.* systems the Lagrangian function of which contains the velocity (apart from its square) also linearly. The paper is but a generalisation of Birckhoff's investigation on "Dynamical Systems with Two Degrees of Freedom" (Trans. Amer. Math. Soc., vol. xviii., No. 2, 1917) to three degrees of freedom. The result arrived at is that the trajectories of such a system coincide with those of an ordinary system of three particles with appropriate constraints moving in a conservative field of force which spins uniformly about an axis. The analogy with such systems leads Dr. Palatini to take up in a second note, entitled "Moti Einsteiniani stazionari" (Ist. Veneto, May 11, 1919), the relativistic problem of what the author proposes to call *stationary* motions, *i.e.* such for which the four-dimensional line-element ds^2 contains non-vanishing, though constant, coefficients g_{14}, g_{24}, g_{34} (coefficients of the mixed, space-time terms, as $dx\,dt$, etc.). The chief result is again the equivalence to a three particles system in a uniformly revolving conservative system. It strikes one that this result could be read off the ds^2 almost directly. The result concerning the "anisotropic and irreversible" behaviour of energy is again obvious and, physically, of comparatively small interest.

The paper is inspired by Prof. Levi-Civita's recent investigations on *static* Einsteinian motions (*Ac. d. Lincei*, 1917, *et seq.*), for which g_{14}, etc., are permanently zero—elegant investigations, no doubt, but of purely formal interest.

Dr. Palatini's third recent article, "La Teoria di Relatività nel suo sviluppo storico" (*Scientia*, September–October, 1919), which, though not without many happy ideas as to the popular presentation of the "old" (1905) and the new or generalised relativity and gravitation theory, lacks that plasticity and freshness which would be imparted to it by a more intimate contact with existing physical ideas. This absence of contact goes in the present case (concluding section of part i., dedicated to the older theory of Einstein) even so far as to ignore the numerous and famous experimental proofs of the variability of mass with velocity. The author does not seem ever to have heard of the beautiful experiments of Kaufmann, Bucherer, Hupka, and others which have made the variability of β-particles an almost tangible fact. The second part of the article, devoted to general relativity, has the indisputable positive feature of being very enthusiastic, and gives, no doubt, some general idea of Einstein's newest doctrine. Yet even here one cannot help being surprised at one or two misconceptions, marring the introductory section on the concept of space-curvature, defects the more inexplicable as they emanate from a pure mathematician. Thus on pp. 16–17 we are invited to imagine some practically one-dimensional beings or animalcules living in three kinds of capillary tubes, a straight, a circular, and a hyperbolic one (devices not unfamiliar to any reader of the great Clifford). Having endowed these unfortunate beings with a sufficient amount of intelligence, Dr. Palatini (speaking of the first of them) proceeds to say: "In order to arrive from one to another point of its space, the being would state (*constatare*) that it had to follow the straight road." As if that poor thing had a choice in its one-dimensional abode! Equally misleading is not only the remainder of the history of these fictitious three beings, but also the presentation (p. 18) of our own concepts of the "spazio ambiente" in which we live.

Carlotta Longo gives, in her doctorate dissertation of 1918 (Padova), published in *Nuovo Cimento* (vol. xv., 1918, pp. 191–211), a very attractive and geometrically elegant investigation on the elementary electrostatic law according to Einstein's generalised relativity and gravitation theory. She confines herself to the special but most important case of a radially symmetric electrostatic distribution, and, integrating the field-equations in Prof. Levi-Civita's form adapted to the present case, finds for the electrostatic force a law which differs from Coulomb's inverse square law only in so far as the distance r from the centre of the field is replaced by the curvature radius of the geodetic sphere passing through the point in question. A further result of the investigation is that, in a radially symmetric field at least, there can be electric charge only where "there is also matter," unless it be a point-charge at the centre ($r=0$) itself. This striking result would deserve a more definite and critical enunciation. We are not told what kind of "matter" is meant, while, on the other hand, the energy of an electrostatic field is, for Einstein, also a kind of "matter." Yet another very interesting result is reached at the end of the paper. It relates to the "mechanical" force exerted by an electron, *if* its usual "electromagnetic mass" is assumed to be not only an inert, but also a gravitating (heavy) mass. The result is that, in addition to the quasi-Newtonian attraction, there is a *repulsion*, which, however, is comparatively small. Thus, for example, at a molecular distance from the centre the repulsion would be only one-hundred-thousandth of the gravitational attraction.

The paper is clearly written, and, being very suggestive, will certainly attract the attention of Einstein's followers. Nevertheless, one cannot help mentioning here that an excellent paper on this subject (which pushes the analytical, if not the geometrical, solution much farther) was published in 1916 by H. Reissner (*Annalen d. Physik*, vol. l., pp. 106–20). This paper, however, seems to have entirely escaped the notice of the author, whom nobody will fail to congratulate upon her elegant results.

L. SILBERSTEIN.

AGRICULTURE AT THE BRITISH ASSOCIATION.

As might have been expected, the papers read before the Agricultural Section at the Bournemouth meeting had special reference to the abnormal conditions brought about by the war. Most of the members had been engaged either directly or indirectly in food production work, and there was a very marked reduction, as compared with normal years, in the amount of research work reported to the meeting.

[The presidential address appeared in NATURE of December 25, 1919, and need not, therefore, be further considered now.]

Two important papers dealing with the work of "Food Production" were read by Sir Thomas Middleton, formerly of the Food Production Department of the Board of Agriculture and Fisheries, and by Mr. J. M. Caie, an Assistant Secretary of the Board of Agriculture for Scotland, dealing with the methods and results of the food production schemes in England and Scotland respectively.

Sir Thomas Middleton revised the estimates, which he had brought forward at the Manchester meeting, of the number of persons who could be supported on the meat produced on 100 acres of average land under various conditions.

As compared with twelve to fourteen persons who could be supported on the meat produced on 100 acres of average grass land he estimated that:—

	Persons for a year
100 acres average wheat, milled as it was before the war, would support ...	200
100 acres milled (80 per cent.) would support	230
100 acres average barley (60 per cent.) would support	180
100 acres average oats (54 per cent.) would support	160
100 acres average potatoes would support	400
100 acres average mangolds would support	40
100 acres average meadow hay would support	14

Before the war the ploughed land in the United Kingdom was feeding about 84 persons per 100 acres, while the grass land was feeding about 20. Altogether we grew food for about 17,500,000 out of 46,000,000 people, or, in other words, we supplied the week-end requirements of the entire population throughout the year. The Food Production Department was set up in December, 1916, and by April, 1917, plans had been developed for bringing 2,700,000 acres of extra arable land into cultivation in 1918 over the 1916 area; and the agricultural returns for 1918 showed that, as compared with 1916, 1,842,000 additional acres in England and Wales were growing other crops than grass—roughly, two-thirds of the total additional area aimed at. Sir Thomas Middleton paid a high tribute to the assistance given by the scientific staffs of the agricultural departments of the universities and research stations.

As regards Scotland, Mr. J. M. Caie referred to the essential differences in the agricultural conditions of the two countries as exemplified by the following figures relating to 1917:—

Country	Percentage of total cultivated area under: Permanent grass Per cent.	Rotation grass Per cent.
Scotland	30	31
England	58	9

The increased cropping was therefore to be secured much less by ploughing up old grass land and more by a shortening of the rotations on arable farms than was the case in England.

The increased area aimed at in 1918 was 350,000 acres, and of this 241,000 acres were obtained, or approximately 75 per cent. of the extension aimed at. It is a notable fact that the increased cropping was obtained without any appreciable reduction in the number of horses, cattle, and sheep.

It is believed that a noteworthy feature of the schemes for increased food production for Scotland will be their relatively low cost to the State. No special Food Production Department of the Board was set up; the number of officials attached to the Committees was kept down to a minimum, usually one, or at most two, to each Committee, many of them being officers of the agricultural colleges.

Dr. E. J. Russell read a paper of much interest on "War-time and Post-war Problems of Food Production," in which the author referred to the necessity for devoting renewed attention to drainage and liming in particular, and for providing an adequate amount of organic matter in the soil. He referred to the enormous waste in the preservation of farmyard manure, and to the difficulties of conserving the manure from dairies. The ploughing in of green crops was advocated and an increase in the clover crop, as a means not only of providing more keep, but also of increasing the amount of organic matter in the soil. With reference to manures, Dr. Russell stated that the production of ammonium sulphate had risen to 269,000 tons in 1919. Similarly, the production of superphosphate had risen from 560,000 tons in 1916 to 750,000 tons in 1919, and the amount of basic slag from 321,000 tons in 1916 to 540,000 tons in 1919. The British farmers are probably now using more artificial fertilisers than any other farmers in the world. The change in the composition of basic slag due to the alteration in the methods of manufacture was also dealt with, and the necessity for a complete revision of experimental field work with basic slag was insisted upon.

The possibility of the increased recovery of nitrogen from sewage by means of the "activated" process was also considered.

Amongst the other papers communicated were:—"The Value of Lupins in the Cultivation of Light Land," A. W. Oldershaw: "The Past Neglect and Future Improvement of Livestock in British Husbandry," K. J. J. Mackenzie; "The Electrical Treatment of Seeds," Dr. A. E. Blackburn; "The Composition of Linseed Recovered from Flax Crops," T. W. Fagan; and "The Classification of Cattle Foods," J. Alan Murray.

In the last-named paper Mr. Murray pointed out that the object of the classification should be to bring together in natural groups those foods that are of similar character and quality, irrespective of the concentration and the nutrients in them, and he suggested that the amount of available energy per pound of dry matter should be made the basis of classification. If the foods were arranged in this order the distinction between fresh and dry foods would vanish. No sharp line of demarcation between coarse and fine could be drawn, but the foods could be arranged in groups according to quality, and then might be subdivided according to the amount of digestible protein.

The more important foods in the main natural groups are as follows:—

(1) Cereal and pulse straws.
(2) Inferior hays.
(3) Grasses and clovers in flower, good hays, undecorticated cotton-cake.

(4) Mangels, pasture grass, wheat-bran, brewers' grains.

(5) Swedes, molasses, cabbages, oats, pollards, rape-cake.

(6) Potatoes, barley, sharps, peas, beans, decorticated cotton-cake.

(7) Locust beans, rye, wheat, middlings, cotton-seed, maize-germ cake, palm-nut cake, linseed cake.

(8) Maize, maize meal, gluten meal, gluten feed.

Mr. J. Mackintosh dealt with the outlook in dairying, especially with regard to the return obtained (*a*) on the sale of milk, (*b*) on cheese-making. The effect of the control of prices was discussed, and the possible effect of the high prices now allowed for fresh milk on the use of condensed and dried milk imported from other countries where milk is more cheaply produced. Similarly, in connection with the control of cheese, it was pointed out that if the British cheese-maker cannot produce at a much lower price when control is removed, he will have to meet very severe competition, and the outlook cannot be regarded as satisfactory.

A joint meeting was held with Section K (Botany) to discuss forestry problems. Prof. A. Henry, in a paper on "The Afforestation of Water-catchment Areas," advocated the afforestation of all gathering grounds, not only as a hygienic measure, but also as a means of increasing the timber reserves of the nation.

The enormous extent of these gathering grounds, more than 928,000 acres in extent, has not hitherto been recognised. Of this area 183,416 acres are owned by local authorities, but only in a few cases, *e.g.* Leeds, Liverpool, Manchester, and Birmingham, has the work of afforesting these gathering grounds been taken up seriously. Prof. Henry urged that all catchment areas still privately owned should be compulsorily acquired either by the corporation or by the State, and that all ground suitable for planting should be utilised.

Mr. R. L. Robertson, of the Forestry Commission, gave an interesting account of the work of his Department, but had little to say as to its future policy—a question on which the audience would have been glad of some information. Other speakers included Sir Daniel Morris, Prof. Somerville, and Mr. Duchesne. Mr. W. E. Hiley read a paper on "Sources of Infection of Forest Trees by Fungi."

The work of the Section concluded with an excursion to Iwerne Minster, by kind invitation of Mr. Ismay, where the home farm and stock were inspected.

ALEX. LAUDER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual oration in connection with the Medical Society of London will be delivered on Monday, May 10, at 9 o'clock, by Sir D'Arcy Power, who will speak on "The Rev. John Ward and Medicine."

THE Irish Geographical Association, which now enters upon its second year in close connection with the Geographical Association in Great Britain, has elected Prof. Grenville A. J. Cole as president for 1920, and Miss F. M. Berry, 15 Lower Leeson Street, Dublin, as hon. secretary.

THE following are among the forthcoming free courses of public lectures at Gresham College:—Physic, by Sir R. Armstrong-Jones (January 20 to 23); Geometry, by W. H. Wagstaff (February 3 to 6); and Astronomy, by A. R. Hinks (February 17 to 20). The lecture-hour will be 6 o'clock.

A MEETING of zoologists was held in the rooms of the Linnean Society on Friday, January 9, to consider, among other matters, the teaching of zoology in schools and the salaries and remuneration of zoologists in general. Prof. S. J. Hickson presided, and after discussion the following resolutions were passed unanimously:—(1) That this meeting of British zoologists considers that paragraph 10 of the Report of the Investigators of the Secondary School Examinations Council, appointed to inquire into the methods and standards of award in the seven approved First Examinations held in July, 1918, referring to the subjects of natural history and zoology, is likely to discourage the teaching of zoology in secondary schools, and requests the Zoology Organisation Committee to take such steps as may seem desirable to submit to the Board of Education the views of zoologists on the subject. (2) That this meeting deplores the present difficulty in filling vacancies in the scientific staff of the Natural History Museum, and regards it as mainly due to the poor pay and prospects of the members of the staff. It is of the opinion that this, if not remedied, will react adversely not only on the work of the museum, but also on the advance of zoology in this country. It therefore requests the Zoology Organisation Committee to make such representations in the matter as may seem desirable.

UNDER the title *Discovery*, Mr. John Murray has just published the first number of a monthly periodical intended to promote intelligent interest in all branches of intellectual activity and practical achievement. The journal had its origin in a conference held a short time ago at which representatives of many literary, educational, and scientific associations were present. It has the blessing of these associations, and support in the form of suggestions for contributors and subjects of articles. It is to be maintained under a deed of trust, and the trustees, whose names appear on the cover of the magazine, include the presidents of the Royal Society and the British Academy. There is also a committee of management, which will apparently advise the editor, Dr. A. S. Russell, as to the suitability or otherwise of articles submitted or solicited. With such distinguished patronage and competent opinion, *Discovery* should be able to provide interesting fare month by month for the delectation and profit of many thoughtful minds. Prof. R. S. Conway, who has been largely responsible for the inception of the journal, opens the first number with an instructive article on "The Secret of Philæ," particularly with regard to Gallus the prefect and his relations with the poet Virgil. The other articles are on smoke-screens at sea, Dr. T. Slater Price; the modern study of dreams, Prof. T. H. Pear; discovery and education, the Master of Balliol; the Conference at Paris, J. W. Headlam-Morley; sound-ranging in war-time, Dr. A. S. Russell; and Spitsbergen, Dr. Rudmose Brown.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society (Chemical Section), December 18, 1919.—Mr. H. N. Morris in the chair.—**H. Moore**: Future supplies of motor fuel. The author dealt with the possibility of meeting the future demand by an increased production of petroleum spirit; benzol as a motor fuel; alcohol as a motor fuel; and the advantages of mixed motor fuels, with particular reference to the compression pressures of engines and to the vapour tension of mixed fuels.

Literary and Philosophical Society, January 6.—Prof. F. E. Weiss, deputy chairman, in the chair.—**R. W. James**: The Antarctic: Shackleton's Expedition of 1914–17. A description of the life and scientific work of the expedition and of the explorations round the

Weddell Sea, Ross Sea, Elephant Island, and South Georgia. The scientific results especially described included the mapping of two hundred miles of new coast-line, soundings in the Weddell Sea, and the study of the natural history of pack-ice.

DUBLIN.

Royal Dublin Society, December 16, 1919.—Prof. H. J. Seymour in the chair.—Prof. H. H. **Dixon** and T. G. **Mason**: A cryoscopic method for the estimation of sucrose. The depression of freezing point of a solution of sucrose is approximately doubled by inversion. It is evident then that the sucrose content may be estimated by determining the freezing point of a solution before and after inversion. This may be conveniently done by the thermo-electric method of cryoscopy. It is convenient to add the invertase to the fluid to be examined in the cold. Without allowing the temperature to rise above 0°, the freezing point is determined. The mixture is then incubated for forty-eight hours at 30°, and the freezing point again observed. The difference between the two observations is a measure of the amount of sucrose originally present. The method has the advantages that only small quantities of the fluid are required (2·5 c.c.), and treatment to remove proteins and other colloids is unnecessary. Using thermocouples of easily attained sensibility, amounts of about 1 mgr. of sucrose may be detected.—Prof. S. **Young**: Brown's formula for distillation. Evidence, based on the theoretical work of Rosanoff, Bacon, and Schulze, is brought forward in support of the conclusion that Brown's formula is applicable to mixtures of chemically closely related liquids, and that the constant in the formula is equal to the ratio of the vapour pressures of the two pure substances at the boiling point of the mixture.—Miss Anne L. **Massy**: The Holothurioidea of the coasts of Ireland. Twenty-five species are enumerated, belonging to thirteen genera. No new species are described, but the following are added to the British-and-Irish area:—*Stichopus regalis*, Cuvier, *Mesothuria Verrilli*, Théel, and *Benthogone rosea*, Koehler, and the belief is expressed that the previous records of *Bathyplotes natans*, Sars, and *Holothuria aspera*, Bell, are referable to *Bathyplotes Tizardi*, Théel, and *Mesothuria lactea*, Théel. Ten of the species dealt with are restricted in the area to the Irish Atlantic slope.

MELBOURNE.

Royal Society of Victoria, November 6, 1919.—Mr. J. A. Kershaw, president, in the chair.—F. **Taylor**: Australian phlebotomic Diptera, new Culicidæ and Tabanidæ, and synonymy. Descriptions are given of a new mosquito, *Uranotaenia albofasciata*, and two new species of Tabanidæ, *Sylvius distinctus* and *Tabanus Geraldi*; whilst a new genus, Phibalomyia, is suggested for Elaphromyia, previously occupied.—A. J. **Ewart**: The synthesis of sugar from formaldehyde and its polymers, its quantitative relations, and its exothermic character. The author's experiments, conducted over a long period, point to the conclusion that sugar in plants is formed directly, and not by the intervention of formaldehyde.—H. B. **Williamson**: A revision of the genus Pultenæa. The members of this genus present some difficulties as to specific limitations, and the work, of which this is a first instalment, dealing with about thirty species, has been undertaken to place it on a more practical basis. It is expected that few species will be erected, and that there may be a reduction of one or two that have been recently described. The conclusions have been based on an exhaustive examination of specimens from all the Australian States.

SYDNEY.

Linnean Society of New South Wales, October 29, 1919.—Mr. J. J. Fletcher, president, in the chair.—Prof. C. **Chilton**: A new Isopodan genus (fam. Oniscidæ) from Lake Corangamite, Victoria. *Haloniscus Searli*, n.g. et sp., described from a number of specimens obtained from the waters of Lake Corangamite, is assigned to the family Oniscidæ, one of the most strictly terrestrial families of Isopoda. The author suggests that Haloniscus is the descendant of a form that was terrestrial in habits, and that, owing to special circumstances arising from its habitat, it has become re-adapted to aquatic life.—J. H. **Maiden**: Notes on the coloration of the young foliage of Eucalyptus. A series of observations is recorded of the colour of the young foliage in a number of species of Eucalyptus growing wild or cultivated in the Sydney district. The interesting suggestion is put forward that the observations justify the belief that a number of species and some groups can be diagnosed by this means.—E. F. **Hallmann**: New genera of Monaxonid sponges related to the genus Clathria. Ten genera are proposed as new.—A. M. **Lea**: Description of new species of Australian Coleoptera. Part xv. Thirty-one species, belonging to fourteen genera in the groups Scarabæidæ, Melandryidæ, and Cerambycidæ, are described as new.

Royal Society of New South Wales, November 5, 1919.—Dr. R. Greig-Smith, vice-president, in the chair.—R. H. **Cambage**: Acacia seedlings. Part v. The author describes ten species of Acacia seedlings. He records various species having flowered in 5-in. and 6-in. pots. One seedling of *A. montana*, three years old and 4 ft. high, bore about 3000 flowers. A seedling of *A. diffusa* and another of *A. cardiophylla* had flowered when only seventeen and nineteen months old respectively. Seeds of *A. melanoxylon* and *A. penninervis* had readily germinated after having been immersed in sea-water for 889 days.—Prof. C. E. **Fawsitt** and C. H. **Fischer**: The miscibility of liquids. The authors have examined a considerable number of liquids in regard to their mutual solubility or miscibility. The mutual solubility of two liquids depends greatly on the molecular volume of these liquids, and the molecular volume again depends on the chemical composition. The knowledge of the chemical composition of a liquid gives some indication of its behaviour in regard to solubility in other liquids.—J. G. **Stephens**: A new method of measuring molecular weights. The author employs the fact that isotonic solutions have equal vapour pressures as a means of determining molecular weights. Two tubes each containing a solution of different substances in the same solvent are placed in communication. Distillation occurs from one tube to the other until the solutions become isotonic, when the molecular weight of one of the substances may be calculated in terms of that of the other.

BOOKS RECEIVED.

The Romantic Roussillon: In the French Pyrenees. By I. Savory. Pp. xii+214+plates. (London: T. Fisher Unwin, Ltd.) 25*s.* net.

The Foundations of Music. By Dr. H. J. Watt. Pp. xvi+239. (London: At the Cambridge University Press.) 18*s.* net.

The Adventive Flora of Tweedside. By I. M. Hayward and Dr. G. C. Druce. Pp. xxxii+296. (Arbroath: T. Buncle and Co.)

The New Hazell Annual and Almanack for the Year 1920. Pp. liv+941. (London: H. Frowde and Hodder and Stoughton.) 6*s.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England.
ROYAL SOCIETY, at 3.30 (Special General Meeting). At 4.30.—Prof. E. G. Coker and K. C. Chakko: The Stress-strain Properties of Nitro-cellulose and the Law of its Optical Behaviour.—S. Marsh: Alternating-Current Electrolysis.—W. H. Eccles and J. H. Vincent: The Variations of Wave-length of the Oscillations Generated by the Three-Electrode Thermionic Tube due to Changes in Filament Current, Plate Voltage, Grid Voltage, or Coupling.—S. D. Carothers: Plane Strain. The Direct Determination of Stress.—F. Horton and Ann C. Davies: An Investigation of the Effects of Electron Collisions with Platinum and with Hydrogen, to ascertain whether the Production of Ionisation from Platinum is due to Occluded Hydrogen.—L. Bairstow, R. H. Fowler, and D. R. Hartree: The Pressure Distribution on the Head of a Shell moving at High Velocities.
INSTITUTION OF MINING AND METALLURGY (at the Geological Society), at 5.30.—W. Broadbridge: Froth Flotation: Its Commercial Application and its Influence on Modern Concentration and Smelting Practice.
INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Civil Engineers), at 6.—J. L. Thompson: Transformers for Electric Furnaces.
CONCRETE INSTITUTE (296 Vauxhall Bridge Road), at 7.30.—Dr. J. S. Owens: The Attrition of Concrete Surfaces exposed to Sea Action.
HARVEIAN SOCIETY (at the Medical Society of London), at 8.15.—Annual General Meeting.

FRIDAY, JANUARY 23.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.
PHYSICAL SOCIETY OF LONDON (at the City and Guilds Technical College, Leonard Street), at 5.—Dr. J. H. Vincent: Maintained Oscillations in Triode Valve Circuits.—Dr. W. Eccles: Measurements of the Chief Parameters of Triode Valves.—F. W. Jordan: Measurement of Amplification of a Radio-frequency Amplifier.—F. E. Smith: The Measurement of Amplification given by Triode Amplifiers at Audible and at Radio Frequencies.—Hon. C. W. Stopford and C. R. Darling: Exhibition of a Method of Determining the Hardening Temperature of Steel.—C. R. Darling: Exhibition of a Thermal Cell of Constant Voltage.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery: His Contributions to our Knowledge of the Alimentary System (Hunterian Lecture).
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—E. M. Bergstrom: Recent Advances in Utilisation of Water Power.
JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7 30.—J. A. Reavell: Evaporation in the Chemical Industry.
ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. F. G. Crookshank: Principles of Epidemiology.—Dr. Cleland and Dr. Campbell: Epidemiology of Acute Encephalomyelitis.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Hon. Sir Charles Parsons: Researches at High Pressures and Temperatures.

SATURDAY, JANUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. Noyes: Aspects of Modern Poetry.
PHYSIOLOGICAL SOCIETY (at King's College), at 4.

MONDAY, JANUARY 26.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery; His Contributions to our Knowledge of the Kidneys, Bladder, and Urethra, and Diseases connected with these Structures (Hunterian Lecture).
ROYAL SOCIETY OF ARTS, at 8.—Capt. H. Hamshaw Thomas: Aircraft Photography in War and Peace (Cantor Lecture).
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—S. F. St. J. Steadman: Dental Sepsis in Children: Its Consequences and Treatment.
MEDICAL SOCIETY OF LONDON, at 8.30.—Pathological Evening.

TUESDAY, JANUARY 27.

ROYAL HORTICULTURAL SOCIETY (at Vincent Square, S.W. 1), at 3.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. G. Elliot Smith: The Evolution of Man and the Early History of Civilisation: I. Man's Origin.
INSTITUTION OF CIVIL ENGINEERS, at 5.30.—J. Mitchell: Whitby Harbour Improvement.—R. F. Hindmarsh: The Design of Harbours and Breakwaters with a View to the Reduction of Wave-action Within Them.—J. W. Sandeman: Wave-action in Harbour Areas; with Special Reference to Works for Reducing it at Blyth and Whitby Harbours.—W. Simpson: The Improvement of the Entrance to Sunderland Harbour, with Reference to the Reduction of Wave-action.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—Major W. Bladon: Life on the Gold Coast.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Annual General Meeting

WEDNESDAY, JANUARY 28.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Cecil Hertslet: The Ruin and Restoration of Belgium.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery: His Contributions to our Knowledge of the Genital and Reproductive Systems (Hunterian Lecture).
BRITISH ACADEMY (at the Royal Society), at 5.—Dr. C. Singer: Magic and Medicine in Early England.

THURSDAY, JANUARY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England.
ROYAL SOCIETY, at 4.30.—*Probable Papers*: Prof. W. Bateson: The Genetics of "Rogues" among Culinary Peas (*Pisum sativum*).—L. T. Hogben: Studies on Synapsis. I. Oogenesis in the Hymenoptera.—H. Onslow: A Periodic Structure in many Insect Scales, and the Cause of their Iridescent Colours.
ROYAL COLLEGE OF PHYSICIANS, at 5.
ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. N. Wood and Others: Discussion on the Merits and Defects of the British Health Resorts.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—R. C. Clinker: A Portable Valve Set and some properties of C.W. Circuits.

FRIDAY, JANUARY 30.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery; His Contributions to our Knowlege of the Eye, Ear, and Nose (Hunterian Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds Technical College, Leonard Street), at 7.—Major K. Edgcumbe and Others: Discussion on Quantity Production as a Panacea.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—S. G. Brown: The Gyrostatic Compass.

SATURDAY, JANUARY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson The Astronomical Evidence bearing on Einstein's Theory of Gravitation I. Movement of the Perihelion of Mercury.
PHYSIOLOGICAL SOCIETY (at King's College), at 4.

CONTENTS.

	PAGE
Wind and Barometric Gradient. By W. H. Dines, F.R.S.	525
Researches on Fluorescence. By R.	526
Scientific Study of the Sugar Group	526
Nutrition and Longevity	527
Cheese- and Butter-making	528
Our Bookshelf	529
Letters to the Editor:—	
Gravitation and Light.—Sir Joseph Larmor, M.P., F.R.S.	530
The Outlook of British Technical Optics.—Prof. F. Cheshire	530
Power from the Sun.—A. A. Campbell Swinton, F.R.S.	532
Sedimentation of Blood Corpuscles.—Prof. A. E. Boycott, F.R.S.	532
The Einstein Theory and Spectral Displacement.—H. Fletcher Moulton and Dr. Andrew C. D. Crommelin	532
Use of a Prismatic Binocular for Viewing Near Objects.—Capt. D. Wilson Barker	532
The Nitrogen Problem. I.	533
The Microscopy of Metals. (*Illustrated.*) By C. H. D.	535
Report of the Calcutta University Commission. By Sir E. Denison Ross	537
Notes	539
Our Astronomical Column:—	
Large Fireball on January 16	544
Prof. W. H. Pickering's Lunar Studies	544
The Solar Eclipse of May 29, 1919	544
Symposium on the Microscope	545
Construction and Use of Microscopes. By J. E. Barnard	546
Microscopical Optics. By Prof. A. E. Conrady	548
Paris Academy of Sciences: Bonaparte and Loutreuil Foundations	550
The Mathematical Association. By Prof. William P. Milne	550
Industrial Research Associations	551
The Organisation of Imperial Statistics. By G. H. Knibbs	551
Italian Papers on Relativity. By Dr. L. Silberstein	552
Agriculture at the British Association. By Prof. Alex. Lauder	553
University and Educational Intelligence	554
Societies and Academies	554
Books Received	555
Diary of Societies	556

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THURSDAY, JANUARY 29, 1920.

THE WORKS OF TORRICELLI.

Opere di Evangelista Torricelli. Edite da Gino Loria e Giuseppe Vassura. Vol. i. Parte 1. Pp. xxxviii+407. Vol. i. Parte 2. Pp. 482. Vol. ii. Pp. 320. Vol. iii. Pp. 521. (Faenza: G. Montanari, 1919.) Price 60 franchi the 3 vols.

THIS work consists nominally of three volumes, of which the first contains mathematical papers, the second papers on mechanics, and the third the correspondence of Torricelli. In reality there are four volumes. It is to be hoped that this inconvenient way of describing the volumes of a work will soon go out of fashion. This is the first complete edition of the collected writings of Evangelista Torricelli; it is published under the auspices of the municipality of his native town, Faenza, who have in this way raised a lasting memorial to their celebrated townsman.

Torricelli was born in 1608, and died in 1647. In the introduction to vol. i., Signor Loria has given the few particulars about his life which it has been possible to gather. In 1627 Torricelli went to Rome to study under Benedetto Castelli, a disciple of Galileo, who in the previous year had been appointed professor of mathematics there. He seems to have remained at Rome until October, 1641, when Galileo, who had heard from Castelli of the valuable work in dynamics done by his pupil, invited him to Arcetri. Torricelli gladly accepted the invitation, but was only for a few months able to benefit by the instruction thus offered, as Galileo died on January 6, 1642. Soon after, Torricelli was appointed to the post of mathematician to the Grand Duke of Tuscany held by Galileo, and spent the few remaining years of his life at Florence until his death on October 25, 1647. The subsequent fate of his unpublished papers and letters is told in the introduction; they had a narrow escape from total destruction in 1733, when they were sold as waste paper to a pork butcher. Fortunately, the first customer to whom one of the papers was handed, wrapped round a sausage, was Nelli, the biographer of Galileo, who to his horror recognised the handwriting of the great man, and at once secured the whole pile of papers.

It was the study of Galileo's "Discorsi e dimonstrazioni matematiche intorno a due nuove scienze" which led Torricelli to make further investigations in dynamics and hydrodynamics. His principal results appeared in two books, "De motu gravium naturaliter descendentium" and "De motu projectorum," which appeared in a volume of tracts, "Opera geometrica," published in 1644. It is the second of these which contains his experiments on the flow of fluids from vessels through a small orifice. These experiments had been commenced by Castelli, whose erroneous result, that the velocity of outflow was proportional to the depth from the surface, was corrected by Torricelli. He showed that the quantity of water flowing from a hole in the horizontal bottom of a vessel in equal times was proportional to the series of odd numbers, if the quantity flowing out in the last unit of time was put equal to one. A particle from the surface flows out with a velocity equal to that which it would have acquired by falling from its original height over the opening. Therefore the outflowing velocity is proportional to the square root of the height. From this it followed that the figure of a jet issuing from a small hole in the side of a vessel is a parabola. Among Torricelli's discoveries is also the mechanical principle that if two or more bodies are so connected that their motion will neither make their centre of gravity rise nor fall: they are in equilibrium.

The fame of Torricelli rests, however, mainly on his discovery of air-pressure. He knew from Galileo that water would not rise in a tube closed at the top more than 33 ft., which was supposed to indicate that Nature's dislike to empty space (*horror vacui*) had a limit. Torricelli thought that this was nonsense and that it would be interesting to experiment with a heavier fluid. He anticipated that mercury would rise only to one-thirteenth of the height to which water would rise. At his instigation Viviani made the experiment in 1643, and found that the column of mercury in a tube closed at one end and inverted in a vessel containing mercury sank to about 30 in. and remained there. Torricelli found, however, by repeated measures that the height of the column of mercury was always changing, and he rightly interpreted this as indicating changes in the pressure exercised by the air on the open surface of the mercury. In a letter to his friend Ricci of June 11, 1644 (vol. iii., p. 186), he says that he has made these experiments, not to produce a vacuum, but chiefly to make an instrument for measuring changes in the density of the air. He explains that we live at the bottom of an ocean of air, the weight of which at the surface of the earth is about equal to one-four-hundredth of the weight of an equal volume of water. During the remaining three years of his life Torricelli does not seem to have pursued these researches further, and the new doctrine was not universally accepted until Pascal in 1648 had proved the connection of barometric height with the height of the observer above the surface of the earth, and Guericke soon after had proved by experiments the enormous power of the pressure of the air.

Not a few of the mathematical papers published in the first (double) volume have never been printed before. They deal with conic sections, spirals (Torricelli discovered the logarithmic spiral), maxima and minima, etc. They make us feel that if a longer span of life had been granted him he would have taken his place among those mathematicians who paved the way for the advent of the differential calculus. The quadrature of the cycloid was one of the subjects treated in the "Opera geometrica." It is well known that Roberval charged Torricelli with having stolen his results on this subject, as well as Fermat's method of maxima and minima, and that Pascal was weak enough to publish this accusation in 1658, adding the assertion that Torricelli had confessed the robbery. This outrageous charge was soon after proved by Carlo Dati and Wallis to be utterly groundless, and it only showed that Roberval was not very particular as to the truth of any statement he made. There is no reason whatever to doubt that Torricelli found his results independently.

This new edition is in every way satisfactory, but we could have wished that the pages of the originals had been given in the margin. This is too often neglected by editors of a man's collected works, and the omission makes it very difficult to look up quotations from the original editions.

J. L. E. D.

PROBLEMS OF THE FRUIT-GROWER.

Science and Fruit-Growing: Being an Account of the Results obtained at the Woburn Experimental Fruit Farm since its Foundation in 1894. By the Duke of Bedford and Spencer Pickering. Pp. xxii+351. (London: Macmillan and Co., Ltd., 1919.) Price 12*s*. 6*d*. net.

THE appearance of this volume will be welcomed by all interested in scientific pomology, and the practical fruit-grower should find it indispensable as a work of reference dealing with many of the problems with which in some form or other he is constantly faced. In neither case will the contents be unfamiliar, since the investigations at Woburn have been closely followed throughout their course, and the results have been published at intervals in a series of reports. Some of the latter, however, have been long out of print, and for this and other obvious reasons the publication of a connected and comprehensive account of the many-sided work conducted at Woburn since its foundation will be appreciated.

The preface quotes at length an article which appeared in NATURE of September 19, 1895, dealing with the genesis of the station, which was due entirely to the public-spirited enterprise of the Duke of Bedford, who furnished the necessary financial aid, and of Mr. Spencer Pickering, who has now for a quarter of a century devoted himself to the elucidation of some of the problems of the fruit-grower, and has laboured single-handed and under the additional handicap, in recent years, of ill-health. Under these conditions the volume of achievement has been remarkable; and although the authors recognise the limitation of aim necessitated by force of circumstances and plead for leniency of criticism, they may be assured that, notwithstanding the controversial character of much of their work and the storms of adverse opinion aroused from time to time, the world of horticulture recognises the great debt which it owes to them both for the value of their researches and for the stimulus given to scientific investigation in horticulture in this country.

It is impossible within the limits of a short review to include adequate notice of all the subjects of horticultural importance considered in this volume. Their range is extremely wide, successive chapters dealing with investigations on soil preparation for planting, methods of planting, pruning, manures, spring frost damage and its prevention, the fruiting of trees in successive seasons, the flowering of apple trees, insecticides and fungicides, insect and fungoid pests, soil sterilisation, the effect of grass on trees, the toxic action of one crop on another, the behaviour of plants in masses, and flocculation in soils. Since, however, opportunity for individual treatment has already been provided on the occasions of the appearance of the separate reports previously referred to, attention here may be confined to a few of the more general issues.

Except in the direction of chemistry, the goal aimed at was the investigation of those cultural problems in which much work could be done without the assistance of specialists in the respective branches of science concerned, since the station was not equipped for a more varied programme. The field of work which it was possible to cover within those limits was, however, remarkably wide, as the list of subjects just enumerated indicates. How far towards the solution of such cultural problems progress can be made under these conditions depends obviously on the nature of the individual problem; but, without in any way detracting from the value of the Woburn work, its main result has been to emphasise the need for the co-operation of the plant physiologist, the soil chemist and physicist, the entomologist, and the mycologist with the expert pomologist in investigations of this character. The ideal fruit experiment station, as the authors recognise in their preface, must be equipped to meet that need.

The difficulties experienced in the measurement of results of experiments on fruit culture have been adequately recognised. The Woburn methods of measurement appear, on the whole, satisfactory, although in certain cases to average the combined results of varieties of dissimilar character tends to obscure their significance. Experience at Woburn has apparently but rarely demonstrated that selection of results by the investigator is necessary, but in this respect the authors have perhaps been particularly fortunate in escaping anomalous behaviour on the part of individual trees caused by pest damage, local soil variations, or other accidental circumstances. It is interesting to note that their conclusions as to the minimum number of trees or plants which each plot under treatment should contain accord closely with those based on recent work in the United States.

The extent to which the results in the experiments with fruit trees may have been affected by root-stock variations cannot be estimated, since the nature of the root-stock and the precautions taken to ensure uniformity are not generally specifically stated. Recent investigations at East Malling and Long Ashton have demonstrated such wide variations in the characters of both Paradise and free stocks in the case of the apple, for example, that it is clear that uniformity of root-stock must be secured if the results are to be beyond criticism.

The investigations on insecticides and fungicides are of particular interest to plant pathologists, since, even if few or none of Pickering's formulæ for individual spray fluids establish themselves in general use, much light has been thrown upon the chemical side of the subject, especially in the case of Bordeaux and Burgundy mixtures. The view adopted as to the method of fungicidal action of the copper compounds concerned in the latter spray fluids has been the subject of considerable controversy, and there are, probably, too many weak points in the evidence adduced and in the line of argument taken in the discussion to permit of its general acceptance.

In a work of this description, covering so wide a range of subjects, it is not surprising to find a few mis-statements, such, for example, as that the scale insect, *Aspidiotus ostreaeformis*, occurs only under glass in this country. Again, the assertion that the greater part of the naphthalene in naphthalene-paraffin-soft soap insecticides of the paranaph type separates out on dilution does not hold in cases where the naphthalene is first dissolved in the paraffin. They are, however, but minor defects in a work distinguished for interest and originality, and sure to serve as a fruitful source of inspiration in many directions.

METAPHYSICAL RESEARCH.

Proceedings of the Aristotelian Society. New series. Vol. xix. Containing the papers read before the Society during the fortieth session, 1918–19. Pp. iii+311. (London: Williams and Norgate, 1919.) Price 20s. net.

Problems of Science and Philosophy. Aristotelian Society. Supplementary Volume II. The Papers read at the Joint Session of the Aristotelian Society, the British Psychological Society, and the Mind Association, held at Bedford College, London, July 11–14, 1919. Pp. iii+220. (London: Williams and Norgate, 1919.) Price 12s. 6d. net.

THE old idea of metaphysics, that it marks a stage of human intellectual activity when, dissatisfied with a primitive anthropomorphic projection of images which peopled the unseen world with gods and developed a theology, man formed for himself abstract entities and quiddities and put these in the place of his gods—a stage of intellectual activity from which we have now passed to the clear, sane world of positive science—has long passed away. The well-worn joke of the metaphysician looking for a black hat in a dark room no longer raises a smile. Metaphysical research is coming into ever closer relations with scientific problems. It is now seen to penetrate deeply into every problem of physics and biology, as well as of psychology. The annual volume of the "Proceedings of the Aristotelian Society" and the supplementary volume entitled "Problems of Science and Philosophy" clearly indicate this new orientation.

The supplementary volume is of special interest from the point of view of science. The Aristotelian Society has organised for some years past an extra session, in which representative leaders in the sciences are invited to join professed philosophers in discussing the fundamental problems of science. The session was held this summer at Bedford College, London, and attracted very wide interest. This volume contains the published papers which were issued for the discussions. They reach a high standard, and are likely to influence the direction of scientific speculation for some time to come.

In the first paper Mr. Bertrand Russell has given a very lucid example of what he has described as scientific method in philosophy. He submits "pure experience" to exhaustive scientific analysis. The outcome, if we follow and accept the writer's argument, is surprising, and probably to most people disconcerting. Like Hume, he fails to discover anything in experience corresponding to the subject, or anything like an act of perceiving which might constitute a subject, and he concludes, therefore, that the subject of experience is a logical construction. The next article is of more distinctively scientific interest. It is a symposium on the subject of "Time, Space, and Material." It is discussed from several points of view, scientific and philosophical, by Prof. Whitehead, Sir Oliver Lodge, Prof. J. W. Nicholson, Dr. Henry Head, Mrs. Adrian Stephen, and Prof. Wildon Carr. The keynote is Prof. Whitehead's criticism of the concept of "all Nature at an instant" and his insistence that the ultimate datum of science is an event. The continuity which science must hypostatise is not an ether of space, but an ether of events. There are two other symposia of present interest, one on the problem of individuality with particular reference to the concept of the relation of the individual to God, the other on the epistemological problem: "Is there 'knowledge by acquaintance'?"

The annual volume contains ten papers read during the past session of varied, but without exception of high, interest. The presidential address by Dr. G. E. Moore on "Some Judgments of Perception" is an admirable piece of close reasoning in analysis of a simple judgment, such as "That is an inkstand." Methodological problems of various kinds are discussed in papers by Prof. Laird, Mr. C. D. Broad, Mr. A. E. Heath, and Prof. J. B. Baillie. Prof. Wildon Carr expounds and defends the concept of "windowless" monads. Mrs. Duddington, in a paper on "Our Knowledge of Other Minds," develops an interesting theory of the immediacy and directness of this knowledge. Principal Jevons writes an appreciation of Tagore. Mr. A. F. Shand has an original study of deep psychological interest on "Emotion and Value." The last paper in the volume is by the Dean of St. Paul's on "Platonism and Immortality." It is a philosophical treatment of the most profound problem in social and political ethics, one which, moreover, is of great scientific interest—is there any reason to believe in human progress? The Dean holds that there is not.

MEDICAL AND SOCIAL WAR-WORK IN EGYPT.

(1) *The Australian Army Medical Corps in Egypt. An Illustrated and Detailed Account of the Early Organisation and Work of the Australian Medical Units in Egypt in* 1914–1915. By Lt.-Col. J. W. Barrett and Lt. P. E. Deane. Pp. xiv+259. (London: H. K. Lewis and Co., Ltd., 1918.) Price 12*s*. 6*d*. net.

(2) *The War Work of the Y.M.C.A. in Egypt.* By Sir J. W. Barrett. Pp. xx+212. (London: H. K. Lewis and Co., Ltd., 1919.) Price 10*s*. 6*d*. net.

(1) THE first book gives a detailed account of the early organisation and work of the Australian Army Medical Corps in Egypt. Prior to the outbreak of war the Corps was of meagre dimensions, in spite of the fact that compulsory medical training had come into operation in Australia in 1911. When war was declared, the Australian Government decided to raise and equip a division, 18,000 strong, the medical establishment of which consisted of regimental medical officers and three field ambulances. Later, further divisions were raised and sent to the front. It soon became clear that "lines of communication medical units" were required, and the first hospital units with a 520-bed hospital arrived in Egypt in January, 1915, and were housed at the Heliopolis Palace Hotel. This afterwards expanded into hospital and convalescent accommodation consisting of 10,600 beds, and in the three days April 30–May 2, 1915, no fewer than 1352 cases were admitted from Gallipoli, and were successfully dealt with—a sufficient tribute to the completeness of the organisation. A general review is given of the sickness and mortality among the Australians, and of the steps taken to prevent epidemics. A chapter is devoted to venereal diseases—described as being the greatest problem of camp life in Egypt—in which much sound advice is given for dealing with these scourges. A further chapter deals with the work of the Red Cross in Egypt, and in another suggestions are made with the view of increasing the efficiency of the Australian Army Medical Service. Sir James Barrett and Lt. Deane have compiled a very readable and useful narrative, and the volume is illustrated with many plates.

(2) This volume deals not with the general work of the Young Men's Christian Association, but with the special war work so successfully undertaken by it in Egypt and Palestine. A brief account is first given of the foundation and general policy of the association and of its pre-war work in Egypt. Two months after war broke

out 20,000 Territorials reached Egypt, and the Y.M.C.A. at once began its work among them. At Heliopolis 5000 troops encamped in the desert, with nothing to do after the day's routine ended, and within four days a marquee had been obtained, and writing accommodation, followed by a circulating library and canteen, provided. In addition, postal facilities were arranged for three weeks until the Government post-office was established, and some 1500–2000 letters were dealt with daily. From 1915 onwards soldiers' clubs were established in all the principal military centres of the Near East. Sir James Barrett bears eloquent testimony to the invaluable work of the Y.M.C.A. In a concluding sentence he says: "The strength, in my judgment, of this organisation lies in the fact that its members possess an ideal which finds expression in services to their fellows of the most practical character. . . . Whether we shall all agree with their ideals in the abstract or not is outside the question, for all can join in admiring and respecting their single-minded efforts to better humanity." Gen. Allenby, who contributes a preface, writes in a similar strain: "No one has more reason than I to be grateful to the Y.M.C.A. for its work in connection with the army. Throughout the campaign its workers have followed closely the fighting line, and their labours have done much to keep up the moral, mental, and physical efficiency of my troops. . . . Broad-minded Christianity, self-regardless devotion to work, a spirit of daring enterprise, and sound business guidance have built up an organisation which has earned the gratitude of the Empire."

SCIENTIFIC BIOGRAPHY.

(1) *Herschel.* By the Rev. Hector Macpherson. (Pioneers of Progress: Men of Science. Edited by Dr. S. Chapman.) Pp. 78. (London: S.P.C.K.; New York: The Macmillan Co., 1919.) Price 2*s.* net.

(2) *Lectures on Ten British Physicists of the Nineteenth Century.* By Alexander Macfarlane. (Mathematical Monographs: No. 20.) Pp. 144. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 7*s.* 6*d.* net.

(3) *Joseph Dalton Hooker.* By Prof. F. O. Bower. (Pioneers of Progress: Men of Science. Edited by Dr. S. Chapman.) Pp. 62. (London: S.P.C.K.; New York: The Macmillan Co., 1919.) Price 2*s.* net.

IN most directions we have had to abandon our aspirations and sanguine prophecies of a reconstruction which should lead to a better world and almost justify the horrors of war. But in one direction hope remains; there has certainly been a growth in the popular appreciation of science. However, like most good things, it has its dangers; it was the applications of science, rather than science itself, which stimulated popular interest during the war. We are not yet sure that the better judgment of value is based on a better understanding; and, if it is not, if science is to be appreciated merely because it is useful in the arts of war and peace, we shall soon be wishing fervently that interest may once more be replaced by apathy.

The danger is partly our own fault. We complain that the populace have neglected science; but science has also neglected the populace; we have not offered the laity of our best. "Popular science" has too often consisted of superficial lectures with showy experiments or trashy sentimentalism about the romance of radium and the starry heavens. We ought not to be surprised if those to whom science is presented in so unscientific a guise are indifferent to its value and ignorant of its meaning.

In order to make the laity understand rightly, we must start from a common ground. And there is a common ground: the proper study of mankind is man. Great men of science are often great men as well; by utilising the universal interest in great personalities, we may lead the way to a true comprehension of their work. Science, it is true, has a strong impersonal element; but it has also a strong personal element; it is on the latter that we must found a comprehension of the former. It is significant that an abstruse scientific problem has been noticed recently in the daily Press under such headlines as "Newton *v.* Einstein." The personal element of the matter was the first to appeal to the popular imagination.

For these reasons the volumes before us would have been welcome, even if they had represented an attempt rather than an achievement. It would not have been surprising if first attempts at popular scientific biographies had been partial failures; but here they are not. We have left little space to speak in detail of Mr. Macpherson's and Mr. Macfarlane's books, because all that there is to be said of them can be adequately conveyed in a single sentence. They are as good as they can be, and a great deal better than we should have imagined possible. Mr. Macpherson's task was perhaps as easy as that of a scientific biographer can be, for Sir William Herschel's work is easy to understand and the facts of his life might have been taken from a romantic novel; but everything looks easy when done by a master of the craft. Mr. Macfarlane's book is even more remarkable;

he gives about fourteen pages (it was originally an hour's lecture) to each of his subjects, and in that short compass manages to bring before his audience the picture of a complete personality, clearly distinguished from all the rest, and an adequate idea of the nature of his scientific work. There are a few minor inaccuracies, but our only quarrel is with the title, for of the ten (Maxwell, Tait, Rankine, Kelvin, Stokes, Airy, Adams, Whewell, Babbage, John Herschel) not all can strictly be said to be physicists. However, this is the fault of the editors, not of the author, for the book is posthumous; and we would not willingly part with any of the ten; Babbage, the least physical, is perhaps the most interesting. We are glad that neither of the authors is ashamed to tell again the old stories; the younger generation must learn them somewhere, and they could not be better told. But did Freddy Tait really drive that golf ball?

Concerning Prof. Bower's "Hooker," little also need be said. It is scholarly, as we should expect from its author, but, alas! it is not interesting. Prof. Bower has not, we think, managed to convey to his readers why either Hooker or his work was great. But some failures in an enterprise of this kind there must be; let us be thankful for the successes. Everyone ought to read Mr. Macpherson's and Mr. Macfarlane's books, and make all his acquaintances do the same. N. R. C.

OUR BOOKSHELF.

The Aviation Pocket-book for 1919–20. A Compendium of Modern Practice and a Collection of Useful Notes, Formulae, Rules, Tables, and Data Relating to Aeronautics. By R. Borlase Matthews. Seventh edition, revised and enlarged. Pp. xxiv + 536. (London: Crosby Lockwood and Son, n.d.) Price 12*s.* 6*d.* net.

THE impression received from a perusal of this book is that the author's chief aim in life is the classification of data, and that the value of the data is of secondary importance. The elaborate arrangements which make the pocket-book suitable for cutting up to fit a number of standard loose-leaf books or card index cabinets are valuable in proportion to the value of the information contained on its leaves. Since many of the tables are inaccurate, it would appear that the author holds a different view.

The resistance of the wings of an aeroplane is stated to have an average value equal to 15 per cent. of the total for the aeroplane, whereas it is probably never less than 50 per cent., and certainly greater than 60 per cent. in the case of modern aeroplanes at economical flying speeds. In the case of engines, the variation of power with height is represented in a table which is seriously wrong when the height exceeds 10,000 ft. Even the tabulated characteristics of a standard atmosphere do not agree with those used in British aeronautics. The weight per horse-power of engines to be used in preliminary design is given too high; the maximum of 200 h.p. there quoted is insufficient to cover the needs of aviation in 1920.

One also wonders why some twenty pages are devoted to tables and formulæ referring to flat plates, whilst four suffice for what the author describes as "modern wings." These instances of defective data suggest that the author would have been better employed in correcting his data than in developing a classification system. It is fortunate that much of the data is taken solidly from the publications of such bodies as the British Engineering Standards Committee and the Royal Aeronautical Society, and it is as a very full index to these works that the pocket-book appears to find a justification for its existence.

A Manual of the Electro-Chemical Treatment of Seeds. By Dr. Charles Mercier. Pp. viii + 134. (London: University of London Press, Ltd., 1919.) Price 3*s.* 6*d.* net.

THIS book is essentially a personal statement, and the reviewer is under the serious disadvantage that the distinguished author died soon after writing it, and can no longer make the rejoinder that a suitable critique would inevitably call forth. It deals entirely with a proprietary process for the treatment of seeds before sowing.

The process consists in placing the seeds in a 2½–5 per cent. solution of sodium or calcium chloride through which an electric current is passing, then taking them out and drying them. Five gallons of solution are needed per bushel of seed, and 8 watts of electricity per gallon. The drying is carried out by means of a blast of air heated to 100° F. The seed must then be sown as early as possible, as the effect lasts only a month.

Extraordinary increases in crop are claimed, and some astonishing photographs are reproduced in the book. Very few actual figures of crop weights, however, are available, and the author did not deal adequately with the awkward fact that the method had not been a success at the experimental stations where treated seed supplied by the proprietors had been tested. No useful purpose would, however, be served by referring further to such points as these, for Dr. Mercier cannot reply.

The New Hazell Annual and Almanack. By Dr. T. A. Ingram. Pp. 873. (London: Henry Frowde, Hodder and Stoughton, 1920.) Price 6*s.* net.

ON p. 206 of this useful annual we find a list of the Nobel prizemen for physics, chemistry, medicine, literature, and peace from 1901 onwards, together with a note on the Nobel foundation. This is an example of the kind of information which we expect to find in "Hazell," but not in other general annuals; and we are rarely disappointed. The sections on scientific and educational subjects are full of facts concisely presented, and the whole volume rightly claims a place upon every reference bookshelf.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Deflection of Light during a Solar Eclipse.

IT may be worth while to give my endeavour to obtain a rough value for the refraction effect of the atmosphere during a total eclipse of the sun. The simplest case possible is when the sun is in the zenith.

I will assume that the air density of the normal atmosphere has been removed, and that there is left the atmosphere which produces the abnormal effects in question. This is not necessary, but it makes the calculation somewhat simpler.

If O be the place on the earth's surface of maximum air density, the density ρ_0 of the residual atmosphere there will be one-seventieth of the density of the normal atmosphere if we assume that it corresponds to a fall of 4° C. in the atmosphere when in equilibrium. Take Ox in the direction opposite to that of the motion of the shadow, and Oy the vertical passing through the centre of the moon's disc. This assumes that the density is greatest at the centre of the shadow, which is almost certainly incorrect. I will take the density at any point of the residual atmosphere in the plane of xy to be given by

$$\rho = \rho_0(1 - \kappa x)e^{-\beta y},$$

where β, although it varies with temperature, is assumed to be constant and equal to $1 \cdot 3 \times 10^{-6}$, distances being measured in centimetres. If we assume that the density of the atmosphere becomes normal at 150 miles distance from O, κ will be $4 \cdot 17 \times 10^{-8}$.

With these values of the two constants, the above formula expresses that the horizontal density gradient is uniform and independent of height, and that the atmosphere has its normal density at a distance of 150 miles. None of these statements is correct. The shadow-cone in the earth's atmosphere acts like a down-draught chimney or a kind of thermal air-compression pump, increasing the density in the central region of the shadow and diminishing it in surrounding regions. Thus κ may have a very much greater value than that given above, and, indeed, the factor $1-\kappa x$ may be quite incorrect in form.

However, taking this formula for the density, the index of refraction of the residual atmosphere at any point is

$$\mu = 1 + (\mu_0 - 1)(1 - \kappa x)e^{-\beta y},$$

where $\mu_0 = 1 \cdot 000004$.

The path of any ray in the plane of xy might be got by solving the usual differential equation for this case, but I have not succeeded in getting a solution. However, the amount of the deviation can be obtained without knowing the actual path.

If ϕ be the angle which the tangent to a curve of equal refractive index makes with the axis of x, we have

$$\tan \phi = \frac{\partial \mu}{\partial x} \Big/ \frac{\partial \mu}{\partial y} = \frac{\kappa}{\beta(1-\kappa x)}.$$

It can easily be shown that the radius of curvature of the lines of equal density or refractive index in the neighbourhood of the axis of y is much greater than the radius of the earth. Thus, as we have assumed the earth's surface to be plane, we can assume these lines to be straight in the portion of the atmosphere concerned. On the axis of y, $\tan \phi = 0 \cdot 032$, and for an observer at O the refraction of the light coming from a star near the edge of the sun's disc will be the same as if he were looking through an atmosphere stratified in parallel planes, making an angle ϕ with the horizon. A ray coming from such a star will make an angle of $\phi - 15'$ with the normal to these planes, and the refraction will be

$$(\mu_0 - 1)\tan(\phi - 15')$$
$$= 0 \cdot 000004 \times 0 \cdot 0277$$
$$= 1108 \times 10^{-10} \text{ or } 0 \cdot 023''.$$

If the ray come from a star the angular distance of which from the sun's centre is 45′, the result is 0·0082″, which is a little more than one-third of 0·023″. But if, as I believe, κ has been greatly underestimated, the possible values of these refractions are much greater.

If the observer be not at the origin, but at a distance along the positive direction of the x-axis, the refraction of the light from stars on the other side of the sun's disc will not be away from the sun's centre, but towards it, and *vice-versa*, if he be on the other side of the origin. But no difficulty of this kind occurs for refraction in planes perpendicular to Ox if the position of the observer be on the x-axis. Perhaps it is worth mentioning that, from the only account of the observations I have seen, it appears that, with the exception of one star, all the changes in right ascension were of the same sign, whereas the changes in declination were all in the right direction.

I ought to mention in reference to Sir Arthur Schuster's letter (NATURE, January 8, p. 468) that I never thought of a ray that, in its passage through the earth's atmosphere, lay partly inside and partly outside the umbra. And I thank him for correcting the slip that I made in the angular radius of the sun's disc. In these days of relativity, an error of fifteen minutes either of arc or of time is, perhaps, excusable.

ALEXR. ANDERSON.

University College, Galway, January 14.

"The White Water."

IT is possible that some readers of NATURE can enlighten me on the cause and nature of what the Arabs call "The White Water." This phenomenon was witnessed by me on two occasions at the entrance to the Persian Gulf in the vicinity of the Quoin. On both occasions the time was about 8 p.m. There was no moon on the first occasion, but a moon on the second.

I first observed what appeared to be a line of breakers ahead of the ship; this was not possible because we were in deep water and the position of the ship was known. As we approached, it seemed that these supposed breakers were a succession of phosphorescent waves of a period of about sixty to the minute. The waves extended, so far as could be seen, for about two miles.

In addition to these waves there were also phosphorescent Catherine-wheels, both right- and left-handed, also phosphorescent light apparently coming to the surface and radiating out in all directions.

The phenomena lasted for about half an hour, gradually fading away, apparently sinking. There were strong atmospheric disturbances at the time. Both nights were clear and the sea was calm. I could obtain no local information. I may add, in conclusion, that I was not the only person who witnessed this display.

A. R. PALMER.

Portsmouth, January 13.

I HOPE that Capt. Palmer's letter will induce officers of the Indian Marine to investigate any cases of "White Water" that come under their notice. I am sure that the director and staff of the Indian Museum at Calcutta, where the collections of the I.M.S. investigator are deposited, will give them every assistance, and examine any specimens they may obtain. We want to know what are the organisms concerned in the production of the phosphorescence, and the physical conditions of the water in which they were living. The organisms can be strained out of the water by a silken or muslin net—or the hose turned to run through a piece of either cloth—and preserved in spirit or formic aldehyde (1 part in 30 of sea-water). They should be accompanied by exact information as to position, state of weather and moon, and temperature of the water; a sample of the actual water in a green beer-bottle would also be useful.

Phosphorescence so diffused as to make the sea appear absolutely white is, in my experience, rare. Indeed, I have seen "White Water" only on two occasions; the first halfway between Ceylon and Minikoi, on a dirty night towards the end of May, 1899 (heavy weather from south-west, maximum effect about 9.30 p.m., dark again by 11 p.m.); the second seen from Minikoi, about five weeks later, at the commencement of the Great Monsoon (south-west), time 9–10 p.m. A bottled sample of the water of the first showed only the same organisms as normally produce "sparks," but a tow-net sample of the second was so rich in the eggs, etc., of the organisms, which inhabit the slopes of Minikoi, and in breeding worms that normally bore into its corals, that I regarded it as perhaps a seasonal breeding phenomenon.

Waves of fire produced by myriads of sparks from minute water-fleas (especially Ostracods) and Protozoa are common in such tropical seas, but they merely mark the wind waves, and are not the same as the waves described by Capt. Palmer, which I think must be due to an optical effect. Globe or lantern-like effects produced by umbrella or barrel-shaped jelly-fish I associate with calm weather. They are most noticeable in the early part of the night, and do not usually last for more than an hour or two. As patches up to a few hundred yards across occur, and as the jelly-fish are sometimes so abundant that they can be collected in a bucket thrown overboard, the sea might be described as "White Water," but I am sure that this is not what the fishermen of the Indian Ocean know by that name. Fish passing through water highly charged with phosphorescent organisms frequently execute Catherine-wheels, etc., but fish themselves are often phosphorescent from bacteria living upon their skin. J. STANLEY GARDINER.

Zoological Laboratory, The Museums, Cambridge.

Proposals for a Plumage Bill.

PROF. DUERDEN's letter in NATURE of January 15 might by its phrasing lead to the supposition that a few persons only are agitating for a novel Bill to prohibit the importation of plumage. The trade has been keenly opposed by all naturalists, not only in Great Britain, but also in the United States, Canada, Australia, and nearly every country in Europe for many years. The arguments now used were all urged by the trade when the Government Bill of 1914 passed its second reading in the House of Commons.

We are told that the introduction of another Bill will be "viewed with alarm in South Africa," although the ostrich-feather trade is a British Colonial industry carried on under totally different conditions from those of the trade in wild birds' (or "fancy") plumage. In December, 1913, the hon. secretary of the Ostrich Farmers' Association of South Africa, representing 1700 farmers, wrote to the Royal Society for the Protection of Birds as follows:—"My association has from time to time taken the feeling of its members on the subject-matter of the Bill about to be introduced by Mr. Hobhouse, and they have expressed their entire sympathy with, and approval of, the Bill. . . . The attitude taken up by the feather dealers in London is inexplicable to my association, and you have my assurance that they have not the least support from a single ostrich farmer in South Africa."

With regard to the "serious slump" said to have resulted from the Anti-Plumage Bill of 1914, it may readily be supposed that all such luxuries as feathers would suffer a slump during the war; but, as a matter of fact, one of the chief London brokers reported in 1915 that, "in spite of many difficulties, a large quantity of goods has been dealt with," and that there had been "a sudden improved demand from America." This demand followed the passing of the tariff clause prohibiting the importation into the United States of all "fancy" feathers.

Prof. Duerden himself reasons that decrease in "fancy" feathers would improve trade in ostrich feathers when he argues that the æsthetic tastes we have inherited from our barbarian ancestors demand that we should decorate ourselves with feathers of some sort.

The argument that we must encourage a French industry is also well-worn. It is true that the traders in Paris cried out in 1914 that the Hobhouse Bill was designed to protect the ostrich feather industry of the Cape at the expense of Parisian feather-dressers; but the Société d'Acclimatation de France replied: "The interests of workpeople will not be affected. . . . It is only a very small batch of speculators that can have to suffer. They are very rich."

Prof. Duerden has "grave doubts" whether the "ruthless destruction of birds" for trade can best be prevented by discouraging or prohibiting that trade. It is open to him to suggest a better way. The proposition that birds-of-paradise, lyre-birds, egrets, herons, trogons, orioles, terns, kingfishers, and all the rest of the feather-traders' victims, from albatross to humming-bird, might be "farmed" after the manner of the flightless ostrich, and plucked or killed for the market "in conformity with the highest humane demands," may be of interest to aviculturists; it has no practical bearing on the question of to-day. What science and humanity alike demand is immediate action to save the birds of the world from the ruthless and stupendous slaughter on which the trade now lives. L. GARDINER,

Secretary, Royal Society for the Protection of Birds.

23 Queen Anne's Gate, S.W.1, January 20.

THE suggestion made by Prof. Duerden (NATURE, January 15) for special breeding of birds as an alternative to prohibiting imports of their plumage is unacceptable to us for several reasons, but of these I need now only mention one, since this one appears to us conclusive. We hold that it would be impossible for the Customs to differentiate between the feathers of those birds which had been "farmed" and of those which had fallen victims to the ruthless plume-hunter. Prof. Duerden is, perhaps, unaware that a scheme similar to that which he adumbrates was advanced in 1914 by the Committee for the Economic Preservation of Birds, and was considered by the Government of the day to be unworkable.

The idea of our desired Bill being dangerous to the ostrich-farming industry has surprised us, previous Plumage Bills having been warmly supported by the direction. Whitman's most cogent evidence is derived from a knowledge of the juvenal plumage in many wild species, and naturalists can scarcely fail to agree with his interpretation on this point, for he shows that many species which have more or less completely lost their chequers or bars in the adult plumage pass through a stage in which these markings appear.

(2) This brings out another aspect of Whitman's work—his strong support of the recapitulation theory. In his own words, "all development . . . is essentially a repeating or recapitulating process. This is the central fact of heredity and the doctrine of descent." Elsewhere he refers to heredity as "nature's silent rehearsal of past history." In this connection he pointed out that the formula, "ontogeny recapitulates phylogeny," places the emphasis in the wrong place, since phylogeny can be nothing more than the lineal sequences of ontogeny regarded from the historical point of view, while recapitulation is simply reproductive repetition. The orthogenetic process is considered to be the primary and fundamental one, which bridges the incipient stages of characters until natural selection can get a foothold, and may even sweep onwards and completely erase a pattern which selection would have retained.

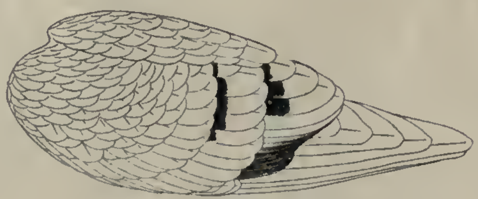

FIG. 3.—Wing of *Columba aenas*, related to *C. livia*. The two bars are incomplete.

That something other than selection is at work on these patterns is indicated also in such species as the European stock-dove, *Columba aenas* (Fig. 3). In this species the reduction of the bars has proceeded farther than in the rock pigeon, but the spots composing some of the partial bars are completely concealed by overlying feathers.

The same process is studied in great detail in the crested pigeons of Australia, the phylogeny being interpreted as "always advancing in one predetermined direction, like a tidal flow guided along a prepared channel, and flowing to varying distances, according to the initial momentum."

(3) Perfect continuity in development and variation is another feature which Whitman is at great pains to demonstrate. By plucking feathers at intervals from the juvenal plumage, he showed that underlying the apparent discontinuity in pattern between one moult and the next there was complete continuity of the underlying physiological processes. The exact nature of this physiological developmental continuity is a nice problem on which we have very little light at the present time. But the author carries his conception of continuity much farther. In his many crossing experiments he found usually a blending result, with a fluid condition and no halting places from character to character. Granting that this may be generally true of species crosses in pigeons, yet the author himself describes cases of sex-linked inheritance and other phenomena which indicate some fixed boundary line between certain characters. We therefore feel that a universal philosophy of continuity is misleading because untrue. The enormous Mendelian literature is not based entirely upon superficial or hasty observation, although such cases no doubt occur. The author would have been on safer ground had he recognised, with Galton, that both continuity and discontinuity exist in Nature, and both are equally worthy of an explanation. We may perhaps look forward to a harmonisation of these two opposing principles on the basis of cell structure.

(4) Several aberrant birds arising in these experiments are described as "mutations." For example, a Zenaida (Fig. 4, *a*) produced a mutant in which the juvenal plumage (Fig. 4, *b*) was more primitive than in the type, but the adult plumage was normal. This condition was transmitted through five generations in a generic cross. It recalls a type of yellow seedling occurring in maize which, if carefully nurtured, finally grows up into a green plant. Similarly, a Japanese turtle-dove (Fig. 5) produced three partial albinos in her old age. In this case there was also inbreeding. The orthogenetic interpretation assumes that the colour pattern is being progressively reduced, and that albinism is the final condition to which the whole group of pigeons is tending. This being the case, we may expect the reduction series to be hastened in a weakened germ, so that a long step in this direction might be anticipated. Here it would seem possible to find a basis for adjusting the conception of mutation with that of orthogenesis, even in pigeons.

(*b*) (*a*)

FIG. 4.—(*a*) *Zenaida vinaceo-rufa*, normal juvenal plumage. The light apical edge of the feathers is a primitive character in birds. (*b*) Mutant, juvenal plumage, showing a mesial extension of the light apical edge. This condition is a specific character in *C. guinea*.

(5) The conception of germinal weakness or strength is one on which Whitman lays great stress, and it is supported by much experimental evidence. Differences in "strength" or develop-

mental power are shown not only in hybrids, but also in pure species. By removing their eggs when laid, the birds can be overworked in reproductive activity, with a corresponding decrease in energy of the offspring. The result is more females and a shorter term of life. Even in normal reproduction there is found to be a gradual diminution in developmental power of the germs throughout the season.

This idea of relative and varying germinal weakness and strength runs through all the work, and will be found difficult to controvert. It is probably but the beginning of a theory of evolution founded primarily, not on morphological, but on energy conceptions.

(6) Another important relationship which was studied in great detail is that between fertility and sex. The problems involved are too many-sided to discuss here. It was found, for example, that while in crosses between closely related species the sexes appear in equal numbers, in inter-

FIG. 5.—The Japanese turtle-dove, *Turtur orientalis*. Believed to represent the primitive colour pattern in pigeons, from which the chequers of *C. livia* were developed by the disappearance of pigment along shaft of feather.

family crosses only or chiefly males are produced. In wide crosses the development may only begin, or it may stop at any stage between hatching and maturity, resulting in short-lived birds. All these and many other results are interpreted in terms of developmental energy, the difference between the sexes being regarded as essentially a difference in metabolic level. This view is in accord with the classical theory of sex of Geddes and Thomson. Some means must be found of harmonising it with the chromosome theory.

(7) The study of voice, instincts, and behaviour in pigeons has added much to the value of the whole work. Whitman's intimate knowledge of pigeons from this side frequently furnishes corroborative evidence of relationships. It also made possible his singular success in crossing many species which had never been crossed before. The differences in the instincts of the reproductive cycle are often surprisingly marked and definite in different species. In a discussion of instinct in relation to intelligence, the author's view is that as instincts become more complex and plastic the possibility of choice finally enters, so that without any added brain structure the organism is encouraged or constrained by circumstances to *learn* to use its privilege of choice.

These notable volumes, two of which are sumptuously illustrated with coloured plates by Japanese artists, will doubtless arouse much discussion. It is to be regretted that an index has not been added, to make their contents more readily available.

R. R. G.

THE NITROGEN PROBLEM.[1]

II.

BEFORE the war the United Kingdom produced and exported large quantities of ammonia nitrogen, upwards of 70 per cent. of the home production being, in fact, exported. Indeed, the British export trade in ammonium sulphate was larger than that of any other country. On the other hand, she was entirely dependent upon the Chile product for her nitric nitrogen. Agriculture accounted for the major portion of the home consumption of fixed nitrogen, but this only represented 23·5 per cent. of the total home production and importation. Indeed, in proportion to the total area under cultivation, the United Kingdom uses less artificial nitrogenous fertilisers than any other progressive agricultural country.

The war has had a serious effect upon the home industry. Whereas the estimated output of by-product ammonia in America and of by-product and synthetic ammonia in Germany in 1917 was more than double what it was in 1913, with us it declined in 1914 and 1915, slightly recovered in 1916, and in 1917 showed only an increase of 6 per cent. over the amount in 1913. Our export trade in ammonium sulphate practically ceased in 1917. Countries which formerly imported our sulphate of ammonia are now making their own by-product ammonia. This result is due to the action of the Government in controlling the export and price. As is well known, there has been a remarkable development in agriculture in this country during the last four years, and the home demand for nitrogenous fertilisers has been in excess of the supply. There can be no doubt that both the industrial and the agricultural demand for nitrogen products will continue to increase. The Committee estimates that on the assumption that the present scale of food production is at least maintained, the demand in the near future will probably represent a quadrupling of the average pre-war requirements. Our export trade in ammonia fertilisers will have in future to reckon to a still greater extent with synthetic products. It can only successfully compete by this country itself manufacturing such products. No doubt economies and improvements in existing by-product processes are conceivable and possible, but

[1] "Ministry of Munitions of War. Munitions Inventions Department. Nitrogen Products Committee. Final Report." Pp. vi+357. (London: H.M. Stationery Office, 1919.) Cmd. 482. Price 4s. net. Continued from p. 535.

it is unlikely that low-temperature carbonisation will have any considerable influence on the main result, and attempts to utilise peat and sewage afford no certain promise of success. Although our existing processes have admittedly shown themselves to be a national asset of the greatest value in times of war, they need to be supplemented, in a time of national emergency, by methods which will render this country independent of external supplies of nitrates.

The cost of power is, of course, a vital factor in connection with the establishment of any synthetic process of nitrogen fixation; and to this question the Committee necessarily devoted great attention and with special regard to the conditions of the United Kingdom. It has considered such water-power schemes as appeared practicable, and the cost of obtaining electrical energy from coal. The comparison is complicated by the many complex factors involved, and especially by the uncertainty concerning the future cost of coal and labour. At the same time, it offers an estimate of the cost of a particular water-power scheme which it has investigated, but of which it gives no details, and it is of opinion that for a power of more than 28,000 continuous kilowatts the running cost, under post-war conditions, would be 3·93*l*. per full kilowatt-year, inclusive of capital charges. The only possible chance of obtaining electrical energy from coal at a cost which would compare with this would be by direct firing at a power station operating on a very large scale. This with coal at 10*s*. per ton and an annual load factor of 97·5 per cent. works out at about 4·5*l*. per kilowatt-year of 8540 hours.

After careful consideration of the main features of the various nitrogen fixation processes and of the ammonia oxidation process, in the light of British conditions and requirements, the Committee concludes that (*a*) the *arc* process, in spite of certain disadvantages, viz. its large power requirements, its low electro-chemical efficiency, and the costly character of its chemical plant, would compete with the retort process of obtaining nitric acid so long as the cost of electrical energy was below 9*l*. per kilowatt-year. (*b*) The *calcium cyanamide* process affords a cheaper marketable form of combined nitrogen, so long as electrical energy is below 5*l*. per kilowatt-year, than any other established fixation process, and gives a solid nitrogenous fertiliser as a primary product. The manufacture may be combined with that of calcium carbide and crude cyanides, and, as the raw materials are cheap and abundant in this country, there is good ground for assuming that it would be successful with us, in spite of the relatively high cost of electrical energy. The Committee is of opinion that a steam-power station of 30,000-kw. maximum load is the minimum size that would be justifiable under British conditions. (*c*) The *Haber* process, with pure hydrogen at 2*s*. 6*d*. per 1000 cu. ft., is capable of producing ammonia at a cost below that of any ammonia process as yet established. The Committee, of course, had no opportunity of inquiring into the Claude process, the details of which have only recently become known. Both these processes are the most promising of all the synthetic methods of making ammonia and ammonium sulphate. It is too soon to express any definite opinion as to their relative merits as commercial processes, but it is certain that both of them have a great future.

The *ammonia oxidation* process for making nitric acid, although probably not in its final form, can even now furnish concentrated acid at a lower cost than the retort process from Chile nitrate, and ammonia oxidation converters are well adapted for use in the chamber process of making oil of vitriol. It is not unlikely that such converters will soon supersede the wasteful system of nitre-pots.

It should be stated, however, that the last word has not been said in favour of existing by-product processes. It is pointed out that improvements in the metallurgical coke industry, such as the more rapid replacement of beehive ovens by recovery ovens, and improvements in the existing practice in gasworks, both large and small, would do much to augment the yield and recovery of by-product ammonia, and the Committee was unanimously of opinion that energetic measures should be taken to ensure that industries making such a large annual demand upon our coal reserves should be made to utilise them to the maximum advantage, and it indicates in outline what these measures should be. The waste that has hitherto taken place in the potentiality of coal, as regards both its energy and its products, is a national scandal that ought no longer to be tolerated. Its continuance would be the strongest argument that the advocates of nationalisation could adduce.

Considerations of space prevent any attempt to deal with many other points which have engaged the attention of the Committee, and are set out in detail in its voluminous report, such as the question of the nitrogen problem as it affects other parts of the Empire. The Dominions beyond the seas are rich in latent resources in coal and other raw materials, and some of them possess exceptional water-power facilities, accessible to the seaboard and capable of easy development. Nor have we been able to devote much space to the question as it affects national defence. It must be evident, however, from past experience that, notwithstanding our maritime supremacy, the military situation has been, as the Committee states, fundamentally changed. We must no longer be dependent upon Chile nitrate for the manufacture of explosives. We agree with the Committee that a wise policy in regard to defence can well go hand in hand with a sound economic policy.

The Committee recommends that:—

1. The calcium cyanamide process should be established in Great Britain without delay, either by private enterprise (supported, if necessary, by the Government) or as a public work, and that the scale of manufacture should be sufficient to produce 60,000 tons of cyanamide per annum,

equivalent to about one-eighth of the present home production of ammonium sulphate, the necessary water-power being obtained in Scotland, or from a large steam-power station.

2. That the synthetic ammonia (Haber) process should be established forthwith on a commercial unit scale and extended as rapidly as possible, as a post-war measure up to a minimum manufacturing scale of 10,000 tons of ammonia (equivalent to 40,000 tons of ammonium sulphate) per annum; and it suggests that the factory at Billingham-on-Tees, which the Government, in 1918, decided to erect, mainly for the manufacture of ammonium nitrate, might be utilised for the purpose.

3. That an ammonia oxidation plant should be established in conjunction with the synthetic ammonia factory on a scale sufficient to produce 10,000 tons of 95 per cent. nitric acid, or its equivalent in nitrates, and that the plant should be designed to utilise either synthetic or by-product ammonia.

4. That steps should be taken with the view of conserving and increasing the output of combined nitrogen from existing by-product ammonia industries, of securing the better utilisation of the national resources in coal, and of reducing the consumption of *raw* coal as fuel. (The various steps which it is suggested should be taken to secure these ends are set forth.)

5. The Committee further recommends that certain nitrogen fixation processes—*e.g.* the Häusser process, certain cyanide processes, and sulphate recovery processes—should be systematically investigated on a small works scale. It understands that the question of low-temperature carbonisation of coal is being investigated by the Fuel Research Board. It suggests that the researches on the nitrogen problem initiated during the war should be continued under the auspices of the Government for the general benefit of the country; and that the results of the researches carried on up to the present should be edited, and published at the earliest possible moment, subject to such reservations as may be considered necessary by the Government, members of the Research Staff of the Munitions Inventions Department being allowed to communicate to scientific societies the details of their work, subject to such reservations as may be considered necessary by the Government.

The Committee concludes its report with a recommendation that a co-ordinated policy should be framed by an Imperial authority for safeguarding the future nitrogen requirements of the Empire. It points out that, so far as the United Kingdom is concerned, nitrogen fixation and allied industries will constitute a new "key" industry. The Committee is of opinion that the initiation and development of the industry will require the active support of the Government.

It is not to be anticipated, in the present state of the political position, and in view of the large arrears in its programme of reconstruction with which the Government is faced, that any immediate consideration will be given by it to the Committee's recommendations, or that any practical steps will be taken to give effect to them beyond attempting to dispose of the Billingham-on-Tees property, and possibly permitting the Research Section of the Munitions Inventions Department to continue its investigations. We understand that negotiations on behalf of an important group of firms are in progress for the purchase of the Billingham works. But whether the Haber process or the American modification of it will be carried on there remains to be seen. Within the last few days it has been announced that an influential financial syndicate is about to establish a factory in the neighbourhood of Maryport, West Cumberland, to work the Georges Claude process, which is already in operation at Montereau, near Fontainebleau, by which it is claimed that the production of ammonia is increased fourfold as compared with the Haber process, as worked by the Badische Anilin & Soda-Fabrik at Oppau, near Ludwigshafen. The first unit of the synthetic plant will be of sufficient size to produce the equivalent of 50,000 tons of sulphate of ammonia per annum. If this consummation is reached it will go far to solve the problem which the Nitrogen Products Committee has been considering with such thoroughness and care during the last three or four years.

EXPLORATION IN TIBET AND NEIGHBOURING REGIONS.[1]

COL. LENOX CONYNGHAM has done right good service to the science of geography by compiling in one comprehensive volume the complete story of the early exploration of the great Tibetan uplands before that land of mystery and romance became attractive to European geographers, who evolved the map of Tibet as we now know it on a more scientific basis. It would indeed have been useful if the brief preface to the volume had included a somewhat more detailed explanation of the means and the methods employed by these early native surveyors in those amazing journeys which gave us the first (and sometimes the last) outlines of Tibetan geography, and laid the foundations for subsequent map superstructure. The narratives of the individual explorers are given in chronological order, commencing with the journey of Pandit Nain Singh, in 1865, from Nepal to Lhasa, and terminating with that of Atma Ram, who accompanied our first adventurer, Capt. (now Sir Hamilton) Bower, when he traversed Tibet from Kashmir to China in 1891–2, following a route which was not very far removed from that of Nain Singh in earlier days. Then for the first time were the eyes, not only of geographers, but also of archæologists, opened to the immense wealth of scientific and historical knowledge which was to be gathered in that remote part of Asia.

[1] "Records of the Survey of India." Vol. viii. (in two parts). Part i., "Exploration in Tibet and Neighbouring Regions, 1865–79." Pp. xi+213+charts. Part ii., "1879–92." Pp. xi+215–411+charts. (Dehra Dun: Office of the Trigonometrical Survey, 1915.) Price 4 rupees or 5s. 4d. each part.

For some twelve years the native explorers of the Indian Survey had the field to themselves, and it may safely be said that no Asiatic geographers of the past, not even the Arab adventurers of the Middle Ages, or the Chinese pilgrims of yet earlier times in search of such evidences of their Buddhist faith as were to be found on the frontiers and plains of India, ever established such a remarkable record of geographical accomplishment as did these Lamas and Pandits of Indian Survey history in so short a time. Their success was due primarily to the fact that they were well selected for the special line of exploration which they were expected to follow. Then they were thoroughly well trained in the first elements of geographical reconnaissance by Indian Survey officers.

As a rule their methods were simple, for they included no more than the first principles of traversing on bearings taken by the prismatic compass, distances being measured by pacing, and occasional most valuable checks being derived from latitude observations with the sextant. This involved the use of small instruments which were concealed either in their clothes or in false bottoms to their boxes. A rosary was the convenient means of checking their paces. Considering that many thousands of miles were covered in this way, and that the final reduction of their voluminous records (concealed usually in the lining of their coats) was most satisfactory, no higher and better evidence of the patience and determination of such men as Nain Singh, Kishen Singh (the A–K of the Survey records), or of Ugyen Gyatso could be desired. They were frequently engaged for years on the same quest; they were occasionally caught and enslaved, but almost always managed to save their instruments and their records; and their journeyings carried them across the great plateau to Mongolia and China, and into regions where hitherto no European has followed them.

With the influx of European explorers, started by the remarkable discoveries of Bower, the later stories of Tibetan exploration became public property, but it should be noted that many of the most successful of these later white adventurers have employed native explorers to do the spade work of their geographical mapping, and that with the close of the period indicated in this useful volume (which has conveniently brought together information hitherto scattered and rather difficult to retrieve) the work of the native geographer has by no means come to an end. Another and an even greater volume might follow which should show how much our well-known Tibetan travellers owe to the indefatigable perseverance and the remarkable skill as topographers of their native assistants.

Col. Lenox Conyngham's compilation merely brings together the narratives of the earliest native adventurers, and no book of travel that ever was written contains such a wealth of thrilling personal incident as underlies the simple (and sometimes prosaic) account of these humble Indian workmen. T. H. H.

NOTES.

A special meeting of the Royal Society was held on Thursday, January 22, when the Prince of Wales was admitted a fellow, following election by ballot, which took place on May 22, 1919. This election was in pursuance of a clause in the society's statutes which permits any one of his Majesty's subjects who is a Prince of the Blood Royal to be proposed at one of the ordinary meetings by any fellow, provided such proposal shall have been made at a preceding meeting. Under this provision King George V. was elected in 1893 when Duke of York. His Royal Highness was received in the society's vestibule by Sir Joseph Thomson and the officers and vice-presidents, whence, preceded by the mace-bearer, a procession was formed through the ranks of the fellows to the meeting-room. The Prince occupied a seat on the front bench among the fellows. The senior secretary having announced the attendance, his Royal Highness advanced to the president's table and subscribed his name in the charter book, thereupon taking a seat on the left of the president. An attractive discourse was then given by Prof. W. H. Bragg on methods of detecting submarines by sound. Upon its conclusion the Prince thanked the society for his admission, and assured the fellows of his interest in the advancement of scientific research.

Disturbances of wireless messages are commonly known to all operators, and are usually regarded as atmospheric effects. Mr. Marconi, however, in a statement published in the *Daily Mail* of January 27, describes interruptions which occur simultaneously in London and New York, and in which certain long and short signals are repeated more frequently than others, as, for example, the three dots signifying the letter S in the Morse code. In the absence of a physical explanation of these regular and simultaneous interruptions, it is perhaps human, and certainly sensational, to suggest that the signals represent attempts of intelligent beings on another planet, or the moon, to communicate with the earth. The *Daily Mail*, therefore, refers to "recent investigations by Prof. Lowell with his giant telescope" of Martian canals (Prof. Lowell died in 1916), and to Prof. W. H. Pickering, who "has caused extraordinary interest in the United States by recently announcing that he sees signs of life on the moon," though these views have been before the astronomical world for many years, and the phenomena observed admit of other interpretations. The interruptions described by Mr. Marconi are no more wonderful than the magnetic disturbances long registered in magnetic observatories. Such disturbances of the photographic records are often very definite in character, and occur at about the same hour on successive days, while they are also found to occur simultaneously at stations so far apart as Christchurch (N.Z.) and Kew. The magnetic and wireless effects are closely related, but whether they originate in the sun or arise from a common cause operating throughout the solar system has yet to be determined. That they are signals from other worlds is attractive to the imagination, but the hypothesis is more of popular than of scientific interest.

It is with deep regret that we record the death of Dr. C. R. C. Lyster on January 26 at the age of sixty years. Dr. Lyster held the position of head of the X-ray and electro-therapeutic departments at the Middlesex Hospital during the last seventeen years. Even in quite the early years of radiology Dr. Lyster made extensive use of X-rays in the treatment of disease, especially cancer. It was at this period, when the harmful nature of repeated fractional doses was not known, that he himself sustained damage which afterwards developed into the disease he sought to alleviate in others. Dr. Lyster fully realised the additional risks he ran by continuing his work, but nothing could deter him from pursuing it, and his work of later years should be viewed in the light of a sacrifice on his part to the cause of advance in medicine. Dr. Lyster was president of the electro-therapeutic section of the Royal Society of Medicine for the year 1918–19, and served on its council and on that of the Röntgen Society for a number of years. His publications were few, and provide no adequate guide to the value of his services to medicine, especially to medical radiology. The recent institution of a diploma in radiology and electrology by Cambrige University was largely due to the efforts which Dr. Lyster made in the first instance. Throughout the whole of his work he combined in a rare degree a breadth of outlook and an unselfishness of purpose which ensured a respect for his views and counsel. Of his personal charm and character a wide circle will preserve a permanent memory.

The Rev. Edmund Warre, D.D., who died at Eton on January 22, the anniversary of the death of Queen Victoria, was a notable and commanding figure in the Victorian age. During his headmastership of Eton, which lasted from 1884 until 1905, many new buildings, including three science laboratories, were added, and science teaching, more particularly with a view to military requirements, was extended and developed. Dr. Warre was in the habit of saying that, like the horse-leech, Madam Science had many daughters, all crying "Give, give"; but he was a generous and wide-minded man, whose own scientific tastes lay in the direction of botanical work. His ruling passion, however, was for the river, and he used frequently to lament that, because his mathematical training had been neglected, he was unable to work out satisfactorily the ideal lines of a racing-boat. Dr. Warre had been for some years an invalid, and he retired from the Provostship of Eton in 1918. No man can have had a wider circle of friends, and he will be remembered with affection and esteem by many men of science.

The award of the Straits Settlement gold medal, founded by Scottish graduates in the Malay States, to Dr. R. T. Leiper was announced in our last issue. The medal is given for the best thesis for M.D. on a subject of tropical medicine offered during the last five years, and is awarded by the Senate of the University of Glasgow. Dr. Leiper's thesis, for which he gained a Bellahouston gold medal in 1917, comprised an account of the brilliant work which he did on Bilharzia disease in Egypt (1915–16), whither he was sent by the Government as consultant parasitologist and Lt.-Col., R.A.M.C., to investigate the disease and to advise as to preventive measures in connection with the troops. It will be recalled that by his researches Dr. Leiper established the existence of two species of parasites in human bilharziosis, traced their life-history outside the human body in molluscs, and demonstrated the modes of infection, besides elucidating numerous other points. The award of this medal by Dr. Leiper's university is a fitting recognition of an epoch-marking advance in parasitology.

British botanists have an opportunity of showing practical sympathy with the eminent French bryologist, M. Jules Cardot, who has suffered severely from the effects of the war. Driven from his home at Charleville by the German advance in 1914, M. Cardot had to abandon all his possessions. He has now returned to find that the greater part of his property has been destroyed or removed, including his books and MS. notes and a large portion of his collections. Fortunately, his mounted herbarium of mosses, containing between 30,000 and 40,000 specimens, representing more than 10,000 species, is practically intact. The herbarium is a valuable one, containing the types of a large number of new species described in M. Cardot's numerous monographs of various families and works on the geographical distribution of mosses. It is M. Cardot's wish that his herbarium should find a home in the Paris Natural History Museum, but with his present restricted means he is unable to make a gift of it to the nation, and the museum has not sufficient funds at its command for the purchase. A suggestion has been made by bryological friends, simultaneously in the United States and this country, that if the museum authorities will find half the amount required the remaining half might be raised in Great Britain and in America. The authorities in Paris have gratefully expressed their willingness to agree to such a scheme, and the price of 10,000 francs has been mentioned. The proposal to raise one-fourth of that amount in this country would at the present rate of exchange entail a sum of between 60*l.* and 70*l.* The well-known British bryologist, Mr. H. N. Dixon, is acting as treasurer of the fund, and his address is 17 St. Matthew's Parade, Northampton.

Dr. Edwin Deller, secretary of the Brown Animal Sanatory Institution, University of London, has been appointed assistant secretary to the Royal Society.

With the approval of the Lords Commissioners of the Treasury, Major H. E. Wimperis, R.A.F., has been transferred from the Office of the Crown Agents for the Colonies to the Air Ministry, to take up the position of Head of the Air Navigation Research Section.

We are informed that the council of the Glass Research Association has appointed Mr. R. L. Frink, Lancaster, Ohio, U.S.A., director of research. The secretary of the association says:—"Mr. Frink has a lifelong experience of the American glass trade and glass research, is well known to the foremost English glass manufacturers, and his appointment is welcomed by the British glass industry."

The death is announced, in his seventy-second year, of Mr. R. L. Garner, the American author who published a book on "The Speech of Monkeys" in 1892, and afterwards visited the Gaboon, the country of the gorilla, where he stated he lived for some months in a steel cage to study the language of the great apes. On his return to London, early in 1894, Mr. Garner delivered a lecture on his experiences, which attracted a large audience, but clearly showed that science had nothing to expect from his enterprise.

We regret to record the death on January 24 of Mr. R. F. Wallace, who retired from the Meteorological Office at the close of last year. Mr. Wallace was in his sixty-eighth year, and should have retired some two years ago, but remained in the service during the closing period of the war. He entered the Meteorological Office in 1883, and first served in the marine division. About twenty years ago he took general charge of the meteorological instruments.

Influenza seems to threaten to be prevalent in this country before long, judging by the outbreaks in America and elsewhere. Since the commencement of October influenza has been present to a limited extent in the British Isles. The deaths in the ninety-six great towns of England and Wales have risen from 14 and 20 in the two closing weeks of September last to 70 or 80 deaths per week at frequent intervals during the autumn and winter. In London the deaths rose to 22 in the weeks ending November 15 and 22, but they have not touched 20 in any week since, according to the returns of the Registrar-General to January 17. The highest death-rate is between twenty and sixty-five years of age, the deaths for those ages in the last thirteen weeks being 59 per cent. of the total number.

In the current number of the *Annales de la Société Royale Zoologique et Malacologique de Belgique* appear the names of ten honorary members who have recently been elected to that society. Among the names are those of Prof. L. Cuenot, Faculté des Sciences, Nancy; Prof. M. Caullery, the Sorbonne, Paris; Dr. A. E. Shipley, Christ's College, Cambridge; Senator B. Grassi, Italy; Prof. E. G. Conklin, Princeton University; and Prof. Th. H. Morgan, Columbia University.

The annual meetings of the Institution of Naval Architects will be held on Wednesday, March 24, and the two following days, in the hall of the Royal Society of Arts, John Street, Adelphi, W.C.2. The Right Hon. the Earl of Durham, president, will occupy the chair. A gold medal will be awarded by the council to any person not being a member or associate member of council who shall at the forthcoming meetings read a paper which, in the judgment of the council, is deemed to be of exceptional merit.

Owing to the prevalence of diseases in prepared timber, and in view of the impending increase in the use of timber—much, possibly, of immature growth—in building construction, the Science Standing Committee of the Royal Institute of British Architects, under the chairmanship of Mr. Alan E. Munby, has had the question of such defects under review, and Dr. C. J. Gahan, of the Natural History Museum, has been asked, and has consented, to associate himself in an advisory capacity with this inquiry. The committee will welcome any information which seems likely to further such investigations. Correspondence should be addressed to the Secretary, Royal Institute of British Architects, 9 Conduit Street, W.1, and marked "Science Committee."

The following awards have been made by the council of the Institution of Mining and Metallurgy:—(1) Gold medal of the institution (premier award, and the highest distinction within the power of the institution to confer) to Mr. H. Livingstone Sulman, in recognition of his contributions to metallurgical science, with special reference to his work in the development of flotation and its application to the recovery of minerals. (2) "The Consolidated Gold Fields of South Africa, Ltd." gold medal to Mr. William Henry Goodchild, for his papers on "The Economic Geology of the Insizwa Range" and "The Genesis of Igneous Ore Deposits." (3) "The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to Dr. Edward Thomas Mellor, for his paper on "The Conglomerates of the Witwatersrand."

At the annual general meeting of the Royal Meteorological Society, held on January 21, the following officers and council were elected:—*President:* R. H. Hooker. *Vice-Presidents:* J. Baxendell, F. Druce, Sir Napier Shaw, and F. J. W. Whipple. *Treasurer:* W. V. Graham. *Secretaries:* W. W. Bryant and J. S. Dines. *Foreign Secretary:* R. G. K. Lempfert. *Council:* C. E. P. Brooks, Dr. J. Brownlee, Capt. C. J. P. Cave, J. E. Clark, R. Corless, Capt. G. M. B. Dobson, J. Fairgrieve, Lieut. H. D. Grant, H. Mellish, Dr. J. E. Petavel, M. de Carle Sowerby Salter, and G. I. Taylor. The Symons gold medal awarded to Prof. H. H. Hildebrandsson, of the University, Upsala, was presented on his behalf to the Swedish Minister.

Mr. Ikbal Ali Shah gives in *Folk-lore* for December last (vol. xxx., No. 4) a comprehensive account of the folk-life of Afghanistan, a subject about which little information has hitherto been available. He traces the life of an Afghan from the cradle to the grave, his account of the marriage and death ceremonies being particularly interesting. On the whole, though Mr. Shah is perhaps influenced by his natural prepossessions, he gives a pleasing impression of the family life of the people, and the general result is that, as Afghanistan borders on both Persia and India, the domestic rites of the Afghans have been influenced both by Persians and by the Hindu or Mussulman culture of the Punjab.

In *Sudan Notes and Records* (vol. ii., No. 3, July, 1919) Dr. C. Crossland treats the question "Comfort and Health in the Tropics." "Remove the mosquitoes and the fevers they carry, and most tropical countries can be made fairly healthy." He gives good advice on clothing. "Air which is already moist can have little drying or consequent cooling effect unless it is in fairly rapid motion. Consequently what is known as ventilation in Europe is of little use in the tropics, and houses designed in Europe are never, so far as I have seen, sufficiently airy for the Red Sea coast." Hence he lays down, with the help of diagrams, what is his idea of a suitable house. The author does not appear to have any experience of India, where the subject has been carefully investigated. But the paper will be useful to all who intend to reside in the tropics.

MR. H. BOLTON, Director of the Bristol Museum and Art Gallery, in his report for the year 1918–19, points out that the museum suffered from the necessity of exercising a strict economy in order that the changed conditions of the cost of labour, supplies, and museum material may be met as well as possible by the unaltered pre-war income—conditions affecting institutions of this kind throughout the country. But the educational work has been carried on with success, no fewer than 60,000 visits having been made by wounded soldiers during the war period. The important collection of guild banners has been increased by some welcome gifts; Mrs. C. Ryland presented a valuable series of pictures, and Mr. H. Mardon a large collection of European engravings and his extra-illustrated copy of Nichol and Taylor's "History of Bristol," extended to fourteen volumes and containing almost every known illustration and map of importance relating to Bristol.

SIR C. HERCULES READ describes in the January issue of *Man* an ancient Chinese bronze from the collection of Mr. H. Oppenheim. It represents a monstrous mammalian quadruped, winged, with a long neck and a feline head, which seems to be struggling with a snake-like form. Figures of a similar kind are said to have been used as a refrigerator for food, or as a brazier for heating water or wine. Sir C. H. Read remarks that "the practical identity of the Tartar figures and the surrounding animals would further suggest that if one be of the Han dynasty type, the other is also. In any case, the suggestion helps my theory as to the affinities of the Oppenheim bronze, viz. that in some respects it has clear connection with the later Bronze age in the Far East. The architectural treatment of the base is quite un-Chinese, and at the present moment I can think of nothing nearer than Gandhara with which to compare it. Ten years ago such a suggestion would have been thought fantastic, but Sir Aurel Stein's discoveries have reduced it to a commonplace."

DR. J. W. H. HARRISON, continuing his experiments with the Geometrid subfamily Bistoninæ, finds peculiar sex-relationships particularly in inter-generic hybrids of these Lepidoptera (*Journal of Genetics*, vol. ix., No. 1). Occasional inter-sexes, intermediate between males and females, were produced, and in several crosses only males appeared, although all the fertilised ova developed. In such cases the male parent in the cross is found to be "phylogenetically older" than the female. Thus *Nyssia zonaria* × *Lycia hirtaria* yielded males only. A further complication is found in the fact that *hirtaria* has fourteen (haploid) chromosomes, while *zonaria* has fifty-six. An explanation of the results is attempted in terms of intensity of sex-factors.

"NOTES on the Survey of India Maps and the Modern Development of Indian Cartography," by Lt.-Col. W. M. Coldstream, R.E., is the title of a volume recently published by the Survey of India. The author traces the history of map production in India and the development of colour printing. The size of sheets, use of symbols, selection of colours, and lettering and other problems in cartography are discussed at length, and the volume is illustrated by forty coloured plates showing specimens of all the most important maps published by the Survey of India, as well as illustrations of several old maps. The collection of these plates alone makes the volume of great interest.

MILITARY operations in the Libyan desert in 1914–18 gave Dr. J. Ball opportunities of taking the latitude and longitude of several places of which the position had not been accurately determined. These are published by the Egyptian Survey (Survey Department Paper No. 34). The positions determined extend from the Nile west to the Siwa oasis and Jarabub, and south to the oases of Kharga and Dakhla. The position of Bir Terfawi, which had hitherto only been guessed at, was determined by Lieut. Moore, who places the well nearer to Wadi Halfa than had been previously supposed.

THE question of Suess's "sal" and "sima" magmas is dealt with by Dr. Holtedahl in relation to continental margins in a paper on the causes of large earth-movements, which appears in *Naturen*, 1919, p. 266.

MR. F. L. HESS proposes (*Amer. Journ. Sci.*, vol. xlviii., p. 377, November, 1919) a new and useful geological term, "tactite," for the body of rock altered by contact with an igneous mass. The abbreviation rendered possible in descriptions of contact-phenomena by the adoption of so simple a word is at once obvious and welcome to geologists.

MEMOIR 111 of the Geological Survey of Canada, on "The Silurian Geology and Faunas of Ontario Peninsula," is of special interest, since it includes the well-known Niagara group and its development in the Niagara district. Few new species of fossils are described, but the fauna is admirably illustrated by photographs, and two coloured maps are added in a pocket at the end.

ALL known occurrences of platinum in Canada are described and usefully set down upon a general map by Mr. J. J. O'Neill in Part G of the Summary Report of the Geological Survey of Canada for 1918 (issued in 1919). The conclusion is that "Canada certainly has possibilities of becoming one of the world's largest producers of metals of the platinum group." It appears that at present a very large quantity of platinum, here estimated at 50,000 oz. annually, is lost by the absence of proper methods of recovery in placer working.

M. EMILE BELOT (*Revue Scientifique*, 1919, p. 686) begins in the happiest manner a discourse on vulcanicity in general and on an artificial volcanic field of his own manufacture, by reminding his audience of the "big Bertha" that assailed their lecture-hall in the Sorbonne. While the usual height attained by the vigorous projection of volcanic material is 8 km. to 10 km., the dust from Krakatoa rose to 27 km. The experimental volcanoes of the "Bertha" type threw projectiles to a height of 30 km. into a layer where atmospheric pressure is reduced to about 1 mm. of mercury, and the horizontal range thus rendered possible was as much as 120 km. Though the conception was that of a Jules Verne, we must remember that its brilliant realisation was due to the scientific thoroughness of the Germans. M. Belot goes on to show that the lunar crater-rings can be accounted for by normal volcanic projection *dans le vide*, and he then describes and illustrates a model volcano that derives its water from the percolation of an artificial sea.

AT the end of the article upon the Physical and Optical Societies' Exhibition, in the issue of NATURE for January 15, reference was made to the comparative absence of simple forms of apparatus for teaching purposes. The Zenith Manufacturing Co. showed a representative series of its regulating resistances and controllers of very simple form, and the manager of the electrical department writes to say that a special aim is made at instructional needs. We are aware that the company devotes much attention to the details of rheostats for electrical testing, but this affects very slightly the point of the paragraph in question, namely, the desirability of making all apparatus for use in schools and colleges so simple that the principle can be readily understood.

AN important paper by Otto Hahn and Lise Meitner on "The Genesis of Actinium" appeared in the December 1 issue of the *Physikalische Zeitschrift*. In 1908 Boltwood examined a number of uranium minerals, and found that the ratio of their actinium and uranium contents was constant—a result which indicated a genetic connection between actinium and uranium. From these results Rutherford calculated that 8 per cent. of uranium disintegrates along the actinium series. In 1917 Fussler found a value somewhat less than 8 per cent., though only three values were obtained, and these vary as much as 60 per cent. St. Meyer and Hess re-examined the question in 1919, and found a constant relation Ac : U for a set of uranium minerals from various parts of the globe. Hahn and Meitner separate the eka-tantalum [called prot-actinium (Pa) in Germany] from Joachimsthal pitchblende, and compare the total α-ray ionisation from this product with that due to the uranium in the pitchblende. Three methods of separating the eka-tantalum were used, both solutions and residues being examined. The authors find that only 3 per cent. of uranium disintegrates along the actinium series, and the probable error in their results is 10 per cent. This result is in accord with the work of Antonoff and of Hahn and Meitner on UY, which appears to be the mother of eka-tantalum. These workers found that the branch ratio of UY to uranium was about 2 per cent. Hahn and Meitner discuss the available evidence, and conclude that the actinium series originates from UII according to the scheme

$$\mathrm{UII} \underset{\alpha}{\longrightarrow} \mathrm{UY} \underset{\beta}{\longrightarrow} \text{Eka-Ta} \underset{\alpha}{\longrightarrow} \mathrm{Ac},$$

which agrees with that suggested by Soddy in the Trans. Chem. Soc. (vol. cxv., p. 1, 1919). The atomic weight of actinium would thus appear to be 226.

FROM the annual report of the Government Chemist for the year 1918–19 (Cmd. 419) it appears that the total number of samples analysed at the Government Laboratory was 289,180. This represents an increase of more than 20,000 compared with the previous year. Owing to the cessation of hostilities and the subsequent demobilisation of a part of the combatant forces, about 16,000 fewer samples were analysed at the central laboratory; but, on the other hand, the partial revival of trade led to a considerable increase in the number of samples of wine examined, and many more samples also were analysed for the Food Controller and the Air Board. Among other items of interest in the report, two unusual instances of the contamination of foods with metallic poisons may be noted. In one case chocolate sweetmeats were found to contain mercury; this was traced to the metal trays used in the processes of manufacture. In the second instance pastry made from self-raising flour contained antimony, due to the use of tartar emetic as a substitute for cream of tartar instead of the acid phosphate of lime intended to be used as a "tartar substitute."

HORSE-CHESTNUTS have in recent years been utilised for the production of acetone and normal butyl alcohol by a special process of fermentation. The distillate yields a "mixed oil," of which about one-third consists of acetone and the remainder is the butyl alcohol. In the Journal of the Society of Chemical Industry for December 31 Mr. A. Gill gives an account of some experiments carried out at H.M. Factory, King's Lynn, in studying certain aspects of the fermentation. Outstanding features of the operations were (1) frothing and (2) slowness; these were attributed to the presence of æsculin or æsculic acid—a bitter, saponin-like substance which, besides producing froth, is apparently inimical to the development of the special micro-organisms employed. The æsculin can be extracted by treatment of the nuts with water or alcohol. The mature nuts contain about 12·5 to 14·5 per cent. of husk, and immature specimens may have nearly double this proportion. It has been stated that, for successful fermentation, the husk must be completely removed; this was not found to be necessary, though it is an advantage to remove as much as possible, since an excessive quantity retards the fermentation. About 19 per cent. of "mixed oil" was yielded by the nuts.

LLOYD'S shipbuilding returns for the quarter ended December 31 last—commented upon by *Engineering* for January 16—indicate that Great Britain has now regained her foremost position in the world of shipbuilding, having 757 vessels under construction, with an aggregate gross tonnage of 2,994,249. This figure is 27,734 tons in excess of the tonnage now in hand in the United States. In all other countries of the world, including the United States and the British Dominions, but excluding Germany (for which country the figures are not yet available), there are 1381 vessels, making 4,867,114 tons in all; so that British tonnage building now amounts to more than 38 per cent. of the world's total. Our shipbuilding industry is thus in a highly satisfactory condition. More than one-third of the total British tonnage now under construction is building in Clyde shipyards.

An interesting paper on radio direction and position finding was read by Capt. H. J. Round to the Institution of Electrical Engineers on January 14. Capt. Round gave a history of the development of the radio goniometer for war purposes which took place immediately war broke out. The record of the difficulties that were overcome is instructive. It was soon found out that the German Navy directed its Zeppelin fleets by direction-finding from land stations. On several occasions, however, when there were nine or ten Zeppelins in a raid all doing their utmost to communicate with their base stations for bearings the German messages got into a hopeless tangle. Our Naval Intelligence operators believed that one special German operator was so skilful that whenever he took control everything proceeded smoothly. The Germans had two radio phare stations which enabled their Fleet and submarines to determine their positions in the North Sea without the necessity of transmitting signals. In each station there was a rotating frame continually sending messages and giving a special zero signal once every revolution. Any operator noting the time-interval between the zero signal and the instant at which the received signal was a minimum could tell at once the angular position of the ship with respect to the station. Doing this for both stations, the position of the ship was determined. During night-time many anomalous results were obtained when direction-finding, the reasons for which have not yet been satisfactorily explained.

Messrs. A. and C. Black, Ltd., announce "Insect Life," by C. A. Ealand, illustrated, and a new edition of "Studies in Fossil Botany," by Dr. D. H. Scott, part i., Pteridophyta, illustrated. *Messrs. Crosby Lockwood and Son* promise "Oils, Fats, and Waxes: Their Manufacture, Refining, and Analysis, including the Manufacture of Candles, Margarine, and Butter," by Dr. G. Martin; "Applied Chemistry for Technical Students," by Dr. C. K. Tinkler and H. Masters; and "The Principles of Air Navigation," by J. E. Dumbleton. The *S.P.C.K.* is bringing out an edition of Clerk Maxwell's "Matter and Motion," revised and brought up to date by Sir Joseph Larmor; also the following new books: "Archimedes," by Sir Thomas L. Heath (in the Pioneers of Progress: Men of Science Series); "The Nature-Study of Plants in Theory and Practice for the Hobby-Botanist," by T. A. Dymes; and "The Book of the Sea-shore," by W. P. Pycraft (the first of a new series entitled The Nature Lovers' Library).

OUR ASTRONOMICAL COLUMN.

NEW COMET 1920*a*.—A comet of the 10th magnitude has been discovered by Señor Comas Sola at Barcelona. It was photographed by Mr. Wilson at Carleton College Observatory, Northfield, Minnesota, U.S.A., on January 20d. 15h. 51·8m. G.M.T. R.A. 7h. 57m. 40·5s., N. decl. 21° 40′ 54″, referred to the equinox of 1920·0. No information is to hand about its motion. The comet's appearance is almost stellar.

SPECTRUM OF COMET BRORSEN-METCALF.—Pubs. Astr. Soc. Pac. for December contains an account by Prof. Slipher of the spectrum of this comet photographed at Flagstaff on October 17. It resembles that of comet *b* 1914 (Zlatinsky) fairly closely. The third and fourth carbon bands and the first, second, and third cyanogen bands are shown, also six unidentified lines between 4016 and 4074. There is also a faint continuous spectrum.

THE FIREBALL OF JANUARY 16.—A few additional observations of this brilliant object have come to hand, and they prove it to have been of a very exceptional character. At Diss, in Norfolk, the streak it left remained visible for fifteen minutes.

The height of the meteor was from about 52 to 44 miles, and its velocity 15 miles per second. Its course at first lay above Saffron Walden, whence it travelled to above Watford, and then disappeared. Its radiant point appears to have been in the northern region of Cancer, which was not far above the north-east horizon at the time of the meteor's apparition.

This particular part of the sky seems to be the focus of emanation of many fine meteors in January, but they do not appear to favour any particular date. Thus on January 1, 1913, January 21, 1898, and January 29, 1905, bright meteors were traced to the same point, and it has also been conspicuously active in the months of November and March.

OPEN STELLAR CLUSTERS.—Dr. Harlow Shapley has extended his studies of the globular clusters to include the more widely extended clusters chiefly found in the Galaxy (Proc. Nat. Acad. Sci., Washington, August, 1919). He determines the distances of these objects by methods similar to those employed for the globular ones; the distances range from 60 parsecs for the Pleiades to 16,000 parsecs for one cluster and 14,000 parsecs for four others (1 parsec=3¼ light-years). The average of the seventy clusters discussed is 6000 parsecs. Their centroid is distant some 3000 parsecs from the sun towards galactic longitude 270°. Since these clusters would seem to be embedded in the galactic star-clouds, these results would indicate a greater distance for the latter than that which was until lately thought probable.

Dr. Shapley is inclined to abandon his earlier view that the globular clusters cannot exist in the galactic plane, and break up as soon as they enter it. He realises the cogency of the evidence that there is much absorbing matter in this plane, which conceals objects lying beyond it. He still thinks that the open clusters are the remnants of former globular ones, but does not postulate such a sudden transformation from one type to the other as he did at first.

The Astronomer Royal and Mr. Melotte give some details about one of these veiled regions, which lies in the constellation Taurus (Monthly Notices R.A.S., November, 1919). Since the paucity of stars in the region is the same for all magnitudes, it is concluded that the obscuring cloud is comparatively near us. This diminishes the difficulty of the great mass that would be required if the cloud were more remote.

PARIS ACADEMY OF SCIENCES.

PRIZES PROPOSED FOR 1921.

Mathematics.—The Francœur prize (1000 francs), to the author of discoveries or works useful to the progress of pure or applied mathematics.

Mechanics.—The Montyon prize (700 francs), for the invention or improvement of instruments useful to the progress of the mechanical arts; the Poncelet prize (2000 francs), to the author (of any nationality) of the work most useful to the progress of applied mathematics; the Boileau prize (1300 francs), for new researches concerning the motion of fluids (if theoretical, experimental confirmation is required); the Henri de Parville prize (1500 francs), for original work in mechanics; the Pierson-Perrin prize (5000 francs), for a discovery in mechanics.

Astronomy.—The Lalande prize (540 francs), for the most interesting observation or memoir most useful to the progress of astronomy; the Benjamin Valz prize (460 francs), to works conforming to the same conditions as the Lalande prize; the Pierre Guzman prize (100,000 francs), for the discovery of a means of communicating with a celestial body (excluding Mars); the G. de Pontécoulant prize (700 francs), for encouraging research in celestial mechanics.

Geography.—The Gay prize (1500 francs), for a memoir on the most recent improvements introduced into geodesy; the Tchihatchef foundation, for the assistance of explorers in the less known parts of Asia.

Navigation.—The prize of 6000 francs, for progress of any nature tending to increase the efficiency of the French naval forces; the Plumey prize (4000 francs), for improvement in steam-engines or any other invention contributing to the progress of steam navigation.

Physics.—The Gaston Planté prize (3000 francs), for the author of a discovery, invention, or work important in the domain of electricity; the Hébert prize (1000 francs), for a treatise or discovery useful for the popularisation or practical use of electricity; the Henri de Parville prize (1500 francs), for original work in physics; the Hughes prize (2500 francs), for an original discovery in physical science, especially electricity and magnetism or their applications; the Clément Félix prize (2500 francs), for facilitating the continuation of researches concerning the applications of electricity.

Chemistry.—The Montyon prize (Unhealthy Trades) (a prize of 2500 francs and a mention of 1500 francs), for the discovery of a means of rendering some mechanical art less unhealthy; the Jecker prize (10,000 francs), for work in organic chemistry; the Cahours prize (3000 francs), for encouraging young workers already known by their chemical researches; the Berthelot prize (500 francs), for researches in chemical synthesis; the Houzeau prize (700 francs), for a young deserving chemist.

Mineralogy and Geology.—The Cuvier prize (1500 francs), for the most remarkable work in mineralogy and geology; the Delesse prize (1400 francs), for a work on geological or mineralogical science; the Victor Raulin prize (1500 francs), for facilitating the publication of works relating to geology and palæontology; the Joseph Labbé prize (1000 francs), for geological work or researches contributing to the development of the mineral resources of France, its colonies and its protectorates.

Botany.—The Desmazières prize (1600 francs), for the best work on Cryptogams published during the preceding year; the Montagne prize (1500 francs), to the author or authors of important works or discoveries on cellular plants; the Jean Thore prize (200 francs), for the best memoir on European algæ, mosses, lichens, or fungi; the de Coincy prize (900 francs), for a work on Phanerogams; the Jean de Rufz de Lavison prize (500 francs), for work on plant physiology.

Anatomy and Zoology.—The Da Gama Machado prize (1200 francs), for the best memoir on the colour of animals; the Savigny prize (1500 francs), for the assistance of young travelling zoologists, not receiving Government assistance, who make a special study of the invertebrates of Egypt and Syria.

Medicine and Surgery.—The Montyon prize (three prizes of 2500 francs, three honourable mentions of 1500 francs, and citations), for improvements in medicine or surgery; the Barbier prize (2000 francs), for a valuable discovery in surgery, medicine, pharmacy, or in botany in relation to the art of healing; the Bréant prize (100,000 francs), for the discovery of a cure for Asiatic cholera or of a means of eradicating it; the Godard prize (1000 francs), for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs; the Mège prize (10,000 francs), to the author who continues and completes the essay of Dr. Mège on the causes which have retarded or favoured the progress of medicine; the Bellion prize (1400 francs), for discoveries profitable to the health of mankind or for the amelioration of the human species; the Baron Larrey prize (750 francs), to a physician or surgeon (Army or Navy) for the best work dealing with military medicine, surgery, or hygiene; the Argut prize, for a discovery of a means of medically treating a disease hitherto amenable only to surgery.

Physiology.—The Montyon prize (750 francs), for work in experimental physiology; the Lallemand prize (1800 francs), for work on the nervous system; the Philipeaux prize (900 francs), for experimental physiology; the Fanny Emden prize (3000 francs), for the best work treating of hypnotism, suggestion, and in general of physiological actions exerted at a distance from the animal organism.

Statistics.—The Montyon prize (one prize of 1000 francs, two mentions of 500 francs), for statistical researches.

History and Philosophy of Sciences.—The Binoux prize (2000 francs), for work on the history and philosophy of science.

Medals.—The Arago medal, awarded at the discretion of the Academy; the Lavoisier medal, for eminent work in chemistry; the Berthelot medal, with each prize in chemistry awarded annually.

General Prizes.—The prize founded by the State (3000 francs)—subject proposed for 1921: to establish a methodical classification of the vascular palæozoic plants; the Le Conte prize (one prize of 50,000 francs, encouragements), for notable discoveries in mathematics, physics, chemistry, natural history, medical science, or new practical applications of these sciences; the Jean Reynaud prize (10,000 francs), for original work in science; the Baron de Joest prize (2000 francs), for work in physical science; the Parkin prize (3400 francs), for work on the relations between volcanic action and abnormal atmospheric disturbances; the Saintoin prize (3000 francs), for contributions to the mathematical sciences; the Henri de Parville prize (1500 francs); the Lonchampt prize (4000 francs), for the best memoir on diseases of man, animals, or plants from the point of view of the introduction of mineral substances in excess as the cause of these diseases; the Henry Wilde prize (one prize of 4000 francs or two of 2000 francs), for discovery or work in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics; the Gustave Roux prize

(1000 francs), for a young French scientific worker; the Thorlet prize (1600 francs).

Special Foundations.—The Lannelongue foundation (2000 francs), to one or two persons in need of assistance belonging either themselves or through their parents to the scientific world; the Laplace prize, to the first pupil leaving the Ecole Polytechnique; the L. E. Rivot prize (2500 francs), between four pupils leaving each year the Ecole Polytechnique.

Research Foundations.—The Trémont foundation (1000 francs); the Gegner foundation (4000 francs); the Henri Becquerel foundation (3000 francs); the Bonaparte foundation, for assisting researches by workers who have already given proofs of their capacity and lack sufficient resources to undertake or pursue their investigations (minimum grant, 2000 francs); the Loutreuil foundation (125,000 francs); the Charles Bouchard foundation (5000 francs), for the assistance of researches in medicine or physiology.

APPLIED PLANT MORPHOLOGY.

THE importance of a knowledge of the special physiology of a crop plant in attempting to improve the yield or quality of the product needs no demonstration. The case for the study of the morphology of the plant is no less clear, and is reinforced by the fact that the two lines of investigation should go hand in hand. There are numerous familiar instances where successful cropping depends upon the correct understanding of morphological principles, and those botanists wise enough to reflect upon the lore of the intelligent practical man are aware that the knowledge possessed by him of the essential morphology of the plants with which he deals is frequently of no mean order.

There can be little doubt that fuller investigation of the morphology of economic plants (and especially of those of the tropics) would be profitable from both the scientific and commercial points of view. An example of such work is afforded by the fourth of Dr. C. A. Barber's memoirs on Indian sugar canes, in which he deals with the tillering or underground branching of the plants (Memoirs of the Department of Agriculture in India: "Studies in Indian Sugar Canes," vol. x., No. 4, June, 1919). Since in the sugar cane (Saccharum) the crop comprises aerial stems derived from the branching of the underground rhizome, the desirability of a full knowledge of the methods of branching and of the factors regulating the process is evident. By careful organisation Dr. Barber and his assistants have dissected and examined a large series of canes (both adult plants and seedlings), and the results so far obtained are of considerable interest and promise.

The chief classes of canes occurring in India include "thick" canes obtained from tropical sugar-growing countries, and Indian cultivated canes, together with wild Saccharums not used for sugar production. The results of the research show that branching in the various groups, from the wild Saccharums to the thick tropical canes, is of the same nature, but of very different degree. Taking a to represent main shoot, and b its branches, c branches of b, and so on, Dr. Barber arrives at a series of formulæ for the structural composition of the clumps at crop time varying from $a+mb+c$ in the thick canes to $a+mb+nc+nd+me+f$ in the wild Saccharums; while the different groups of Indian canes can be arranged in a series between these two extremes. The difference in form and size between the branches of different orders in the same plant have also been carefully studied. The general tendency is for the later branches to be successively thicker, to have longer joints, and to show greater curvature at the base. The characters of the branches of different orders are found to be so definite that the harvested canes can be easily separated at the mill and classified into early and late canes. This opens up a new line of work, since it becomes possible to examine these different classes of canes separately at the mill and to ascertain their relative sugar content and milling qualities. A further point of practical interest arises in connection with this question. The differences exhibited by canes of varying ages in the same clump are often much more marked in clumps raised from seedlings than in those grown from cuttings. The question as to whether this variation is handed on when the seedling is propagated vegetatively is not yet definitely known, and experiments are being conducted to determine this point, which is of considerable importance in the proper selection of seedlings.

The factors influencing the amount of tillering in a plant are, of course, both inherent and external. Different species and varieties, as well as seedlings from the same parents, differ widely, but such differences are complicated and often masked by others brought about by variations in environment which in the case of the sugar cane appear to be translatable into terms of amount of food available. Dr. Barber points out that light, spacing in the field, moisture, soil constituents, and manuring appear to be the chief controlling factors, and of these he regards the light as "probably the most important limiting factor in the production of the greatest number of canes per acre." The results obtained in the investigation raise the hope that it may be found possible to develop the work along the lines indicated by Dr. Barber.

THE ROYAL SOCIETY OF WESTERN AUSTRALIA.[1]

WESTERN AUSTRALIA has followed the other Australian States in the development of its senior scientific society into a Royal Society, and has issued the first four volumes of the Journal in its new form. Thanks to the enlightened support of the State, which undertakes the printing and publication, the society is able to issue a better journal than would be possible if it were dependent on its still small roll of members. The society has started well owing to the cordial co-operation of the new and democratic local university with the scientific services of the State. The first four presidents have been Profs. Dakin and Ross, Mr. Gibb Maitland (the Government Geologist), and Mr. Montgomery (the Government Mining Engineer).

As the reorganisation of the society marks a new start, the journal appropriately includes some synopses of existing knowledge of Western Australia; thus Mr. Alexander begins an interesting series of papers on the early history of Australian zoology, and he also contributes a list of the Orthoptera; Mr. Hedley has compiled a useful catalogue of Westralian Mollusca; and the third volume is mainly occupied by W. V. Fitzgerald's memoir on the botany of Kimberley, including the description of two new genera and eighty-eight new species. In the presidential addresses Prof. Dakin deals with vitalism, adopting a non-committal conclusion, but being quite unconvinced that there is in life any non-material factor; and Prof. Ross discusses the problems of national scientific organisation and education in the light of

[1] Journal and Proceedings of the Royal Society of Western Australia. Vol. i. Pp. xxx+251+16 pls. (1914–15.) Vol. ii. Pp. xv+112+7 pls. (1915–16.) Vol. iii. Pp. xii+227+2 pls. (1916–17.) Vol. iv. Pp. xii+54+1 pl. (Perth, W.A., 1916–19.) Price 5s. each.

the lessons of the war and offers some illuminating personally collected information.

Mr. Gibb Maitland begins his address with the unexpected claim that geology has nothing to do with war, ignoring the many millions that might have been saved had geologists been employed earlier on our side; the Germans, of course, had a large geological staff at the beginning. Mr. Maitland's address is devoted to the problems connected with the Nullagine formation, and his most generally interesting conclusion is that the scratched stones found in it are not, as has been claimed by some Australian geologists, evidence of an early glaciation, but are due to friction during earth-movements. Mr. Montgomery's address is a new statement of his view that the level surface of the plateau of Western Australia is a plain of marine denudation, and that the escarpments, locally known as "break-aways," are sea-cut cliffs. Mr. Montgomery's arguments are, as usual, interesting, ingenious, and fair. It is important to remember that a geologist who knows the arid regions of Australia so intimately as Mr. Montgomery should have arrived at conclusions as to wind-action so different from those adopted in Africa. The view that in recent times nearly all Western Australia was covered by the sea does not explain the restriction of the marine deposits to a relatively narrow band or the change in the topography above their margin. These deposits have a wide extension in the zone seaward of Norseman; the limestones there he accepts as Miocene.

The paper by Messrs. Jutson and Simpson in vol. ii. on the geology of Albany gives further evidence of these marine deposits, as their "Plantagenet beds" are a narrow coastal series ending inland on the slope of the ancient plateau. The marine origin of the "break-aways" is rejected by Messrs. Talbot and Clarke (vol. iii., p. 79) in their valuable contribution to the geology of the little-known country toward the eastern frontier. These authors claim the discovery of an upper Cretaceous or early Kainozoic glaciation in the Wilkinson Range (lat. 26° S.) on the basis of a bed with striated boulders, which, as they recognise, must have been formed by icebergs in shallow water. The evidence for the age of this boulder bed seems, however, quite inadequate. The chief contribution to anthropology is by Mr. W. D. Campbell on the natives of Sunday Island, who make their boomerangs of tank-iron and obtain their firewood from the mainland, although the author describes the wide intervening channel, owing to its fierce currents, as "dangerous to small craft."

The treasurer of the society, Mr. Allum, of the Royal Mint, Perth, discusses the decimalisation of currency in a paper which conveys a warning how strongly some authorities feel against it. He quotes the view of the *Engineering and Mining Journal* of New York that the compulsory adoption of the metric system would be a "calamity of the first order." Mr. Allum is less emphatic, but he is opposed to the decimal system, as its advantages may not be equalled by its drawbacks, and holds that if it be adopted the sovereign should be the standard of value, and the shilling should be retained and divided into ten pence.

J. W. G.

A NEW DEVELOPMENT IN AGRICULTURAL RESEARCH.

ALL interested in agricultural progress will welcome as one of the most significant events in the history of British agriculture the establishment of a research department by the Olympia Agricultural Co., Ltd.

The company, under the chairmanship of Mr. Joseph Watson, is farming on a scale probably unprecedented in this country, having purchased for its operations agricultural estates totalling practically 20,000 acres in the counties of Yorkshire, Northamptonshire, Cambridgeshire, Suffolk, Warwickshire, and Wiltshire. The research department will exercise advisory functions in connection with the farming operations of the company, but its primary object is to conduct research in various branches of agricultural science and practice for the general welfare of British agriculture, to which end liberal financial provision for its activities has been made.

The direction of the department has been assumed by Dr. Charles Crowther, lately professor of agricultural chemistry in the University of Leeds and director of the institute for research in animal nutrition in that University, who will continue and extend his experimental work in that subject.

Plant-breeding research will be a further prominent feature of the department's activities, under the direction of Capt. Hunter, lately in charge of the plant-breeding work carried out in Ireland under the Department of Agriculture and Technical Instruction; whilst provision has also been made for research on soil problems and plant nutrition under the direction of Capt. C. T. Gimingham, late chemist to the agricultural research institute of the University of Bristol.

The headquarters of the department have been located on the company's estate of some 2700 acres at Offchurch, near Leamington, where the ancient mansion of Offchurch Bury is being adapted to provide the necessary laboratories, etc., which are now approaching completion. From this centre experimental work with crops and stock on all the company's estates will be carried out under the general supervision of Capt. F. H. Billington, late of the staff of the Irish Department of Agriculture.

It is the desire and intention of Mr. Watson and his co-directors that the department shall be an "agricultural research station" in the fullest sense of the term, and that the results of its work, in so far as they may be of general interest, shall be made fully available to the general body of British agriculturists.

For some time the activities of the department must necessarily be directed to the experimental work essential to the establishment of a sound basis for its advisory work, but this is bound to produce much information of general interest.

The enhanced appreciation of the importance of research to British industries is one of the most significant effects of the war, and it is gratifying to find that British agriculture, despite its traditional conservatism and suspicion of academic "theory," is not to lag behind other industries, and a good omen that it should contain in its ranks men so alive to the value of research as to provide for it within the industry without the stimulus of subvention from the public purse.

MATHEMATICAL STATISTICS.[1]

PARTS III. and IV. of the twelfth volume of "Biometrika" contain papers of interest to all classes of statistician. Those especially attracted by work on the general mathematical theory of probability will welcome the continuation of Prof. Tchouproff's paper on the "Expectation of the Moments of Frequency Distributions." It will be agreed that the notation of mathematical expectation offers certain ad-

[1] "Biometrika." A Journal for the Statistical Study of Biological Problems. Vol. xii., Parts iii. and iv. Pp. 185–376+iv+viii plates. (London: Cambridge University Press, November, 1919.) Price 20s.

vantages over the forms of expression more commonly adopted in this country, but Prof. Pearson does well to point out that the supposed fundamental distinction of method claimed by some Continental writers is non-existent. He himself contributes a very interesting paper on a method of generalising Tchebycheff's first theorem. He finds that the method of approximating to the limits of a probability is unlikely to be of much practical value in the classes of function of usual occurrence. This result does not, of course, deprive Tchebycheff's work of its interest in permitting of the establishment of Bernoulli's theorem and of Poisson's generalisation of that theorem by elementary methods.

Papers of importance both to the student of theoretical statistics and to the practical computer are those of Miss Pairman and Prof. Pearson on the correction of the moment coefficients in limited range frequency distributions, of "Student" on deviations from the Poisson limit to the binomial in actual data, and an editorial, entitled "Peccavimus," correcting errors in various published formulæ.

Those who are engaged in psychological investigation will turn to Dr. G. H. Thomson's memoir on psychophysical curves and to the same author's discussion of hierarchical order among correlation coefficients, a subject to which other recent papers have been devoted. In the miscellanea and in a co-operative study of the eggs of the common tern, the biometrician will find much to interest him. It is invidious to cite any one paper as deserving of special praise, but, from the point of view of practical statistics, the discussion of the correction of moment coefficients in the cases to which the classical method of Sheppard does not apply is of chief interest. The volume includes a touching tribute to the memory of Dr. Charles B. Goring, whose untimely death has deprived criminology of one of its most devoted and skilful workers.

THE KINEMATOGRAPH IN SCHOOLS.

THE use of the kinema for schools, and not merely for school children, has been definitely carried a few stages nearer realisation by two recent developments which were brought to the notice of teachers attending the annual meeting of the Geographical Association. In the first place, a portable instrument at the fairly reasonable price of 60*l.* is now on the market. The case itself is fireproof; the lamp is in one separate fireproof chamber within the case, and the film is contained in another, all except the four inches or so actually in the gate; while the instrument is operated by pressing two or three buttons on the outside. The adaptation of the kinema to the class-room in this way has two incidental advantages which are in themselves very great advances. Owing to the fact that the light required is not nearly so strong as for a hall, (1) the instrument can be run off one of the lighting points in the ordinary lighting circuit, and (2) the reduction in light is accompanied by a reduction in heat, so that the film can actually be stopped for some minutes for discussion by the class.

Secondly, the provision of the films seems to be in process of being placed on a more satisfactory basis. Films were used during the war for the instruction of soldiers, and the kinema takes its place in the university, notably in the instruction of medical students. The difficulty in the past has been to know what there was to choose from, and how to choose what one wanted. It is not easy to choose lantern-slides, and it is less easy still to choose films. It cannot be said that this difficulty is wholly met, but the establishment of the Community Motion Picture Bureau goes a long way towards meeting it. There is, at any rate, somewhere to go to inquire whether that exists which one desires, and there is a central body which will gradually learn what it is that schools demand, and with the demand will come the supply. The firm receives films and edits them to make them more or less suitable for schools. One of the sessions of the recent annual meeting of the Geographical Association was taken up by a demonstration by Capt. Hodges of the value of the kinema in the teaching of geography. The films showed varied greatly in quality; the most ambitious, an American film dealing with the life-history of a volcano, was the least successful for several reasons, the most fundamental of which was that it suffered from the distinctly American failing of being non-regional. Other films, dealing with Egypt and the Nile, lumbering, and coffee culture in Java, could very easily be fitted without any jars into geography courses. This is, perhaps, not all that is desired, but it shows, at any rate, that the problem is being tackled, and that there is every prospect of a satisfactory solution ere long.

IRRIGATION IN EGYPT.

WE had occasion in NATURE of September 18 and October 9 last to allude to the controversy which has arisen out of the proposals put forward by the Egyptian Government, under British advice, for the development of the agricultural districts of Egypt and the Sudan by means of additional irrigation works on a very extensive scale. The controversy culminated in the appointment of a Foreign Office Committee, which sat in London to inquire into the charges brought by Sir William Willcocks against the Egyptian Public Works Department. The Committee's findings exonerated the Department, but failed to satisfy Sir William, who forthwith reiterated and amplified his accusations with increased vehemence. Criticism so trenchant and persistent from an engineer of undoubted standing and experience could not be ignored, and now it has been decided to submit the whole question to an International Commission consisting of three members—an irrigation engineer, nominated by the Government of India, as president; a British physicist, nominated by the University of Cambridge; and an irrigation engineer, nominated by the Government of the United States. The terms of reference are:—"To advise the Egyptian Government upon the projects prepared by the Public Works Department, with a view to the further regulation of the Nile for the benefit of Egypt and the Sudan, and in particular to examine and report upon the physical data upon which the projects rest, and to report upon the propriety of the manner in which, as the result of these projects, the increased supply of available water thereby provided will be allocated at each stage of development between Egypt and the Sudan, and to advise as to the apportionment of the cost as between Egypt and the Sudan." In a matter so seriously affecting the welfare and development of two important countries, it is to be hoped that the decisions arrived at by the Commission will be such as to command a general consensus of expert approval.

The Cairo correspondent of the *Times* states, in a message published in the issue of January 23, that the Commission is constituted as follows:—Mr. F. St. John Gebbie, Chief Engineer, Bombay, who was last engaged on the Sukkur barrage scheme—nominated by the Indian Government (chairman); Dr. G. C. Simpson, meteorologist at Simla—nominated by Cambridge University; and Mr. H. T. Cory, who directed the Salton sea works, California, in 1906—nominated by the American Government. Mr. J. L. Capes, of the Egyptian Ministry of Education, will be secretary of the Commission.

VERTEBRATE REMAINS IN THE CAVERNS OF GRIMALDI.

PROF. MARCELLIN BOULE has completed his studies of the remains of vertebrate animals found with primitive man in the caverns of Grimaldi, and the final results of his work have just been published as the concluding part (fasc. iv.) of the first volume of the Prince of Monaco's "Les Grottes de Grimaldi (Baoussé-Roussé)." The new instalment deals with the Carnivora, Insectivora, Cheiroptera, and Rodentia, and various fragments of birds and lower vertebrates, and ends with a valuable general summary. Besides the technical descriptions of the fossils, illustrated by beautiful plates in heliogravure, Prof. Boule continually introduces short discussions of the relationships and distribution of the various animals with which he deals, adding several maps and some genealogical diagrams. He has therefore produced a most interesting and readable treatise on the European Pleistocene vertebrate fauna, which we commend to the notice of both geologists and zoologists. He specially emphasises the importance of the discovery that in the low latitude of the south coast of France there is the same succession of Pleistocene mammalian faunas that has already been observed throughout the rest of Central and Western Europe. In the bottom layers on the floor of the caverns of Grimaldi there are the animals of the warm Chellean episode (*Elephas antiquus, Rhinoceros Mercki*, hippopotamus, etc.); in the next layers is the cold fauna of the Acheulian and Mousterian (glutton, ermine, marmot, reindeer, etc.); in the upper layers are the ordinary mammals of historic times. Among the animals now described Prof. Boule considers he can recognise every gradation between the Pliocene bears and the modern brown bear; he also sees some approach to a Pliocene species in the Pleistocene leopard. He agrees with other observers that the wild cat most nearly approaches that of Africa, now named *Felis ocreata*. Equally interesting is his account of the fossil lynx, which proves to be exactly intermediate between the northern and the Spanish races of the lynx at the present day.

APPARATUS FOR VAPOUR-PRESSURE DETERMINATIONS.

DIRECT measurement of the vapour-pressure of solutions for the estimation of molecular weights has never been much used, Raoult's barometric method being too cumbersome for general use. A simple apparatus for this purpose is, however, described by Mr. Robert Wright in the Journal of the Chemical Society for October. It consists of a flask (150 c.c.) and test-tube (20 cm.×3 cm.) connected by a delivery tube fused into well-fitting glass stoppers. This delivery tube is provided with a stopcock just above the flask; it reaches nearly to the bottom of the test-tube, but does not pass through the stopper of the flask. The stopper to the test-tube is provided with an exit tube carrying a stopcock. To carry out a vapour-pressure determination, a weighed quantity of the solute is placed in the test-tube, flask and tube are half-filled with solvent, and the apparatus connected together and evacuated by means of a filter-pump attached to the exit tube of the test-tube in order to boil all the air out of both solvent and solution. Expulsion of the air is facilitated by gently warming the flask. After exhaustion is complete both stopcocks are closed, and the apparatus left for two or three hours to attain the ordinary temperature. Then the tap above the flask is gently opened, and the extent to which the column of liquid in the delivery tube is depressed below the level of the solution in the test-tube is a measure of the vapour-pressure. The observed depression must be corrected for capillarity. The test-tube is then removed and weighed in order to ascertain the mass of the solution, and if the latter is concentrated its density must be measured. As a solvent water is unsuitable, alcohol and carbon tetrachloride are satisfactory, but benzene cannot be used because of the action of its vapour on the tap-lubricant.

EXPERIMENTS ON TRAIN RESISTANCE.

TO railway engineers Bulletin 110 of the University of Illinois is of special interest, because it contains a report of some experiments on train resistance carried out by the experimental station of the University in co-operation with the Illinois Central Railway. Tests were made to measure the resistance of passenger trains in service up to speeds of seventy miles per hour. The main results are embodied in a set of curves. The peculiarity brought out by the experiments is that the resistance is not a function of the speed alone, but a function of the speed and the car-weight. The inference from the experiments is that, other things being equal, the heavier the car the less the resistance.

The results are likely to differ from those obtained by experiments on English railways, because the track is different, the standard of maintenance is probably different, and also the construction of the cars. Experiments on train resistance on British railways have been made by Sir John Aspinall. In these experiments it was found that the train resistance is a function of the speed and the length of the train. Probably if the Illinois experiments could be re-examined in terms of the length of the train, the Aspinall formula might be found to fit the data obtained, because increase in car-weight generally means increase in length of train; one is the function of the other.

Our American friends realise the national advantage to be gained by co-operation between university and railway. They have an experimental station organised and maintained by a university co-operating with a railway company in an experimental research. Similar relations might be hoped for between university and railway in this country. There is no doubt that both would gain considerably by mutual co-operation.

THE EVOLUTION OF BOTANICAL RESEARCH.[1]

A MEETING of the American Association in St. Louis is of special interest to botanists. When this city was little more than a frontier town, Dr. George Englemann became one of its citizens. In spite of his duties as a successful physician, he became one of our greatest botanists; in fact, in the days when taxonomy was practically the whole of botany, and our virgin flora was being explored, the great American trio of botanists was Asa Gray (of Cambridge, Mass.), John Torrey (of New York), and George Englemann (of St. Louis). Englemann's distinction was that he published no general botanical works, but selected a series of the most difficult problems in taxonomy, and in a masterly way organised for us many perplexing groups. With these groups his name will always be associated. To a botanist, therefore, St. Louis means the home of George Englemann.

There is another association also for the botanist. St. Louis is the home of one of our great botanical

[1] Presidential address delivered at the St. Louis meeting of the American Association for the Advancement of Science, December, 1919, by Prof. John M. Coulter.

gardens, identified for those of us who are older with the name of Henry Shaw; but we are becoming accustomed to its later name, the Missouri Botanical Garden. Its plans and activities represent a fitting continuation of the spirit of Englemann and Shaw adapted to the progress of botanical science.

In consequence of these associations St. Louis may be said to have a botanical atmosphere, of which botanists are very conscious. We have the feeling, therefore, not of a visit, but of a home-coming.

A presidential address delivered to a group composed of investigators representing all the sciences, and including also those interested in science, should deal with some interest common to all. In my judgment, our common bond is interest in research; in fact, the major purpose of this association is to stimulate research by the personal contact of investigators. In selecting as my subject, therefore, the evolution of botanical research, I am assuming that the situation developed may apply in a general way to all scientific research.

My purpose is not to outline the history of botanical research, but rather to direct attention to certain evolutionary tendencies and to project them into the future. We are all familiar with the gradual historical development of different phases of botany, until botanists became segregated into many distinct groups, the only common bond being the use of plants for investigation. This segregation was for a time very complete, so that the interests of one group would not have been affected if none of the other groups had existed. This monastic phase of botany has subsided somewhat, not for all individuals, but for the subject in general. The different groups are coming into contact, and even interlocking, so that the science of botany bids fair to be recognised as an increasing synthesis rather than as an increasing disintegration. In connection with these gradual evolutionary changes, I wish to emphasise three tendencies which seem to me to be significant. As in all evolutionary progress, the tendencies may seem numerous, but the three I have selected seem to me to be especially prophetic of a new era of botanical research.

(1) One of the growing tendencies of botanical research is to attack problems that are fundamental in connection with some important practice. The outstanding illustration, of course, is the increasing attention given to the problems that underlie agriculture; but there are many other practices also which are embedded in botanical investigation. We all realise that this tendency was stimulated by the war; in fact, this has been the experience of all the sciences, more notable, perhaps, in physics and chemistry than in the other sciences, but a very obvious general result. This tendency is so strong at present that I do not believe it will ever subside, but it should be understood. There is no evidence that it is tending to diminish research, the sole purpose of which is to extend the boundaries of knowledge, which all of us must agree is the great objective of research. It merely means that experience developed in connection with an important practice has suggested fundamental problems the solution of which is just as important in extending the boundaries of knowledge as in illuminating some practice. In fact, among our most fundamental problems are those that have been suggested by experience. The injection of such problems among those not related to general experience is not to the detriment of the latter, but simply extends the range of research.

I have no sympathy with the artificial segregation of science into pure and applied science. All science is one. Pure science is often immensely practical, applied science is often very pure science, and between the two there is no dividing line. They are like the end-members of a long and intergrading series—very distinct in their isolated and extreme expression, but completely connected. If distinction must be expressed in terms where no sharp distinction exists, it may be expressed by the terms "fundamental" and "superficial." They are terms of comparison, and admit of every intergrade. The series may move in either direction, but its end-members must always hold the same relative positions. The first stimulus may be our need, and a superficial science meets it, but in so doing it may put us on the trail that leads to the fundamental things of science. On the other hand, the fundamentals may be gripped first, and only later find some superficial expression. The series is often attacked first in some intermediate region, and probably most of the research in pure science may be so placed; that is, it is relatively fundamental, but also relatively superficial. The real progress of science is away from the superficial towards the fundamental, and the more fundamental the results, the more extensive may be their superficial expression.

Not only are practical problems not a detriment to botanical science, they, incidentally, also strengthen its claim on public interest as a science that must be promoted. As an incidental result, I look with confidence to a future of far greater opportunity for research than has been possible heretofore—research which must be increasingly fundamental and varied. Even if this were not true, my creed for science is that while its first great mission is to extend the boundaries of knowledge, that man may live in an ever-widening horizon, its second mission is to apply this knowledge to the service of man, that his life may be fuller of opportunity. From the point of view of science, the second may be regarded as incidental to the first, but it is a very important incident, and really stimulates research. In short, I regard this so-called practical tendency in research as being entirely in the interest of research in general, in increasing the range of fundamental problems, in contributing a powerful stimulus, and in securing general recognition of the importance of research.

(2) A second tendency, which I regard as more important, is an increasing realisation of the fact that botanical problems are synthetic. Until recently a problem would be attacked from a single point of view, with a single technique, and conclusions reached that seemed as rigid as laws from which there is no escape. In plant morphology, for example—and I speak from personal experience—we described structures with no adequate conception of their functions. Plant physiologists, on the other hand, would describe functions with no adequate knowledge of the structures involved; while ecologists often described responses with no adequate knowledge of either structure or function. The same condition obtained in the other segregates of botany. We all recall the time when plant pathologists described and named pathogenic organisms and paid no attention to the disease, which, of course, is the physiological condition of the plant. In short, not only taxonomists, but all of us, were simply cataloguing facts in a kind of card-index, unconsciously waiting for their co-ordination. This co-ordination has now begun, and is one of the strong tendencies which are certain to continue. The morphologist is beginning to think of the significance of the structure he is describing, and the physiologist to examine the structures involved in the functions he is considering; while the ecologist realises now that responses to environment which he has been cataloguing are to be interpreted only in terms of structure and function. In other words, around each bit of investigation, with its single

point of view and single method of attack, there is developing a perspective of other points of view and other methods of attack.

This does not mean a multiple attack on each problem by each investigator. We must remain morphologists, physiologists, and ecologists, each group with its special technique and special kind of data. But it *does* mean a better estimation of the results, a watchful interest in the possibilities of other methods of attack, a general toning-down of positiveness in conclusions. We all realise now that plants are synthetic, and that is quite a notable advance from that distant time when we thought of them only as objects subservient to laws of nomenclature. This increasing synthetic view is resulting in a proper estimate of problems. The data secured by each investigation constitute an invitation to further investigation. We have in mind the whole problem, and not scraps of information. In short, the synthetic view has developed about our problems the atmosphere in which they actually exist.

(3) A third tendency, which seems to me to be the most significant one, is the growing recognition of the fact that structures are not static—that is, inevitable to their last detail. As a morphologist I may recall to your memory the old method of recording the facts in reference to the development of such a structure as the embryo of seed-plants. Not only every cell-division in the ontogeny was recorded, but also the planes of every cell-division. The conception at the back of such records was that the programme of ontogeny was fixed to its minutest detail. It is probably true that such a structure is about as uniform in its development as any structure can be, but it has become evident now that many of the details recorded were not significant. Instead of cataloguing them as of equal value, we must learn to distinguish those that are relatively fixed from those that are variables.

In the same way, much of the older work in anatomy must be regarded as records of details of which the relative values were unknown. Even the structures involved in vascular anatomy are not static, but many a phylogenetic connection has been formulated on the conception of the absolute rigidity of such structures in their minutest detail. This conception has made it possible, of course, to develop as many static opinions as there are variables in structure.

Perhaps the greatest mass of details has been accumulated by the cytologists in connection with their examination of the machinery of nuclear division and nuclear fusion. In no other field has the conception of the rigidity of the structures involved become more fixed, even to the minutest variation in form and position. Of course, we all realise that any field of investigation must be opened up by recording all the facts obtained, but we must realise that this is only the preliminary stage. The time has come when even the recorded facts of cytology are being estimated on the basis of relative values—that is, the inevitable things are being differentiated from the variables.

The same situation is developing in the field of genetics. We all recall the original rigidity of the so-called laws of inheritance. It was natural to begin the cultivation of this field with the conception that the programme of heredity is immutable, and that definite structures are inevitable, no matter what the conditions may be. There was probably more justification for this conception in this field, on the basis of the early investigations, than in any other, but experience has begun to enlarge the perspective wonderfully. The rapidly accumulating facts are becoming so various that consistent explanations require a high degree of mental agility. More fundamental, however, is the recognition of the fact that the problem of heredity involves not only germinal constitution, which gives such rigidity as there is, but also the numerous factors of environment. In other words, such problems have become synthetic in the highest degree, making possible results that are anything but static.

In considering these illustrations of the tendency to recognise that facts are not all pigeon-holed and of equal value, it is becoming more and more obvious that our botanical problems are, in general, the application of physics and chemistry to plants; that *laws*, when we really discover them, are by definition static, but that their operation results in anything but static structures. In other words, structure must respond to law, but the particular law that is gripping the situation may be one of many.

With such evolutionary tendencies in mind, what is the forecast for botanical research? I wish to direct attention to three important features that seem certain to characterise it:

(1) It will be necessary for the investigator who wishes to have a share in the progress of the science, rather than merely to continue the card-catalogue assembling of random data, to have a broader botanical training than has seemed necessary heretofore. Our danger has been that the cultivation of a special technique, which, of course, is necessary, is apt to limit the horizon to the boundary of that technique. In some cases the result to the investigator has been more serious than limiting his horizon; it has led him to discredit other methods of attack as of little importance. In case this attitude is associated with the training of students, it is continued and multiplied by pedigree culture. The product of certain laboratories is recognised as of this type, and it is out of line with the evident direction of progress.

This demand of the future does not mean that one must specialise less than formerly. It is obvious that, with the increasing intricacy of problems and the inevitable development of technique, we must specialise more than ever. What the new demand means is not to specialise less, but to see to it that every speciality has developed about it a botanical perspective. In other words, instead of an investigator digging himself into a pit, he must do his work on a mountain-top. This secures some understanding and appreciation of other special fields under cultivation, some of which will certainly interlock with his own field. To meet this situation will demand more careful attention to the training of investigators than it has received. Interested, and even submerged, in our own work, as we must be, still we must realise that the would-be investigator must develop his atmosphere as well as his technique, or he will remain medieval.

To be more concrete, the morphologist in the coming days must appreciate the relation that physiology and ecology hold to his own field. This is far from meaning that he must be trained in physiological and ecological investigation, but he must know its possibilities. The same statement applies in turn to the physiologist and ecologist, and so on through the whole list of specialities.

This first forecast of the future applies to the necessary training of investigators rather than to investigation itself.

(2) A second important feature that is sure to be included in the botanical investigation of the future is co-operation in research. During the last few years the desirability of co-operation has been somewhat stressed, and perhaps the claims for it have been urged somewhat unduly. This was natural when

we were desiring to secure important practical results as rapidly as possible. It opened up, however, the possibilities of the future. No one questions that individual research, to contrast it with co-operative research, must continue to break the paths of our progress. Men of ideas and of initiative must continue to express themselves in their own way, or the science would come to resemble field cultivation rather than exploration. It is in this way that all our previous progress has been made. The new feature is that individual research will be increasingly supplemented by co-operative research. There are two situations in which co-operative research will play an important *rôle*.

The more important situation is the case of a problem the solution of which obviously requires two or more kinds of special technique. There are many problems, for example, which a morphologist and a physiologist should attack in co-operation, because neither of them alone could solve it. Two detached and unrelated papers would not meet the situation. Our literature is burdened with too many such contributions now. The one technique must be a continual check on the other during the progress of the investigation. This is a very simple illustration of what may be called team-work. It is simply a practical application of our increasing realisation of the fact that problems are often synthetic, and therefore involve a synthetic attack.

Another simple illustration may be suggested. If taxonomists and geneticists should work now and then in co-operation, the result might be either fewer or more species, but, in any event, they would be better species. The experience of botanists can suggest many other useful couplings in the interest of better results. In the old days some of you will recall that we had investigations of soil bacteria unchecked by any work in chemistry, and side by side with this were investigations in soil chemistry unchecked by any work with soil bacteria.

Perhaps the most conspicuous illustration of discordant conclusions through lack of co-operation, so extreme that it may be called lack of co-ordination, may be found in the fascinating and baffling field of phylogeny. To assemble the whole plant kingdom, or at least a part of it, in evolutionary sequence has been the attempt of a considerable number of botanists, and no one of them as yet has taken into consideration even all the known facts. There is the palæobotanist who rightly stresses historical succession, with which, of course, any evolutionary sequence must be consistent, but cannot be sure of his identifications, and still less of the essential structures involved. History is desirable, but some real knowledge of the actors who make history is even more desirable.

Then there is the morphologist, who stresses similarity of structures, especially reproductive structures, and leaves out of sight not only accompanying structures, but also historical succession.

Latest in the field is the anatomist, especially the vascular anatomist, who compares the vascular structures in their minutest detail, and loses sight of other important factors in any evolutionary succession.

Apparently no one as yet has taken all the results from all fields of investigation and given us the result of the combination. In other words, in phylogeny we have had single-track minds. This has been necessary for the accumulation of facts, but unfortunate in reaching conclusions.

This is but a picture of botanical investigations in general as formerly conducted, and it seems obvious that co-operative research will become increasingly common as co-operation is found to be of advantage.

The second situation in which co-operative research will play an important *rôle* is less important than the first, but none the less real. It must be obvious to most of us that our literature is crowded with the records of incompetent investigations. Not all who develop a technique are able to be independent investigators. They belong to the card-catalogue class. They are not even able to select a suitable problem. We are too familiar with the dreary rehearsal of facts that have been told many times, the only new thing, perhaps, being the material used; and even then the result might have been foretold. It is unfortunate to waste technique and energy in this way, and the only way to utilise them is through co-operative research, for which there has been a competent initiative, and in the prosecution of which there has been a suitable assignment of parts. In my judgment, this is the only way in which we can conserve the technique we are developing and make it count for something. I grant that the product of such research is much like the product of a factory, but we may need the product.

In one way or another co-operative research will supplement individual research. Individuals, as a rule, will be the pioneers; but all cannot be pioneers. After exploration there comes cultivation, and much cultivation will be accomplished by co-operation.

(3) The most important feature that will be developed in the botanical investigation of the future is experimental control. Having recognised that structures are not static, that programmes of development are not fixed, and that responses are innumerable, we are no longer satisfied with the statement that all sorts of variations in results occur. We must know just what condition produced a given result. This questioning as to causes of variable results first took the form of deduction. We tried to reason the thing out.

A conspicuous illustration of this situation may be obtained from the history of ecology. Concerned with the relation of plants to their environment, deductions became almost as numerous as investigators. Even when experimental work was begun, the results were still vague because of environment. Finally, it became evident that all the factors of environment must be subjected to rigid experimental control before definite conclusions could be reached.

What is true of ecology is true also of every phase of botanical research. For example, I happened to be concerned with materials that showed an occasional monocotyledonous embryo with two cotyledons, while most of the embryos were normal. The fact, of course, was important, for it connected up monocotyledons and dicotyledons in a very suggestive way, and also opened up the whole question of cotyledony. Important as the fact was, much more important was the cause of the fact. We could only infer that certain conditions might have resulted in a dicotyledonous embryo in a monocotyledon; but it was a very unsubstantial inference. That problem will never be solved until we learn to control the conditions and produce dicotyledonous embryos from monocotyledons at will, or the reverse. Comparison and inference must be replaced by experimental control, just as in the history of organic evolution the method shifted from comparison and inference to experimental control. It will be a slow evolution, and most of our conclusions will continue to be inferences, but these inferences will eventually be the basis of experiment. In fact, most of our conclusions are as yet marking time until a new technique enables us to move forward.

These illustrations from ecology and morphology represent simple situations as compared with the demands of cytology or genetics, but the same need for experimental control is a pressing one in those fields. The behaviour of the complex mechanism of the cell is a matter of sight, followed by inference, when we know that invisible factors enter into the performance. How the cell programme can ever be brought under experimental control remains to be seen, but we must realise that in the meantime we are seeing actors without understanding their action. In fact, we are not sure that we see the actors; the visible things may be simply a result of their action. The important point is to keep in mind the necessary limitations of our knowledge, and not mistake inference for demonstration.

Even more baffling is the problem of adequate experimental control in genetics. We define genetics as breeding under rigid control, the inference being that by our methods we know just what is happening. The control is rigid enough in mating individuals, but the numerous events between the mating and the appearance of the progeny are as yet beyond the reach of control. We start a machine and leave it to its own guidance. The results of this performance, spoken of as under control, are so various that many kinds of hypothetical factors are introduced as tentative explanations. There is no question that this is the best that can be done at present, but it ought to be realised that as yet no real experimental control of the performance has been devised. The initial control, followed by inferences, has developed a wonderful perspective, but a method of continuous control has yet to come.

Having considered the conspicuous evolutionary tendencies of botanical research and their projection into the future, it remains to consider the possible means of stimulating progress. It will not be accomplished by increasing publication. It is probably our unanimous judgment that there is too much publication at the present time. What we need is not an increasing number of papers, but a larger percentage of significant papers. This goes back to the selection of problems, assuming that training is sufficient. A leader is expected to select his own problems, but we are training an increasing army of investigators, and the percentage of leaders is growing noticeably less. There ought to be some method by which botanists shall agree upon the significant problems at any given time in the various fields of activity, so that such advice might be available. It is certainly needed.

I realise that our impulse has been to treat a desirable problem as private property, upon which no trespassing is allowed. Of course, common courtesy allows an investigator to work without competition, but the desirable problems are still more numerous than the investigators, and we must use all our investigative training and energy in doing the most desirable things. There need be no fear of exhausting problems, for every good problem solved is usually the progenitor of a brood of problems. We shall never multiply investigators as fast as our investigations multiply problems. In the interest of science, therefore, we should pool our judgment, and indicate to those who need it the hopeful directions of progress.

Not only is there dissipation of time and energy in the random selection of problems, there is also wastage in investigative ability. Every competent investigator should have the opportunity to investigate. The pressure of duties that too often submerge those trained to investigate is a tremendous brake upon our progress. I am not prepared to suggest a method of meeting this situation, but the scientific fraternity in some way should press the point that one who is able to investigate should have both time and opportunity. A university regulation, with which we are all too familiar, which requires approximately the same hours of all its staff, whether they are investigators or not, should be regarded as medieval.

In conclusion, speaking not merely for botanical research, but for all scientific research, it has now advanced to a stage which promises unusually rapid development. The experience of the recent years has brought science into the foreground as a great national asset. It should be one of the functions of this association to see to it that full advantage is taken of the opportunity offered by the present evolutionary stage of research and public esteem. We must choose between inertia and some display of aggressive energy.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

London.—The faculty of medicine has elected Dr. H. L. Eason to be its representative on the Senate in succession to Sir Cooper Perry, who has resigned on his appointment to the post of Principal Officer of the University; and the faculty of science has elected Prof. L. N. G. Filon to be its representative on the Senate in succession to Prof. G. A. Buckmaster, who has resigned on his appointment to the chair of physiology in the University of Bristol.

Prof. T. Loveday, professor of philosophy at Armstrong College, Newcastle-upon-Tyne, has been appointed principal of Southampton University College in succession to Dr. Alex Hill, resigned.

Mr. A. V. Hill, F.R.S., fellow of King's College, late fellow of Trinity College, and lecturer in physiology in the University of Cambridge, has been appointed to the vacant chair of physiology in the University of Manchester.

Girton College, Cambridge, has received a gift of 10,000*l.*, the capital and interest of which are to be applied during the next twenty years for the encouragement of scientific research by women in mathematical, physical, and natural sciences.

Lt.-Col. P. S. Lelean, professor of hygiene, Royal Army Medical College, will distribute prizes and certificates at the Sir John Cass Technical Institute on Tuesday, February 3, and will give an address on applied science in gas warfare.

On Wednesday, January 21, Mr. E. Wyndham Hulme was presented by the Patent Office Library staff with an illuminated address, bound in morocco, recording their appreciation of his work as librarian during the last twenty years. We understand that Mr. Hulme will continue his editorial supervision of the "Subject Index to Periodicals" published by the Library Association. Mr. Hulme has been succeeded in his office by Mr. Allan Gomme, son of the late Sir Laurence Gomme, and formerly an assistant examiner in the Patent Office.

The statement of the Rhodes Scholarships Trust for the year 1919 shows that the number of scholars actually in residence for either the whole or some part of the academic year 1918–19 was eighty-seven, viz. sixty-six Colonials and twenty-one Americans. Of these, thirty-one came into residence for the first time. There were also in residence nine ex-scholars, of whom five were Colonials and four Americans. In the United States the elections this year have been held under new conditions. In the first place, there has been no qualifying examination. The competition has been open, limited only by the fact that, in any given State, no one institution could be represented in the competition by more than a small number of candidates, proportioned to the total enrolment of students in the institution. In the second place, selection committees have been composed of old Rhodes scholars, acting under a chairman not himself a Rhodes scholar. It is hoped by degrees to extend this principle elsewhere, to the extent at least of securing representation of Rhodes scholars on all electing committees. In the course of the year 1920, scholars will be elected to represent the years 1920 and 1921, the former coming into residence in January, 1921, the latter in October, 1921. Revised circulars giving information in reference to the award of the scholarships in each of the communities to which they are assigned will be issued shortly. Any further information may be obtained on application to the offices of the Trust, Seymour House, Waterloo Place, London, S.W.1. In the United States application may be made to Prof. Frank Aydelotte, Massachusetts Institute of Technology, Cambridge, Mass.

WE trust that there will be a ready and generous response to the appeal issued by University College, London, with the approval of the Senate of the University, for a sum of 100,000*l.* to extend and re-equip the school of engineering, which has played so important a part in engineering education and research. Founded in 1828, this school has ever since enjoyed the inestimable advantage of the guidance of some of the most eminent scientific engineers of their day, and its influence on practice has been very great. The reconstruction and re-equipment of schools of engineering are inevitable at intervals if they are to exert an effective influence, and there has probably never been so vital a need as now to provide the best scientific education possible for the young men who, in due course, will have to direct our engineering commerce and compete for world markets. The appeal has met with an excellent initial response. Lord Cowdray has given 10,000*l.*, and promised a further like sum when 70,000*l.* has been reached. The members of the family of the late Mr. Charles Hawksley have given 3000*l.* towards an extension of the hydraulic laboratory which will be associated with his name, while other substantial amounts bring the sums subscribed and promised to about 30,000*l.* There is no more vital need at the present time than the highest scientific training for young men who have borne the brunt of war for years, and are now willing to devote further years to preparation for professional careers. It is to be hoped that the remaining 70,000*l.* will be quickly subscribed in order that the plans now made can be carried out.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, January 7.—Mr. G. W. Lamplugh, president, in the chair.—F. J. **North**: Syringothyris, Winchell, and certain Carboniferous Brachiopoda referred to Spiriferina, D'Orbigny. This paper is the outcome of a suggestion made in 1913 by Prof. T. F. Sibly, who pointed out the desirability of an attempt to remove the uncertainty which had hitherto existed in the naming of the British species of Syringothyris, and of the Carboniferous Spiriferids possessing a lamellose surface ornament, which it was customary to refer to Spiriferina because there was no other genus for their reception, although it had long been recognised that few, if any, of them really belonged to that genus. After indicating the exact sense in which certain frequently occurring terms are used, and reviewing the history of previous research, the author discusses the history in Avonian times of the genus Syringothyris, and suggests a classification of its species. Variations due to time, to environmental conditions, and to distribution in space are recognised, and distinctive names are given to the mutations characteristic of certain horizons.—S. S. **Buckman**: Jurassic chronology: i., Lias. Supplement 1, West England strata. It is found that the preserved strata of the Gloucestershire–Worcestershire Lias under consideration happen in the main to be deposits of dates when the living Ammonites were rather small; while there is faunal failure, and presumably stratal failure, of the times when large Ammonites flourished. The converse phenomena are mainly illustrated by North Somerset deposits. The times when large and small Ammonites lived appear to follow one another like waves, illustrated even in a short table of Liassic deposits.

Aristotelian Society, January 19.—Prof. Wildon Carr, vice-president, in the chair.—Prof. J. A. **Smith**: The philosophy of Giovanni Gentile. The paper began with a general characterisation of the remarkable re-birth of idealistic philosophy in southern Italy. That philosophy, as exemplified in the systems of Croce and Gentile, builds upon the foundation of history, which it conceives of as the content of experience self-created by the mind that seeks the theory of it. The special problem now before philosophy is the understanding of history, and, *imprimis*, of its own history. An endeavour was made to trace the stages in the formation of Gentile's thought—its gradual enlargement from a theory of education into a universal metaphysics. This development culminates in the assertion of the identity of mind's essence with its existence; it *is* the process of its own gradual self-creation. The doctrine that mind is *atto puro* is taken and employed by Gentile as the guiding principle of a new form of absolute idealism. As compared with Croce, Gentile insists more upon the unity of mind or spirit, while recognising certain absolute forms of it as issuing from it and constituting its concrete being or filling. Philosophy is the supreme form of self-consciousness, and so finds in itself the clue to all that mind is or has created—itself and its world. This principle, once accepted, applies itself and advances by an immanent dialectic. No reality outside mind and its activity is needed to account for experience. The paper concluded with an attempt to render the central idea of Gentile's philosophy more familiar, and to meet a few objections to its apprehension and acceptance.

SYDNEY.

Royal Society of New South Wales, December 3, 1919.—Prof. C. E. Fawsitt, president, in the chair.—Prof. C. E. **Fawsitt**: Presidential address: The uniformities of Nature. The principle of continuity was considered in relation to the phenomena of the natural world, and prominence given to the contributions of Mr. A. J. Balfour to this subject. The problem of the creation of the atoms of all, or at any rate of some (primary), elements is still unsolved, and Clerk Maxwell's original description of the atoms as having the nature of "*manufactured articles*" may still be applied. The discontinuity between inanimate matter and living matter remains unbridged, in spite of the hopes and efforts of many to bridge the existing gap. The irregularities noticed from time to time in the periodic classification of the chemical elements have to a very large extent disappeared as a result of the research of recent years, but the difficulty of placing the elements of the rare earth group satisfactorily remains as a blot on what is otherwise still one of the most fascinating regularities known to chemists. The president then gave the periodic arrangement in a form he considered most suitable at the present time.—J. H. **Maiden**: Notes on Acacias. No. iv. With descriptions of new species. The author describes seventeen new species of Acacia or wattle, together with three new varieties. The present are chiefly natives of New South Wales and Queensland, and also of Western Australia; some promise to be of economic importance. This revision of the species will, it is hoped, enable the author later on to offer a modified classification of the whole of the Australian wattles.—C. A. **Sussmilch** and Prof. T. W. Edgeworth **David**: Sequence and correlation of the Permo-Carboniferous and Carboniferous rocks of New South Wales. Part i. The Carboniferous formation of the Hunter River Valley. The Carboniferous strata of the Hunter River Valley, N.S.W., are divisible into a lower and an upper series, the former deposited under marine, the latter under terrestrial, conditions. The Lower Carboniferous strata consist of marine mudstones, limestones, conglomerates, and tuffs, and contain an abundant and typical marine fauna; they also contain some fossil plants (drift vegetation), of which the genus Lepidodendron is the most characteristic. No angular unconformity exists between the Lower and Upper Carboniferous formations, the passage from one to the other being marked by an extraordinary development of conglomerates from 1000 ft. to 2000 ft. thick; above these conglomerates there occurs a very thick series of volcanic rock (lava-flows and tuffs), with which are inter-stratified conglomerates and shales, the latter containing fossil plants (the Rhacoptens flora).—W. A. W. **de Beuzeville**: Determination of the increment of trees by stem analysis: *Eucalyptus viminalis*. The calculations show that the tree increases in height rapidly until about thirty years old, averaging 2·8 ft. per annum. This rate gradually diminishes, dropping to 1·6 ft. mean annual increase when sixty-six years old. The diameter increase likewise is greater during youth, but is fairly evenly maintained during the whole period, ranging from 0·37 in. to 0·3 in. per annum. The mean annual volume increment, which was 0·1 cub. ft. at ten years, shows a steady improvement, reaching 1·13 cub. ft. at sixty-six years of age.

Linnean Society of New South Wales, November 26, 1919.—Mr. J. J. Fletcher, president, in the chair.—G. I. **Playfair**: Peridineæ of New South Wales. Of a total of sixteen species and twenty-three varieties described or recorded, three species and eighteen varieties are described as new. The material dealt with is mainly from the Sydney and Lismore districts, and, in addition, a few examples are from the Brisbane district.—C. T. **White**: A revised account of the Queensland Lecythidaceæ. A revision of the material belonging to the genera Barringtonia and Careya in the Queensland Herbarium. The following species are retained: *Barringtonia speciosa*, Forst., *B. calyptrata*, R.Br., *B. longiracemosa*, n.sp., *B.* sp. (possibly *longiracemosa*), and *Careya australis*, whilst two species, *B. racemosa* and *B. acutangula*, are excluded.—M. **Aurousseau**: An interesting form of sub-surface drainage. The lines of sub-surface drainage described consist either of series of small holes up to a foot in diameter and 3 ft. in depth, spaced irregularly along definite lines, or partly of series of holes and partly of lengths of trench-like depressions terminating in a tunnel at either end. The formation of these is believed to be due, not to any peculiarity of the soil, but to the climate of the region which is characterised by marked seasonal rainfall. The possibility is suggested that this sub-surface drainage may be a factor in the intake of the coastal artesian basin of Western Australia.—J. **Mitchell**: Some additional Trilobites from N.S.W. Four new species are described, one (*Trinucleus Clarkei*) from rocks of Ordovician age, the other three (*Ceratocephala phalaenocephala, Odontopleura Hartleii*, and *Cyphaspis Filmeri*) from Upper Silurian rocks.—Dr. R. J. **Tillyard**: Mesozoic insects of Queensland. No. 7. *Hemiptera homoptera*, with a note on the phylogeny of the order. Twenty-three specimens of homopterous tegmina from the Upper Trias of Ipswich are dealt with in this paper; one of these, *Mesojassus ipsviciensis*, Till., had been previously described. The results show that the Ipswich fauna contains as its dominant element the Upper Permian family Scytinopteridæ, of which seven species, placed in six new genera, are described.—E. W. **Ferguson** and Marguerite **Henry**: Tabanidæ from Camden Haven District, N.S.W. With descriptions of new species. The species described were collected during the course of investigations as to the means of transmission of *Onchocerca Gibsoni* in cattle, special attention being paid to the Tabanidæ as possible vectors of the larvæ. Of the forty-one species described or recorded, ten are proposed as new. The seasonal distribution of the species is indicated by a table.

BOOKS RECEIVED.

Service Chemistry. By Profs. V. B. Lewes and J. S. S. Brame. Fifth edition. Pp. xvi+576+vii plates. (London: E. Arnold.) 21*s*. net.

The *Times* Survey Atlas of the World. Part i. (London: Office of the *Times*.) 2*s*. 6*d*. net.

The Century of Hope. By F. S. Marvin. Second edition. Pp. vii+358. (Oxford: At the Clarendon Press.) 6*s*. net.

Chemistry in Everyday Life: Opportunities in Chemistry. By E. Hendrick. Pp. xii+102. (London: University of London Press, Ltd.) 3*s*. 6*d*. net.

The Theory of the Imaginary in Geometry, Together with the Trigonometry of the Imaginary. By Prof. J. L. S. Hatton. Pp. vii+216. (Cambridge: At the University Press.) 18*s*. net.

The Mason-Wasps. By J. H. Fabre. Translated by A. T. de Mattos. Pp. vi+318. (London: Hodder and Stoughton.) 7*s*. 6*d*. net.

The Dyeing Industry: Being a third edition of "Dyeing in Germany and America." By S. H. Higgins. Pp. viii+189. (London: Longmans and Co.) 8*s*. 6*d*. net.

An Algebra for Engineering Students. By G. S. Eastwood and J. R. Fielden. (With Answers.) Pp. vii+199+xv. (London: E. Arnold.) 7*s*. 6*d*. net.

Memories of the Months. By Sir Herbert Maxwell. Sixth series. Pp. xi+314. (London: E. Arnold.) 7*s*. 6*d*. net.

Etudes de Photochimie. By Dr. V. Henri. Pp. vii+218. (Paris: Gauthier-Villars et Cie.)

Acids, Alkalis, and Salts. By G. H. J. Adlam. Pp. ix+112. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

The Ancient Entrenchments and Camps of Gloucestershire. By E. J. Burrow. Pp. 176. (Cheltenham and London: E. J. Burrow and Co., Ltd.) 21*s*. net.

Food Poisoning and Food Infections. By Dr. W. G. Savage. Pp. ix+247. (Cambridge: At the University Press.) 15*s*. net.

The Design and Stability of Stream-line Kite Balloons, with Useful Tables, Aeronautical and Mechanical Formulæ. By Capt. P. H. Sumner. Pp. viii+146. (London: Crosby Lockwood and Son.) 10*s*. 6*d*. net.

The Elements of Descriptive Astronomy. By E. O. Tancock. Second edition. Pp. 158. (Oxford: At the Clarendon Press.) 3*s*. net.

Problèmes Economiques d'Après-Guerre. By L. de Launay. Pp. 319. (Paris: A. Colin.) 3.50 francs.

The Manufacture of Intermediate Products for Dyes. By Dr. J. C. Cain. Second edition. Pp. xi+273. (London: Macmillan and Co., Ltd.) 10s. net.

Diesel Engine Design. By H. F. P. Purday. Pp. xvi+301. (London: Constable and Co., Ltd.) 21s.

The Use of Colloids in Health and Disease. By A. B. Searle. Pp. vii+120. (London: Constable and Co., Ltd.) 8s. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England.
ROYAL SOCIETY, at 4.30.—Prof. W. Bateson: The Genetics of "Rogues" among Culinary Peas (*Pisum sativum*).—L. T. Hogben: Studies on Synapsis. I. Oogenesis in the Hymenoptera.—H. Onslow: A Periodic Structure in many Insect Scales, and the Cause of their Iridescent Colours.
ROYAL COLLEGE OF PHYSICIANS, at 5.
ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. O. May: Tuberculosis in relation to Life Assurance.
ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. N. Wood and Others: Discussion on the Merits and Defects of the British Health Resorts.
WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—R. C. Clinker: A Portable Valve Set and some properties of C.W. Circuits.
SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JANUARY 30.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery; His Contributions to our Knowlege of the Eye, Ear, and Nose (Hunterian Lecture).
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—R. B. Dunwoody: The Economic Requirements for Inland Navigation Transport in the British Isles (Vernon-Harcourt Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds Technical College, Leonard Street), at 7.—Major K. Edgcumbe and Others: Discussion on Quantity Production as a Panacea.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. E. Lygo: The Manufacture of Hydrogen Gas by the Silicol Process for Airships and Commercial Purposes.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—S. G. Brown: The Gyrostatic Compass.

SATURDAY, JANUARY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation: I. Movement of the Perihelion of Mercury.
PHYSIOLOGICAL SOCIETY (at King's College), at 4.

MONDAY, FEBRUARY 2.

VICTORIA INSTITUTE (in Committee Room B, Central Hall, Westminster), at 4.30.—Sir Andrew Wingate: India.
ROYAL COLLEGE OF SURGEONS, at 5.
INSTITUTE OF ACTUARIES, at 5.—A. Henry: Some Further Suggestions on the Subject of Approximate Valuations.—H. L. Trachtenberg: A New Method of Valuing Policies in Groups.
ARISTOTELIAN SOCIETY (at 74 Grosvenor Street), at 8.—Mrs. N. A. Duddington and Others: Discussion on Lossky's Intuitive Basis of Knowledge.
ROYAL SOCIETY OF ARTS, at 8.—Capt. H. Hamshaw Thomas: Aircraft Photography in War and Peace (Cantor Lecture).
SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society), at 8.—H. M. Wells and J. E. Southcombe: The Theory and Practice of Lubrication: The Germ Process.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—J. W. Simpson: Presidential Address to Students.
ROYAL GEOGRAPHICAL SOCIETY (at the Central Hall, Westminister), at 8.30.—Major-Gen. Sir Frederick Sykes: Air Routes of the Empire.
MEDICAL SOCIETY OF LONDON, at 9.—Dr. H. R. Spencer: Tumours complicating Pregnancy, Labour, and the Puerperium (Lettsomian Lecture).

TUESDAY, FEBRUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. G. Elliot Smith: The Evolution of Man and the Early History of Civilisation. II. Elephants and Ethnologists.
ROYAL SOCIETY OF ARTS (Colonial Section), at 4.30.—Sir Francis Watts: Tropical Departments of Agriculture, with special reference to the West Indies.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—L. A. Jones: A Non-intermittent Sensitometer.
RÖNTGEN SOCIETY (at the Medical Society of London), at 8.15.

WEDNESDAY, FEBRUARY 4.

ROYAL SOCIETY OF ARTS, at 4.30.—A. E. Hayes: The English Language and International Trade.
ROYAL COLLEGE OF SURGEONS, at 5.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. A. Douglas: Geological Sections through the Andes of Peru and Bolivia: II. From the Port of Mollendo to the Inambari River.
ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts), at 8.—Squadron-Leader J. E. M. Pritchard: Rigid Airships and their Development.
INSTITUTION OF AUTOMOBILE ENGINEERS (at the Institution of Mechanical Engineers), at 8.—A. P. Young and H. Warren: The Progress of Ignition.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society), at 8.—(Annual General Meeting), Dr. S. Rideal: Presidential Address.—F. S. Sinnatt and L. Slater: An Investigation into the Composition of the Unsaturated Hydrocarbons present in Coal Gas.—H. Trickett: The Estimation of the Available Oxygen in Sodium Perborate and in Perborate Soap Powders.

THURSDAY, FEBRUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. E. Conrady: Recent Progress in Applied Optics.
ROYAL SOCIETY, at 4.30.—J. H. Jeans and Others: Discussion on the Theory of Relativity.
LINNEAN SOCIETY, at 5.—Dr. R. Ruggles Gates: The Existence of Two Fundamentally Different Types of Characters in Organisms.
CHEMICAL SOCIETY, at 8.

FRIDAY, FEBRUARY 6.

ROYAL COLLEGE OF SURGEONS, at 5.
CONCRETE INSTITUTE (at Denison House, 296 Vauxhall Bridge Road), at 6.—H. J. G. Bamber: The Practical Testing of Cement.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—F. R. Housden: Electric Lifts and Cranes.
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. F. S. Rood: Discussion on Anæsthesia in Throat and Nose Operations.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Sir Walter Raleigh: Landor and the Classic Manner.

SATURDAY, FEBRUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation. II. Displacement of Solar Spectral Lines.

CONTENTS.

	PAGE
The Works of Torricelli. By J. L. E. D.	557
Problems of the Fruit-grower	558
Metaphysical Research	559
Medical and Social War-work in Egypt	560
Scientific Biography. By N. R. C.	561
Our Bookshelf	562
Letters to the Editor:—	
The Deflection of Light during a Solar Eclipse.—Prof. Alexr. Anderson	563
"The White Water."—Capt. A. R. Palmer; Prof. J. Stanley Gardiner, F.R.S.	563
Proposals for a Plumage Bill.—L. Gardiner; Willoughby Dewar	564
The Separation of Isotopes.—Dr. Alexander Fleck	565
A Helium Series in the Extreme Ultra-Violet.—Prof. Theodore Lyman	565
Mirage Effects.—Cicely M. Botley	565
British Irono-res.—D. A. E. Evans; Prof. Henry Louis	565
Displacement of Spectral Lines.—Robert W. Lawson	565
Orthogenetic Evolution in Pigeons. (*Illustrated.*) By R. R. G.	566
The Nitrogen Problem. II.	568
Exploration in Tibet and Neighbouring Regions. By T. H. H.	570
Notes	571
Our Astronomical Column:—	
New Comet 1920*a*	576
Spectrum of Comet Brorsen-Metcalf	576
The Fireball of January 16	576
Open Stellar Clusters	576
Paris Academy of Sciences: Prizes Proposed for 1921	577
Applied Plant Morphology	578
The Royal Society of Western Australia. By J. W. G.	578
A New Development in Agricultural Research	579
Mathematical Statistics	579
The Kinematograph in Schools	580
Irrigation in Egypt	580
Vertebrate Remains in the Caverns of Grimaldi	581
Apparatus for Vapour-pressure Determinations	581
Experiments on Train Resistance	581
The Evolution of Botanical Research. By Prof. John M. Coulter	581
University and Educational Intelligence	585
Societies and Academies	586
Books Received	587
Diary of Societies	588

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THURSDAY, FEBRUARY 5, 1920.

THE NEED FOR AIRCRAFT RESEARCH.

UNDER the stimulus of war the development of aircraft was marvellously rapid, so much so that it not infrequently happened that by the time a squadron of aeroplanes of new and improved design was ready to take the air it was regarded as little else than an obsolete type by its own designers. But with a rate of wastage so high as war conditions made inevitable, one had to get accustomed to such an advance every six months as only the new mental attitude to mechanical developments that the war forced upon us could grasp without surprise. All this is now past. The factories are largely turned to fresh uses, and their skilful staffs scattered to new fields of labour. Even the scientific force of the Government has for the most part returned to the Universities from which it came—notably Cambridge and Oxford.

What is now to happen? Before this question can be answered it must be premised that consequent on the purpose of all this tremendous effort—the defeat of the enemy—having been finally achieved, the diversion of the means to other purposes is no more to be wondered at than regretted; furthermore, we may hope that the need for the re-creation of any such force is remote enough to enable us "to sleep o' nights." The validity of this hope must, however, depend on the sway of politics, and on the political methods followed by the Great Powers—whether a chauvinistic policy be adopted or earnestly avoided.

The enemy to-day is the geographical position with which this country is endowed: as unfavourable for air developments as it is favourable for maritime power. England is not on any air route to anywhere, and its climate deserves, from the air navigator's point of view, all that has been said against it. The sheer march of natural events will not make us an air Power as it has made us a naval Power. Any such result will need to be the consequence of intensely directed effort. But if such an effort can be presumed, then great consequences will ensue, for an air force which can be taught to encounter British climatic conditions and rise superior to them—with the implied possession of the best scientific means of assistance on the ground and in the aircraft—will have been trained in as hard a school as any in the world, and therefore be ready to gain an ascendancy in the easier conditions to be found almost everywhere else.

The experience of the last five years has shown that we have exactly the right kind of *personnel* for air endurance and skill; the work is temperamentally suited to the British type of youth. The aircraft themselves are the best to be found anywhere, and although this does not imply finality it is probable that future important developments will lie in some change of principle, whether thermodynamic (by modification of cycle or change of fuel) or aerodynamic, rather than in greatly improved efficiency in detail. We may, in fact, have to repeat in another fashion our war experience and once more face fundamental problems; we shall not be pressed for time, which will be a great gain, but we shall need all the assistance which can be got from minds trained in the fundamentals of science and as ready as heretofore to face entirely novel conditions. The Universities, at which many of such minds are now again engaged, must help. This, however, is not the most pressing problem; the urgent need is for the provision of means with the utmost rapidity to enable flying in this country, whatever its climate, to be as regular and safe for the traveller as it will surely become in the very near future in other countries.

When the weather is reasonable it is the custom to select that altitude of flight which enables best advantage to be taken of a favourable wind, and perhaps, when flying over Central Africa, that height which adds a pleasant temperature. Under normal winter conditions in this country quite other considerations apply. If the conditions are such as to create, or even to suggest the creation of, local fogs, pilots will choose their altitude from quite another motive; their aim will be to select that altitude which keeps them always within sight of the ground, so that if a fog, or heavy mist, is encountered at ground level, a landing can at once be made. Very often the fog or cloud is not of great thickness, and it would be easy to climb right through it and so to fly in sunshine under a blue sky. By astronomical means the position of the craft could be checked from time to time, and there need be no fear of being blown out to sea when prepared only for a limited number of hours' flight. What makes such flying impossible is not the uncertainty of position, but the doubt whether, when the pilot wishes to land, he will find the lower cloud- or fog-level actually resting on the ground. It is unpleasant enough to walk even a hundred steps along an empty road with one's eyes shut—how much less attractive when one's speed is 100 miles an hour and the feeling of having one's feet on the ground is absent! Unless this difficulty can be removed, the kind of flying which the future demands and other countries can give can never be learnt or practised in this country.

The first need is for some means of flying steadily through thick cloud, either for the purpose of climbing above it, or to approach through it nearer to the destined aerodrome. This problem has lately been solved by the invention of a "turn indicator" which enables the pilot, whether he can see the ground or not, to know when the machine is being flown straight, and it has the valuable effect of allowing the readings of the compass to be relied on; so the gain is double. But in addition to this it is necessary to provide close co-operation with the ground whenever it is wholly or partially fog-enshrouded. The pilot must be told whether his intended aerodrome is fog-free, and, if not, what other aerodromes near his route are sufficiently clear of fog to be safe havens; this will presumably be by means of some increased efficiency in the wireless telephone. Next to this in importance is some means of indicating or conveying to the pilot his height above the ground that happens to be immediately below his machine. These and other such aids are the kind of requirements needed to make all-the-year-round flying possible in this country. It is only a part of the wide field for research, but it is of vital consequence, and it certainly needs (as it is, of course, receiving) Government support, since the immediate financial reward of success must be slight. Moreover, the work is one of public utility, and should be so treated.

Force is lent to what is here urged by the consideration that the air fleet to be maintained by the Government in the near future is so small that it is only by calling in the aid of private craft that the possible needs of an emergency can be met. For this economical procedure to prove a success it is necessary that civil aircraft should exist in sufficient numbers. To facilitate this calls for the encouragement of all who have ability to assist in making flying safe, in making it popular, in making it efficient.

PHYSIOLOGY OF MUSCULAR EXERCISE.

The Physiology of Muscular Exercise. By Prof. F. A. Bainbridge. (Monographs on Physiology.) Pp. ix+215. (London: Longmans, Green, and Co., 1919.) Price 10*s.* 6*d.* net.

IT may reasonably be doubted whether any two physiologists would deal with the subject of muscular exercise along similar lines, nor is it desirable that this should be so, the subject being so complex and presenting so many different points of view. A comparison of the present volume with the writings of thirty years ago on the same subject is an instructive demonstration of the fact that physiology, as regards certain of its branches at least, has in the course of a generation reached a stage at which experimental results begin to show an integrative connection with problems of a broad and complex nature.

It is with the wonderful co-ordination of functions which is displayed in muscular exercise that the book chiefly deals. The energy usage of the body in exercise may be from eight to twelve times that during rest, and of this about one-third may, in the most favourable circumstances, appear as work; this energy is ultimately supplied by oxidation, chiefly of carbohydrates, and the central point of the problems of the physiology of muscular exercise is that the muscles suddenly demand from the blood a supply of oxygen which is from ten to twelve times what they receive when at rest. "If the body is to work efficiently and to develop its physical powers to their full extent, it is absolutely essential that the movements of the muscles on the one hand, and the activities of the circulatory and respiratory systems on the other hand, should be co-ordinated and integrated into a harmonious whole" (pp. 3–4).

The complex co-ordination of circulation and respiration is to a great extent effected by the central nervous system, though the heart and blood-vessels are to some extent autonomous. Chaps. ii. to vii. deal with an analysis of the changes by which the blood and the organs of circulation and respiration are adapted to their several needs. The heart is itself a muscular machine working with a gross efficiency of 20–30 per cent., and the adaptation of this organ is very fully discussed. This is important, since, in ordinary circumstances, it is the working power of the heart which is the limiting factor to the amount of exertion which is possible in any individual; though training may improve the heart, "no man can be an athlete who does not possess a powerful (*i.e.* a muscular) heart." At high altitudes, on the other hand, the limiting factor seems to be the rate at which oxygen can diffuse through the pulmonary epithelium into the blood.

In the eighth chapter the manner of the exact balancing of the various partially autonomous systems by means of the central nervous system is discussed, and it is shown that, as in so many other instances in the body, the promptness in response to altered conditions is owing to the control of the central nervous system, while the coarser adjustment is effected by the influence of various chemical or mechanical factors. The importance of the presidence of the nervous system is well seen in the reduced efficiency of the body during fatigue, and in the enhanced efficiency in circumstances where interest or emotion is aroused; in chap. xi. there is included a brief discussion of the subject of industrial fatigue, on which so much useful work has been done during and since the war, and one of the conclusions, that "the establishment of a uniform length of working day for all classes of manual workers would lead in many cases to inefficiency" (p. 183), is worthy of careful note.

The subject of training is discussed in chap. ix., and in chap. xii. it is shown that the differences between the circulation in the trained and untrained man can be extended to explain the condition of *effort syndrome*, or soldier's heart, in which the heart becomes inadequate to its work abnormally soon, owing to an impaired state of its nutrition.

Considered as a whole, the work is extremely good; it is well written, the viewpoint is broad, and the management of the arguments clear and convincing; indeed, a possible fault is that the inexpert reader may be misled as regards the complexity of the problems dealt with in such a clear and simple manner, or fail to appreciate what a vast deal of work lies behind some of the seemingly plain and obvious conclusions. Should this prove to be the case, it is but an indication of the excellent way in which the author has treated his subject. The references are to modern work chiefly, and in every respect the book is thoroughly up-to-date. Prof. Bainbridge is to be congratulated most heartily on having added to these valuable monographs such a cleverly written exposition of a difficult subject.

THEORIES OF SOUND PERCEPTION.

Some Questions of Phonetic Theory. Chap. v. *The Perception of Sound.* By Wilfrid Perrett. Pp. 39. (Cambridge: W. Heffer and Sons, Ltd., 1919.) Price 2*s.* net.

THIS work may be regarded as a continuation of the interminable discussion regarding the functions of the cochlea, or more particularly the part of the internal ear concerned in hearing. Theories of sound perception may be divided into two classes: first, those which assume that somehow analysis takes place in the cochlea; and secondly, those that relegate the analysis to the brain. The first theory also assumes that the principle of sympathetic resonance is the foundation of the method by which the organ of Corti in the cochlea works, while the second theory, as it involves ganglion-cells and part of the brain, has no experimental basis on which to rest, and leaves the function practically insoluble. The resonance theory owes its clear inception to Thomas Young and its development to Helmholtz. While it explains many experimental facts, and has been supported by many physicists and physiologists, it has now and again been assailed by critics who have advanced some form of the second theory, and founded their objection to the older theory mainly on facts which apparently cannot be accounted for by the Young-Helmholtz theory.

Mr. Perrett supports the second theory, and denies the existence of any resonating mechanism in the cochlea. In a short notice it is impossible to meet all his points, but it seems he does not meet the difficulties of the case. No explanation is offered of the extremely complicated organ of Corti, unless it serves some such purpose as is implied in the older theory; there are obvious difficulties relating to the fibres of the cochlear nerve; and the explanation is hopeless when we reach the ganglionic mechanism of the brain. On the other hand, the resonance theory, on the whole, meets the facts, and, if not free from objections, as Helmholtz and his supporters admit, it serves the purpose of a good theory by stimulating research, while it satisfies the mind. The same may be said of the retina and the action of light, and, indeed, of all the end-organs of special sense. Mr. Perrett, while he has evidently studied the subject, historically and otherwise, seems unduly biased against a fair presentment of the older theory, and we recommend caution and a wider view. J. G. M.

KASHMIR AND INDIAN SILKS.

The Silk Industry and Trade: A Study in the Economic Organisation of the Export Trade of Kashmir and Indian Silks, with Special Reference to their Utilisation in the British and French Markets. By Ratan C. Rawlley. Pp. xvi+172. (London: P. S. King and Son, Ltd., 1919.) Price 10*s.* 6*d.* net.

THIS volume forms a natural complement to the official report on Indian silk by Prof. Maxwell Lefroy and Mr. E. C. Ansorge recently published by the Government of India. In the official report the Indian silk trade is dealt with primarily from the Indian trade point of view; in the volume now under notice Indian silk is considered in its relation to the markets of Great Britain and France. As is well known, raw silk from India at the present day does not occupy a high place in the estimation of manufacturers, and it was with the object of ascertaining the exact requirements of the British and French markets that the present investigation was undertaken by Mr. Rawlley with the financial assistance of the Carnegie Research Trust and the India Office.

In his inquiry the author visited nearly all the principal silk centres in this country and in France, and the chief value of the investigation lies in the fact that it has secured expression of authoritative views of the leading members of the trade. The wide ground covered by the inquiry can be only briefly summarised here. It will be sufficient to say that we have now a consensus of expert opinion that with adequate improvement in quality and reeling (embracing evenness in size, cleanliness, and uniformity of strength), together with improved trade organisation (mainly with a view to regular supplies), there is an assured market in this country, and in France, for Indian raw silks. The comparative success of the improved Kashmir silk, especially in the French market, is already a demonstration of this fact. As regards waste silk, and also wild Eri silk, the position is the same; given better quality, greater cleanliness, and improved trade organisation, there will be no difficulty in finding a European market for these products. The author's inquiry has performed a double function, inasmuch as it indicates the possibilities of a neglected source of supplies to the consumer of raw silk and an undeveloped outlet for the producer.

A GREAT INDUSTRIALIST.

George Westinghouse: His Life and Achievements. By Francis E. Leupp. Pp. xi+304. (London: John Murray, 1919.) Price 15*s.* net.

THE author, in his preface, regrets the lack of all those written records on which biographers usually rely for providing interesting personal reminiscences. Despite this, however, he has succeeded in compiling an interesting, straightforward narrative which will be inspiring to youth for the example it sets forth of success achieved by indomitable courage and persistent effort, and of fame won on sheer merit, without aid from influence or wealth.

Older readers will find the book of interest in so far as it provides an easily assimilated history of many of the important industrial developments of the past generation. On the other hand, they are likely to be disappointed by the feeling that the part accorded by the author to George Westinghouse in bringing about these developments falls short by no small distance of the part he actually played.

Mr. Leupp frankly admits that he confines himself to a portrayal of the human side of his subject. He dwells particularly on a certain bigness which he finds characteristic of George Westinghouse, who was large-minded and large-hearted, and had the grand style as an inventor, worker, optimist, and industrialist. "Nothing was ever big enough for him." Splendid as was the human side, and worthy as it is of this record, we share with the author the hope that one day some well-known technologist will compile the record of the great inventions and achievements of the man.

It is notable that Westinghouse did not excel at school and college, and that during his brief college career he admitted that he might have been more successful if he could have spared his time for study that he spent more pleasurably in investigating machinery and in making mechanical models. His ready grasp of the opportunity that led to his early connection with railroad work, and ultimately to his development of the air brake, with which his name will always be associated; his investigations into natural gas and its industrial application; his fair appreciation of the inventions of others and readiness to put them into commercial use; his fight for alternating electric current; his care for the welfare of his workpeople; his buoyancy, carrying him over financial crises of a most disturbing character; the esteem of his workpeople that held them to him through precarious times—these tell the man of unusual industrial capacity, personality, and courage.

The book does not possess any marked literary value, but all who are not debarred by its high price will find it worthy of perusal.

FARMING IN THE NEW ERA.

(1) *A Large State Farm: A Business and Educational Undertaking.* By Lt.-Col. A. G. Weigall and Castell Wrey. Pp. xiii+82. (London: John Murray, 1919.) Price 2*s.* 6*d.* net.

(2) *The Farmer and the New Day.* By K. L. Butterfield. Pp. xi+311. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 8*s.* 6*d.* net.

(3) *The Sugar-beet in America.* By Prof. T. S. Harris. (Rural Science Series.) Pp. xviii+342+xxxii. plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 2.25 dollars.

(4) *Strawberry-growing.* By Prof. S. W. Fletcher. (Rural Science Series.) Pp. xxii+325+xxiv plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 1.75 dollars.

(1) A GREAT deal is being spoken and written about the new era into which we are entering, and agriculturists are wondering what will become of their subject, and incidentally of

themselves. The problem is not peculiar to any one country: it is world-wide.

The British problem was discussed some time ago by Sir A. D. Hall in his book, "Agriculture after the War," and not long since by an anonymous writer in a recent number of the *Edinburgh Review*. One aspect of it is discussed by Lt.-Col. Weigall and Mr. Castell Wrey in the first volume on the list. These authors set out the advantages of the large 10,000-acre farm as a business proposition. The farm of 3000 acres, hitherto considered large, they regard as simply inconvenient; it is too small to be a really big farm, but too large to be a satisfactory small one. They suggest that the State should run one large farm as a demonstration and educational institute, and they consider that others would soon follow, with the result that the method would take its proper place in British agriculture. Many of the difficulties of farming disappear when the scale is made sufficiently large, and the authors make out a good case for the 10,000-acre farm. We doubt, however, whether they will induce any Government Department to embark in the business, Government trading being somewhat under a cloud for the moment; but a company might feel disposed to take the matter up.

(2) The American problem is discussed in the second of the volumes before us by Dr. Butterfield, the well-known president of the Massachusetts Agricultural College, who sets out his views with characteristic frankness, saying exactly what he thinks with the engaging candour that has made him so potent a factor in American agricultural life. One great difficulty Dr. Butterfield finds is that farmers are not, and rarely have been, prominent in the councils of the nation; consequently others have had to devise policies for them. The farmers of ancient Rome and the yeomen of medieval England were in a stronger position, and in Germany, Denmark, and Ireland farmers are a power in the land; in the main, however, they have had but little influence. Some serious consequences follow. The great majority of American farmers are said to receive insufficient return for their labours, the average labour income being only 400 dollars per annum. The middleman, on the other hand, obtains too many of the consumers' dollars; the system of distribution is in general against the farmer's interests. Still worse, there is no agricultural policy. Dr. Butterfield writes sternly about this deficiency in the United States, and notes with surprise the same lack of policy in this country and in the Labour Party's memorandum on reconstruction, of which otherwise he approves. He insists on the need for a strong agriculture, which, however, can eventuate only if the farmer conforms to the spirit of the new age. This calls for a better chance for the ordinary man, the intelligent planning of human progress, a reconciliation between organised effectiveness in human life that also leaves individuals and classes truly free, and an insistence on service to fellow men as the great motive in life.

We need not follow Dr. Butterfield in the elaboration of his thesis; he discusses the various agencies in American country life in their relationship to these four aspects of the new age. The position is similar to that dealt with by Sir Horace Plunkett in Ireland, whose famous slogan, "Better farming, better business, better living," has made a vivid appeal in the States also. More fortunate than Sir Horace, however, Dr. Butterfield has no religious problem, and is able to discuss the Churches as candidly as he does the schools. The author makes certain criticisms of the rural education system of the United States—the most remarkable scheme of educational activities on behalf of the farmer to be found in the world. Englishmen visiting the States have marvelled at its completeness; Dr. Butterfield's criticisms, after all, show that it is human; while sound in essentials, it is apt to go wrong in details.

(3) The two other books on the list furnish good examples of the educational work done by the agricultural experts of the States. Prof. Harris, the director of the Utah Experimental Station, describes the growth of sugar-beet in the States, and brings together a good deal of material previously scattered through many books, journals, and bulletins. The industry has developed there in a remarkable manner. In the 'sixties the production of beet-sugar was less than 300 tons per annum; now it is 800,000 tons. This astonishing development has not been at the expense of cane-sugar, for during the same period raw cane-sugar has risen from 200,000 tons per annum to $2\frac{1}{2}$ million tons. The story of the beet-sugar industry in Europe is well known, and is one of the most interesting cases on record of a fostered key industry growing and flourishing. The history of the crop in America is not so well known, and the author devotes an interesting section to it, also reproducing photographs of some of the early pioneers. The first factory, established in Massachusetts in 1838, failed after two years. The second was established in Utah in 1842, and had the advantage of a considerable natural protection, imported sugar having to be hauled all the way from the Missouri River, and, therefore, costing no less than 40 cents to 1 dollar a pound in Salt Lake

City. But the promoters could not crystallise the sugar; they could only make syrup, and before long they gave up the business. The industry was not definitely established until 1890; development was fostered by means of tariffs, and was very rapid during the war. In the early days of the nineteenth century the percentage of sugar in the root was about 5; now it is about 16–18 per cent. It differs in the different varieties, and is affected by the soil and weather conditions. Sufficient irrigation in dry seasons increases the amount of sugar.

The great difficulty in dealing with the crop is the amount of labour involved in lifting. This is now obviated to a considerable extent by the use of suitable implements, two types of which are described.

The crop is liable to attacks by insect pests and fungi; no fewer than 150 species of insects feed on the beet, of which about forty are of economic importance; the number of fungus pests is small at present, but it is increasing.

(4) The last book on the list, on strawberry-growing, is by Prof. Fletcher, of the Pennsylvania State College. The author opens with the statement, which will be new to many people, that "the strawberry is distinctly North American. Most modern varieties sprang from species only found in the Americas. Progress in the domestication of the fruit was coincident with the introduction into Europe of American types." In 1910 the acreage under strawberries in the United States and Canada was 150,000 acres, said to be more than the combined acreage of all other countries.

Bearing in mind the results of fertiliser experiments at the Woburn fruit farm, the English reader turns with interest to discover what results have been obtained in America. Curiously few fertiliser experiments with strawberries seem to have been made. At the Missouri Station phosphates were beneficial, but nitrogenous and potassic manures were harmful. At the Tennessee Experimental Station no fertilisers proved effective. At Cornell phosphates and potassic fertilisers were beneficial, while nitrogenous manures were harmful. But the experiments lasted only a year or two, and hence the results do not yield as much information as they might as to the needs of the plant. In nature the strawberry flourishes on an acid soil, and in cultivation lime is not found necessary.

As usual in the Rural Science Series, the author brings into the book information on all aspects of the crop, dealing with such diverse subjects as the shape of boxes for packing, the raising of new varieties, insect and fungus pests, etc. It is obvious that no one man can be competent to deal adequately with all branches of the subject, but the general treatment is good and gives the practical man all the help he needs; there are also references to experimental station bulletins, where further information by experts on particular subjects can be obtained.

Some years ago productivity figures were worked out for the farm workers of the different countries of the civilised world. America easily headed the list, which was as follows:—

America	292
Great Britain	126
Germany	119
France	90
Italy	45

Looking through this Rural Science Series, edited by Dr. L. H. Bailey, and seeing how earnestly the authors strive to deal with the conditions actually obtaining in the States, we find at least a partial explanation of the striking superiority of the American worker. Such books could scarcely be written in this country as yet, but there are hopeful signs for the future. A body of young men and young women is gathering at the agricultural experimental stations and colleges of this country capable of doing good work that will bear comparison with anything done elsewhere, and there are increasing signs that their work is favourably and respectfully received by the agricultural community.

E. J. RUSSELL.

OUR BOOKSHELF.

The Building of an Autotrophic Flagellate: Botanical Memoirs. No. 1. By A. H. Church. Pp. 27. (London, etc.: Humphrey Milford and Oxford University Press, 1919.) Price 2*s*.

"THE story of the evolution of the plant regarded as expressed in simplest terms as an autotrophic flagellate of the plankton-phase from nothing at all but ionized sea-water" is the subject of Mr. Church's extremely condensed and technical paper. In reality it is rather the requirements of the problem than its solution which Mr. Church indicates, and, whilst he realises the magnificence of the factors with which he has to deal (the sea, for example, is "a medium complex beyond the possibilities of human computation"), he presents the results of much learning in huge unbroken and almost unintelligible paragraphs. Who, for example, would imagine that the following sentence refers to the origin of seaweeds from free-floating algæ? "In the case of initial benthic organism, the first inception of such a continuous deposit [he is talking of cell-walls] prepares the way for the general formula adopted in describing the events in the life of an algal zooid. . . . In such wise the autotrophic zooid of highly differentiated anisokont habit may be visualised as passing on to the initiation of the series of the great marine group of the Phæophyceæ." Strange that an old Oxford teacher should have employed for his exposition a medium "complex beyond the possibilities of human computation."

Yet if the reader can summon up courage to face the repellent language of this tract he will find suggestions of extraordinary interest. The superiority of the botanist over the zoologist is emphasised; even "a tree is in many respects more entitled to respectful admiration than a man," unless, we presume, he be a botanist.

Human Personality and its Survival of Bodily Death. By Frederic W. H. Myers. Edited and abridged by S. B. and L. H. M. Pp. xiii + 307. (London: Longmans, Green, and Co., 1919.) Price 6*s*. 6*d*. net.

THE original two-volume work, published in 1903, is abridged by condensing the text and omitting the greater part of the appendices. The illustrative cases which are published form part of the text, and are nearly always quoted in full.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Nature of the Katmai Volcanic Gases and Encrustations.

THE fumarole activity following and continuing after the great Katmai eruption of June, 1912, has provided south-western Alaska with the first among the natural wonders of the world. The volcanic gases force their way to the surface over an area of more than fifty square miles. This area is covered with volcanic ash and pumice, largely distributed by an enormous flow of mud following the explosion of the Novarupta volcano, but preceding the outburst of Katmai ten miles to the eastward. The relatively coarse ash and pumice from Novarupta were not ejected to any considerable distance, but, falling locally, quickly melted the snow on the mountains, and, with the rainfall accompanying the eruption, slid down into the adjacent valleys, forming a viscous mass which poured down the Bering Sea slope of the peninsular axis for a distance of more than fifteen miles.

As the mud drained away, unlike the more fluid water,

Photo] [*J. W. Shipley.*

Photo] [*J. W. Shipley.*

FIG. 1.—Fractured sections of the Great Mud Flow. Note the conglomerate nature of the fragments and the irregular cleavage planes. Sometimes, however, the cleavage is quite regular, as shown in Fig. 2.

it left a very large residue adhering to the valley floor. Subjected to heat from below, the mud dried, caked, and was eventually baked. The contracting, hardening mass split and cracked according to the strains and stresses set up by the irregularities of the valley floor beneath. The Katmai volcanic ash lies conformably on top of this mud-flow. Apparently the order of the sixty-hour eruption of June, 1912, was:—(1) Novarupta explosion, followed by the great flow of mud; (2) Katmai eruption; and (3) the upthrusting of the lava plug of Novarupta. No ash covers this plug. It was the last major event to happen.

Photo] [*J. W. Shipley.*

FIG. 2.—Cross-section of horizontal tunnel about fifteen feet below the surface of the mud-flow. Note the cleavage planes of the mud above the vent. One hundred feet from this is another horizontal tunnel seventy-five feet below the surface, and large enough to drive a team and wagon through. These have most probably been formed by the solvent action of superheated steam and hydrofluoric acid.

The mud-flow occupies the floor of the Valley of Ten Thousand Smokes described in this journal by Dr. Griggs ("The Eruption of Katmai," NATURE, August 22, 1918, vol. ci., p. 497). The volcanic gases force their way upward through this superincumbent detrital material, using the existing cracks and fissures, and dissolving out new channels where openings were not already available. As chemist of the 1917 Katmai Expedition, it fell to my lot to examine these gases and the encrustations deposited around the fumaroles.

The gases contain some of the strongest disintegrating agents known. Hydrofluoric acid and hydrochloric acid, together with superheated steam, proved to be the most common constituents of the outpouring gases, frequently issuing at a temperature above 400° C. Many fumaroles were so impregnated with these acids that it was impossible to breathe the vapours. The surface of the mud-flow surrounding some of the more acid vents was covered with ferrous chloride and impregnated with free hydrochloric acid. The presence of hydrofluoric acid in the emanations was accompanied by a deposit of amorphous silica around the vents, almost completely closing the orifices and forcing the gases to issue through cracks in the hot, baked silica. These deposits, sometimes 98 per cent. of pure silica and altogether anhydrous, formed dykes several feet high around the hotter vents.

This association of hydrofluoric acid and silica is not accidental. Hydrofluoric acid decomposes silicates, setting free the silicon as gaseous silicon tetrafluoride, and this in turn is decomposed in the presence of water, forming SiO_2 and free acid. The majority of the samples of encrustants brought back gave a qualitative test for fluorine, while quantitative results ran as high as 7 per cent.

Realgar and orpiment were found in conjunction with deposits of sulphur. Hæmatite in the form of "Venetian red" and small crystals of pyrites embedded in a matrix largely silica were common secondary reaction products of the volcanic gases. Hydrogen sulphide was almost ubiquitous.

Hygroscopic iron and aluminium salts formed in the throats of vents protected from the weather and at a temperature above 100° C. Unfortunately, these were highly deliquescent, and lost their crystalline form on exposure to the air.

The throats of several vents near Novarupta were lined with quantities of ammonium chloride crystals, almost 99 per cent. pure.

One of the most interesting deposits was a tarry substance found in the proximity of the ammonium chloride fumaroles, which proved on analysis to contain hydrocarbons of an asphaltic character.

Many of the fumaroles contained ammonium compounds in the issuing gases, strikingly indicated by the growth of algæ. Wherever blue-green algæ were

Photo] [*J. W. Shipley.*

FIG. 3.—The surface of the mud is very deeply eroded by watercourses, and these are frequently hard to distinguish from the fissures. These gullies are in a very active area on the northern slope of Trident Volcano.

observed growing, there the issuing gases or encrustants contained ammonia; while, conversely, an active area not supporting algæ proved to have no trace of ammonia in its emanations or encrustants.

In connection with the presence of hydrofluoric acid, the deposits of sulphates, such as alum, are very significant. Potassium alum, appearing as lichen-like growths after every rainfall, covered the surface of the ash over many of the areas of activity. Sulphuric acid is a strong disintegrating agent, and its presence in the emanations gives a key to the formation of hydrofluoric and hydrochloric acids, for sulphuric acid acting on fluorides and chlorides sets free the more volatile halogen acids.

The volcanic ash and pumice which constitute the mud-flow have been highly altered by the passage of the volcanic gases. Analysis shows that in the vicinity of the vents the ash has lost a portion of its silica content, while the iron, calcium, and magnesium have been relatively concentrated. Sometimes the ash and pumice are completely disintegrated. Superheated steam containing halogen acids is a disintegrating agent that even rhyolite cannot withstand. The presence of so many large vents, tunnels, and channels in the mud-flow may well be attributed to the action of the volcanic gases.

Photo] [*J. W. Shipley.*

Fig. 4.—A typical volcanic vent. The gases were escaping from another hole some distance away along the horizontal tunnel. Note the thickness of the encrustants covering the tunnel. They consisted of silica, sulphur, fluorides, and compounds of iron.

The nature of the emanations, and the continuous evolution of heat and gases for seven years, with little indication of any diminution in volume, indicate direct magmatic origin for the phenomena of this valley. The extrusion of semi-fluid lava from Novarupta and in the bottom of the Katmai crater may signify a similar approach of the magma to the surface in the Valley of Ten Thousand Smokes.

J. W. Shipley.

Chemical Department, University of Manitoba, Winnipeg.

The Control of Scientific and Industrial Research.

Announcement is made in Nature of January 29 of the appointment of Mr. R. L. Frink to be director of research of the Glass Research Association, which has recently been formed as one of the Industrial Research Associations of the Department of Scientific and Industrial Research. The appointment raises a question which has intimate relations with scientific interests and progress, and it should not be permitted to pass without protest.

It has always been urged in the columns of Nature, and accepted as a cardinal principle by men of science generally, that scientific research can only be rightly understood and sympathetically promoted by a director who has himself taken part in it. The essential qualification, therefore, of a director of research of each of the industrial research associations should be proved capacity for research; for without such aptitude the work undertaken is bound to be narrow, and the scientific aspects upon which progress ultimately depends to be neglected. This point of view, however, seems to have received secondary consideration only in the recent appointment; for what the secretary of the Glass Research Association says as to the qualifications of the director of research is: "Mr. Frink has a lifelong experience of the American glass trade and glass research, is well known to the foremost English glass manufacturers, and his appointment is welcomed by the British glass industry."

It is scarcely too much to say that this appointment has been received with intense astonishment by all scientific men connected with the glass industry, and by many glass manufacturers as well. In the glass industry, more, perhaps, than in any other, it was naturally expected that a director of research would be a man of distinguished eminence whose work was of proved scientific value; yet practically no such evidence is forthcoming in the case of Mr. Frink.

A scientific friend in America, who is recognised as one of the first authorities upon scientific matters connected with glass, tells me that Mr. Frink is not known as a research man or in research circles, but that he is highly spoken of by practical glass-makers "as a man of long experience in the window-glass trade who is accustomed to be called in as 'first aid' for furnace troubles, colour troubles, and like technical difficulties. This trade he has pursued for some years with success, and his reputation in this domain is among the best. He maintains a so-called laboratory and has a number of technical assistants, and, I fancy, has gathered together a considerable amount of rough-and-ready wisdom which has found extensive application in an industry where research laboratories have hardly been thought of until recently."

It seems quite possible that the Glass Research Association has secured the services of a very able, practical man, but in making the appointment the council of the association has negatived the policy elaborated with such care in the article published in Nature of November 13 last: "The ideal director for this association is not an individual research worker whose glory is to work in splendid isolation, but is he who will bring *expert knowledge of the methods of scientific research* to bear upon these complex problems, who possesses such personality as to attract promising young research workers to his side . . . and to co-ordinate the efforts being made through the various laboratories, institutions, and works to which specific research and experimental work will be allotted." (Italics are mine.)

If the writer of that article, the temporary secretary of the association, had been a scientific man, he would have realised that our greatest investigators rarely "work in splendid isolation," but that only a man who has proved his capacity as an investigator can lead and co-ordinate research. It is certain that British scientific men will not submit to control and direction from the practical man; thus a definite breach is opened between science and an important branch of industry.

It has not been sufficiently clearly realised that scientific and industrial research is passing out of the control of the recognised scientific and technical societies and institutions and of the universities into the hands of the Department of Scientific and Industrial Research, and, in accordance with Government policy, the secretary of this Department is an administrator without practical knowledge of science, industry, or research. The associations which are formed under the ægis of the Department are governed by councils upon which organised science is unrepresented, but to which the Department may nominate scientific men. To the council of the Glass Research Association the Department has nominated two scientific representatives, one of whom is in India. On the executive committee science is not represented; and when this appointment was discussed between that body and the secretary of the Department, the scientific aspects of the case can have received no consideration. As the Department controls funds for research which are vastly greater than those at the disposal of the Royal Society and all the other societies and universities put together, the outlook for science is a poor one unless scientific men are prepared to take united action with the view of securing a proper share in the control of research.

MORRIS W. TRAVERS.

The Predicted Shift of the Fraunhofer Lines.

MAY I submit the following two propositions for the consideration of relativists?

(1) An occurrence takes place at a point S. Light-signals are dispatched from S at the beginning of the occurrence to two observers A and A′, and signals are again dispatched at the conclusion of the occurrence. By means of these A and A′ measure the time of the occurrence to be dt and dt' respectively. Then

$$\sqrt{g_{44}}.dt=\sqrt{g'_{44}}.dt',$$

where g_{44} and g'_{44} are the values of Einstein's 44 potential at A and A′.

(2) An occurrence takes place at S, and is measured by an observer there to take the time dt. Another occurrence takes place at S′, and is measured by an observer there to take time dt'. By means of light-signals dispatched from S and S′ at the beginning and conclusion of each occurrence, an observer A measures the times of each occurrence to be equal. Then

$$\sqrt{g_{44}}.dt=\sqrt{g'_{44}}.dt',$$

where g_{44} and g'_{44} are the values of Einstein's 44 potential at S and S′.

Prop. (1) seems to be a correct inference from Einstein's theory, and prop. (2) is deduced by applying (1) to the occurrence at S as measured by S and A, and then to the occurrence at S′ as measured by S′ and A.

If these propositions are sound, how does the Einstein theory predict the displacement of the solar lines? For it seems to me that the criterion for "similarity" of two radiating mechanisms in different parts of a gravitational field is that the invariant space-time elements corresponding to one oscillation of each should be equal. For two mechanisms at rest in the field this condition reduces to $\sqrt{g_{44}}.dt=\sqrt{g'_{44}}.dt'$.

JAMES RICE.

University of Liverpool.

EINSTEIN's prediction of a shift of the Fraunhofer lines to the red can be analysed into two assertions:—(1) That the period of vibration of an atom at rest on the sun differs from that of a similar terrestrial atom; and (2) that this difference is preserved unchanged by the light-waves travelling from the solar atom to the earth, so that it is revealed by a comparison made in a terrestrial laboratory. It is the second assertion that is challenged by Mr. Rice; and, so far as I can make out, the same objection was at the root of the criticisms formerly made by Sir Joseph Larmor. Since criticism centres entirely round the second assertion, I will deal with it solely. I may state, however, that although I regard the first assertion as highly probable, I do not regard it as proved with complete rigour; and had the criticism been directed against this, I should have been much less willing to take sides in the controversy.

The interval ds between two events is a quantity having an absolute significance independent of co-ordinate systems; and when the two events take place at the same place, $ds=\sqrt{g_{44}}.dt$. Mr. Rice's first proposition states that if we have two light-pulses travelling from the sun to the earth, the interval ds between their passages through any point is the same all the way along the track. The statement has a certain appearance of plausibility, but I cannot see any definite argument in favour of it. Space-time round the sun is non-Euclidean; the geodesics have, accordingly, defined but rather complicated tracks, and there need be no constancy of interval between points on neighbouring geodesics. The rule deduced from Einstein's theory for comparing the passage of two light-pulses at the points A and A′ respectively is not $ds=ds'$, but $dt=dt'$, *provided the co-ordinates used are such that the velocity of light does not change with* t.

If we found that the velocity of light changed secularly, we should at once condemn our time-reckoning as non-uniform; accordingly, the proviso is satisfied in practice. With the co-ordinates most commonly adopted the velocity of light is $1-2m/r$, which depends on the position r, but not on the time t. Then if t_1 and t_2 are the times of the two pulses at r, t'_1, t'_2 the times at r', since the mean velocity of the first pulse $(t'_1-t_1)/(r'-r)$ has to be the same as the mean velocity $(t'_2-t_2)/(r'-r)$ of the second pulse, over the same course but at a later time, it follows at once that $t'_2-t'_1$ is equal to t_2-t_1, which proves the statement made. The time between the two light-pulses is preserved unchanged on the journey from the sun to the earth.

In his letter (NATURE, January 22, p. 530) Sir Joseph Larmor describes this condition, that the velocity of light (or the formula for ds) shall not contain the time explicitly, as "a reasonable assumption." I cannot see that any assumption is involved; nor can I agree that it is of "an absolute type." The well-known expression

$$ds^2=-(1-2m/r)^{-1}dr^2-r^2d\theta^2-r^2\sin^2\theta d\phi^2+(1-2m/r)dt^2 \quad . \quad . \quad . \quad (A)$$

is, in the first place, simply a particular integral of Einstein's differential law of gravitation. It can be shown that it is an appropriate solution for the case of an isolated particle. But there is a fourfold infinity of other solutions applicable to the same case; so there can be nothing absolute about this solution, or about the co-ordinates r, θ, ϕ, t which it defines. It is, in fact, often more convenient to write $r=r'+m$, and use r' instead of r as our radial co-ordinate. Whether we use (A) or any other expression, we have to find out from the expression itself the meaning of the co-ordinates introduced. In the limiting case $m=0$, the above expression agrees with the formula for polar co-ordinates and time in a Euclidean world; hence it is usual to call r the distance from the sun and t the time. But there can be no exact identification of variables in a non-Euclidean world with quantities the definition of which presupposes a Euclidean world; and the only exact definition of r and t is that they are mathematical intermediary quantities which satisfy equation (A). The variable t is in no sense an absolute time; it is specifically associated with the sun, which in equation (A) is regarded as the only mass in the universe worth considering.

Without troubling about the approximate identification of t with our common notion of time, our results may be stated in the following form:—At a point in the laboratory (r=const.), dt_1 for a light vibration from a solar atom differs from dt_2 for a terrestrial atom. It follows from the formula (A) that ds_1 and ds_2 will differ in the same ratio, since we are now concerned only with the relation of dt and ds on the earth. The intermediary quantity t is thus eliminated; and the difference in the light received from solar and terrestrial sources is an absolute one, which it is hoped the spectroscope will detect.

A. S. EDDINGTON.

The Straight Path.

IN my book, "A Theory of Time and Space," I directed attention to the fact that in the simple four-dimensional time-space theory there are three types of plane in addition to three types of line.

On p. 360 I stated the following results:

"If A, B, C be the corners of a general triangle all whose sides are segments of one kind, then:

"(1) If the triangle lies in a separation plane, the sum of the lengths of any two sides is greater than that of the third side.

"(2) If the triangle lies in an optical plane, the sum of the lengths of a certain two sides is equal to that of the third side.

"(3) If the triangle lies in an acceleration plane, the sum of the lengths of a certain two sides is less than that of the third side."

These results were published in 1914, and, in spite of the fact that they were printed in italics, so that he who runs might read (that is to say, provided anyone should run on the occasion of reading my book), yet I still find writers continually making statements to the effect that the straight line in this geometry is the shortest distance between its extremities.

As a matter of fact, what I call a "separation line" lies in all three types of plane, and is, consequently, neither a minimum nor a maximum, while an "inertia line" can only lie in acceleration planes, and can easily be seen to be a maximum in the mathematical sense. Further, a triangle cannot have all its sides formed of segments of "optical lines."

I have long contended that the usual method of approach to what is generally called the "theory of relativity" is quite inadequate, and this is a further illustration of my contention.

Not only are our ordinary ideas as to space and time disturbed, but also our ideas of simultaneousness and our notions of "straight lines" in the resulting four-dimensional geometry.

From the midst of this wreckage a logical theory has to be constructed, and the difficulty is to find any firm basis at all.

In the course of my own work I succeeded in finding what appears to be such a basis in the relations of *before* and *after*.

On this basis I found it possible to construct a theory of time and space (apart from gravitation) which led to the same equations as those of Einstein, but of such a nature as to be independent of the particular observer, and therefore truly physical and devoid of the subjectivity which seems to cling to Einstein's theory.

These relations are, in fact, what might be described as *physical invariants*, and, with the help of certain postulates concerning them, they serve as a basis for a system of geometry.

If this investigation had been published in the German language it would doubtless have attracted more attention on the part of British physicists, who might then have added the ideas of *before* and *after* to their store of fundamental physical concepts. Instead of this, however, I have seen no mention of them at all in recent discussions on the so-called relativity theory. It is true, of course, that no analysis of Einstein's recent work has as yet been made in terms of the relations of *before* and *after*, but seeing that these have proved a sufficient basis for the simple theory corresponding to Euclidean space, and that such relations do actually hold in our experience, it does not seem unreasonable to suppose that with modified postulates they might serve as a basis for the more general theory.

With regard, however, to my statement that the straight line in the simple theory is not the shortest distance between its extremities, I can imagine some people casting doubts upon my veracity. For the benefit of those who do not believe me, I venture to give some simple arithmetical examples.

Taking v as unity, the length s of the segment of a separation line between elements the co-ordinates of which are (x_0, y_0, z_0, t_0) and (x_1, y_1, z_1, t_1) is given by the equation:

$$s^2=(x_1-x_0)^2+(y_1-y_0)^2+(z_1-z_0)^2-(t_1-t_0)^2.$$

Let A, B, C_1, C_2, C_3 be elements the co-ordinates of which are as follows:

	x	y	z	t
A	0	0	0	0
B	10	0	0	0
C_1	5	12	0	0
C_2	5	5	0	5
C_3	5	0	0	4

On substituting these values we get:

$$AB=10$$
$$AC_1=13 \qquad C_1B=13$$
$$AC_2=5 \qquad C_2B=5$$
$$AC_3=3 \qquad C_3B=3$$

Thus we have:

$$AC_1+C_1B>AB$$
$$AC_2+C_2B=AB$$
$$AC_3+C_3B<AB$$

For the case of an inertia line the length $\bar{s}$ is given by the equation:

$$\bar{s}^2=(t_1-t_0)^2-(x_1-x_0)^2-(y_1-y_0)^2-(z_1-z_0)^2.$$

As before, let A, B, C be elements the co-ordinates of which are as follows:

	x	y	z	t
A	0	0	0	0
B	0	0	0	10
C	4	0	0	5

Here AB=10, AC=3, CB=3.

Thus AC+CB<AB.

These examples should be sufficient to give an air of plausibility to my statements.

A. A. ROBB.

Cambridge, January 23.

Entente Scientific Literature in Central Europe during the War.

THE chief object of my letter, "A Tribute from Prague," published in NATURE of December 11, 1919, was to congratulate the Editor upon the jubilee number and to express my delight at again being able to obtain this invaluable journal after an interval of more than five years. I thought it worth while to state very briefly that this break was caused by political reasons.

The letter by Mr. Lawson published in NATURE of January 1 induces me, unwillingly, to enter a little into non-scientific details.

There is a decided difference between the point of view during the war of an interned distinguished foreigner enjoying the well-known hospitality of the inhabitants of the capital of the late Austro-Hungarian Empire and that of us Bohemians or Czechs whose country was, by the Government of the same Vienna, nearly converted into a desert, whose best men (even poets) were imprisoned and condemned to death for their regard for the Entente, and who, had the war lasted only half a year longer, would have experienced the same fate as 1,500,000 Slavonic, chiefly Serbian, children in Bosnia and Herzegovina, condemned to starvation. Their parents, in so far as they were not shot down, escaped from death only by eating grass and other herbs!

No Englishman can wonder that we (Austrian) Slavs fully sympathised with the contents of the following two remarkable articles, which I select from a great number:

(1) The leader, "The War and After," published in NATURE of September 10, 1914 (p. 29). Never previously had such a fine political article been published in your columns, and I would beg readers to convince themselves that its great truth, and even prophecy, were fulfilled to the last point.

(2) An article published by Sir Oliver Lodge during the early part of the war in the *Psychological Review*. Sir Oliver says that there exists a Great Justice watching over the destinies of mankind who will never allow a crime to become a law. The editor of our leading daily paper introduced this view as "strange ideas of a spiritualist," and only by this trick did it escape the watchful eye of the censor. I thank Sir Oliver for this article, which kept many of my countrymen and me firm in the days of our greatest distress.

All this was known to the Austrian Government, and it is well understood why it withheld during the whole war the circulation of periodicals which contained such articles as those referred to above.

Towards the end of the war, when everyone saw that the old Monarchy was going to pieces, the Austro-Hungarian Foreign Office—and I assure Mr. Lawson that I am by no means "unaware of the fact"—asked the Senate and professors of our University to fill a circular with the names of the Entente scientific journals which they would like to obtain. I denoted several journals—in the first place, NATURE. I know that those belonging to the "privileged nations" obtained the journals they wished, but no notice at all was taken of my desire or that of any other Bohemian scientific institution up to the very end of the Monarchy.

BOHUSLAV BRAUNER.

Chemical Laboratory, Bohemian University, Prague, January 20.

Percussion Figures in Isotropic Solids.

ALL anthropologists will be glad to see the subject of percussion figures receiving attention in the pages of NATURE (October 9 and November 20, 1919), as the figures form the basis of flint-fracture—the important factor in determining the age and origin of man. Unfortunately, the fracture cone is by no means so simple and constant in outline as one might be led to expect from what has already been advanced, and a number of factors enter into the question, such as the shape and elasticity of the percusser, the velocity of the blow, the striking angle, the perfection of surface of the percussed, its elasticity, and, above all, its varying refrangibility.

In Nature and practice we generally find that after the cone has maintained itself for a distance, the surface resolves into a cylinder in the striking plane, which is maintained for a certain varying distance; then it resolves outwards in a more conical direction, which may extend until rupture takes place; or it may even resolve again and again as before, giving rise to *step-cones*. Specimens before me show seven such steps. Further, from causes into which we cannot now enter, the well-known conchoidal ripplings may be set up. These may be very simple and concentric or the very reverse, and may be either apical or marginal; they pass into *step-cones*. Frequently the surface turns inwards, producing cylindrical fracture more or less normal to the striking plane.

Generally, with glass and flint there is another set of features in the form of stellate lines, which may be very few or numbered by hundreds. An examination of these shows the cone to be a surface of revolution, and the direction of the gyrations is shown by the steps made by every radial (some dozen of these are faintly shown in Prof. Raman's illustration in NATURE of October 9). These may increase in size until we get *step-fracture*, where the steps may be, say, 3 mm. or 4 mm. high. It may be noted in passing that these are the lines along which fracture in plate-glass takes place.

Perhaps the most remarkable thing about these steps is that they indicate right and left revolutions in relation to the cone. Sometimes the two hemicones coincide, and we get a perfect cone. At other times the fracture-waves overlap for a distance, giving rise to the mysterious *éraillure*; they may also meet in a re-entrant angle, which may become very acute, say down to 30°. This is only the beginning of the complications. Cones may be quite asymmetrical; one hemicone may be reduced to a plane. There are also *faceted cones, shell-cones* (*cones in cones*), and *cones in cups*. Then there are the phenomena of *cone capture*, and still greater complications of positive and negative hemicones, and multiple hemicones which by mutual capture produce large flat surfaces, and many others.

I suggest that the study involves something more than isotropics, seeing that in glass, silica, and many other substances new atomic or molecular re-arrangements set in which soon render them anisotropic or anisoclastic, and in one direction end in spontaneous disruption into forms which call for mathematical explanation quite as much as, and indeed more than, simple percussion figures in ideal isotropes; and, on the other hand, colloids pass into crystals where both optical and dynamical properties vary according to the lines along which the alterations take place.

W. J. LEWIS ABBOTT.

St. Leonards-on-Sea.

Change of Colour in Plumage of Captive "Sun-birds" or "Honey-suckers."

WE have had considerable success at the Zoological Gardens here in keeping in health nine varieties of "sun-birds" or, as locally known, "honey-suckers," all of Natal, South Africa. The aviaries are of simple wire-netting, in which are growing flowering shrubs and weeds. Their dimensions are 12×9×6 ft.

The food provided is Mellin's (baby) food, honey, and Swiss milk (tin) in equal proportions, and pea-flour one-quarter to the above.

The brilliant scarlet borne by certain of the varieties has changed in every case to a bright orange colour, thus causing the bird to present a great contrast to its original colour. Metallic green, which is borne by so many of the "sun-birds," is in no manner affected. Other colours of these birds are also not affected.

It would appear to be a case of change of plumage caused by the feeding, for the condition of life is almost natural.

We are not aware of such variety of colour having been observed previously. It would be of interest if any contributor to NATURE could give information of examples of similar occurrences with respect to captive wild birds, or offer an explanation of the physiological causes which are at work.

HAROLD MILLAR,
Director.

Zoological Gardens, Mitchell Park, Durban,
Natal, December 30, 1919.

MATHEMATICS IN THE UNITED STATES.

NOT very long ago (perhaps fifteen or twenty years) an English lady, spending a visit in Utrecht, met a distinguished Dutch professor of mathematics. In the course of conversation the lady asked the professor what he thought of contemporary English mathematicians and their work. The answer was not calculated to flatter our national vanity, for it was to the effect that he rarely looked at English mathematical papers, because they were so unconnected with the general progress of the science, and written in such a peculiar way that he could scarcely understand them. Incredible as it seems, this opinion was expressed when Salmon, Cayley, Sylvester, and Clifford had published all their best work. Prejudices die hard, and the professor's attitude would have been intelligible in the earlier part of the nineteenth century.

One moral of the story is that, as there are nationalities in drinks, so there are in mathematics, in spite of the growing tendency towards universal co-operation. The history of recent mathematical progress in the United States presents many points of interest. To a great extent, American mathematicians may be regarded as the grown-up pupils of Germany. From Germany they have acquired habits of thoroughness, breadth of view, and collaboration. But they have clearly passed the time of pupilage, as we see from their growing list of original and eminent writers; it is enough to refer to such men as the two Peirces and Willard Gibbs.

There are several features of the attitude of the Americans towards mathematics which deserve our careful attention. In the first place, it should be noted that the State and private benefactors encourage mathematics for its own sake, quite apart from considerations of utility. Many American professors are allowed to devote themselves to research in such things as group-theory, abstract geometry of all kinds, function-theory, and the higher arithmetic; the predominance of such subjects in American journals and transactions is quite remarkable. The Government and people of the United States appear to be fully conscious of the fact that special ability of *every* kind should be encouraged.

An excellent American institution, which might well be adopted here, is that of the sabbatical year, which gives the teacher an opportunity of bringing his knowledge up to date, or of carrying out some laborious research. As an example of what can be done in such periods of leisure, we may refer to the recently published first volume of Prof. L. E. Dickson's "History of the Theory of Numbers." With almost incredible industry, the author has personally consulted and summarised thousands of papers, notes, and memoirs; and if the work is carried out on the same scale it will fill four or five large octavo volumes, and be an indispensable guide to all who work in this field. It may be remarked here that we owe to the States many valuable works on the history of mathematics (especially from the teacher's point of view), and reprints and translations of scarce and valuable works.

Collaboration, both in the composition of books and in that of papers, is more common than with us. There are two sides to this question; in some cases the advantages of joint authorship are obvious, but those treatises which rank as masterpieces (such as Salmon's "Conic Sections" or H. Weber's "Algebra") are usually, if not always, the work of one man.

American mathematical colloquia are far more serious affairs than anything we have here. They are meetings of experts, lasting for a week or so, at which a serious programme is carried out, and carefully prepared addresses and short sets of lectures are delivered on topics of outstanding interest. In this matter we ourselves seem to vibrate between two extremes; either we have a technical meeting where papers are read (or taken as read), which seldom interest more than one or two of the audience, or we indulge in a picnic, at which a few casual notes are communicated, mainly for the sake of securing priority.

While thus directing attention to some things in which we might well imitate the States, we have no intention of carping at our own countrymen. The *general* condition of mathematics in this country is probably better now than it has been for many years, and we should be sorry to see some of the old English characteristics disappear. For instance, the view that mathematics is a gentlemanly recreation has something to be said for it, and we may avoid being needlessly solemn and serious in our study of it, however conscious we may be of its vital importance for national welfare.

G. B. M.

SHACKLETON'S LAST ANTARCTIC EXPEDITION.[1]

SIR ERNEST SHACKLETON'S book is an exciting story of a polar expedition that was a disastrous failure in almost everything it set out to do, with a difficult, but stolid and dangerous, retreat and a splendid retrievement. It is of popular rather than of scientific value. To readers of NATURE the last twenty-four pages are of the greatest interest.

The volume shows that medical and science graduates from London, Cambridge, and Aberdeen can be as tough and as useful as the most hardened seamen, and do more than ordinary and A.B. seamen's work on a full-rigged auxiliary steam sailing vessel. Also, that they can sit as tight on a dangerous and rotten piece of ice-floe for month after month, and do good scientific work in squalor and filth and in water in a frozen and thawing condition as well as any, and continue scientific observations and collecting—an example to others making observations and records under more favourable conditions. One and all also served as valuable officers in the fighting Services on their return.

The expedition was under-financed and under-equipped, and there was not enough time given to carry it out successfully. The Weddell Sea alone required two ships and a larger scientific staff, especially in meteorology and biology; there should also have been additional sub-Antarctic meteorological and biological stations or ships. But the Treasury and Parliament are hopelessly blind even now after they should have learned that it was on science that the European War was ended. Science has been found essential on the land, on the sea, and in the air in every way; in the fighting and equipment of the forces, and in the maintenance of non-combatants at home, older men and women and children. The Government was sure of a good leader, and should have given not less than 200,000*l.*, with the guarantee that equipment, ships, small stations, and a sufficient and thoroughly good scientific staff were secured, and that more time was afforded.

FIG. 1.—Landing on South Georgia. Composite drawing and photograph. From Sir Ernest Shackleton's "South." (W. Heinemann)

The Weddell Sea and South Atlantic have been shown to be huge suppliers of food and of material for the manufacture of explosives. It has been found that the meteorology of those parts is an important factor in the meteorology of the globe, especially in southern agricultural areas upon which we are largely dependent.

One omission is that there is no special acknowledgment to the British Admiralty, which had come in at the bitter end. The Admiralty, with special

[1] "South: The Story of Shackleton's Last Expedition, 1914–17." By Sir Ernest Shackleton. Pp. xxi+376. (London: William Heinemann, 1919.) Price 25s. net.

scientific experts and Sir Ernest Shackleton's own representatives, helped the explorer with official assistance to secure the vessels he finally obtained. Even before news of the loss of the *Endurance* came to hand, it had begun the organisation of a relief expedition, and secured and re-conditioned the *Discovery*, which actually sailed so far as Buenos Aires, involving the expenditure of a large sum of public money, better given earlier to the expedition.

The *Endurance* was crushed in approximately 69° S. after being beset off Caird Coast, the south-west coast of Coats Land, whence she drifted west, north-west, and north until she sank. Sir Ernest Shackleton and his party later escaped on floating ice, drifting in a track almost parallel to, but a little west of, the *Deutschland*; and, like the Swedish ship *Antarctic*, the *Endurance* was totally wrecked, and the biological collections and most of the records were unfortunately lost. With the *Deutschland* she thus confirmed the drift of the ice to the west of the Weddell Sea, as originally observed by the *Scotia* and others. She also confirmed the *Scotia's* observations regarding Coats Land and the southern part of the Weddell Sea, and refuted Sir Clement Markham's opinion that it was an open sea from which warm winds drove across by a strait to McMurdo Sound. Sir Ernest Shackleton plainly demonstrated that the reverse was the case, and that heavy and light conditions of ice existed there, calling it "the worst portion of the worst sea in the world," enough to imprison, crush, and lose his ship; but Sir Ernest Shackleton and Capt. Worsley allowed themselves to be too much entangled in it, which probably a veteran ice-master like Robertson would not have done.

Mr. Wordie usefully and ably summarises the scientific work done in the Weddell Sea, and says: "The work undertaken and accomplished by each member was as wide as possible, but it was only in keeping with the spirit of the times that more attention should be paid to work from which practical and economic results were likely to accrue."

FIG. 2.—The last of the *Endurance* before she sank. From Sir Ernest Shackleton's "South." (W. Heinemann.)

He also gives an excellent but too short summary on "Ice Nomenclature."

Mr. Clark proved the faunistic richness of the coastal Antarctic waters, but, unfortunately, all his collections were lost with the ship. Doubtless he has brought home some notes of which we shall hear more in time, for he was already well acquainted with the Weddell Sea fauna. He gives an excellent summary of South Atlantic whales and whaling, which should be particularly useful to the Colonial Office now that it is considering the commercial value of the industry to the Falkland Islands colony and its dependencies.

Mr. Hussey follows with a good summary on the meteorology, but, unfortunately, the valuable detailed tracings packed in the ship's hold were lost. Mr. Hussey's discussion shows that "January 1915 was dull and overcast, only 7 per cent. of the observations recording a clear blue sky, 71 per cent. being completely overcast." The clearest weather occurred in winter, when the sky was cloudless for nearly half the time. Some interesting results are likely to accrue when the meteorological records are worked up in detail and co-ordinated with other observations from South Atlantic and South American stations. "Temperatures on the whole were fairly high, though a sudden unexpected drop in February, after a series of heavy north-easterly gales, caused the ship to be frozen in, and effectually put an end to any hopes of landing that year. The lowest temperature experienced was in July, when 35° Fahr., *i.e.* 67° below freezing, was reached."

For determining the position in drifting pack ice, Mr. James found the theodolite a more generally useful instrument than the sextant, as the ice-floes were found quite steady in really thick pack ice, and the theodolite can be set up and levelled as well as on dry land. Mr. James shows that "the *Endurance* was carried by the ice-drift well to the west of the Weddell Sea, towards the position of the supposed Morrell Land, so that the accurate determination of longitude became a matter of moment in view of the controversy as to the existence of this land." The existence or non-existence of Morrell Land, however, has yet to be investigated more thoroughly, in spite of the assurance of Sir Ernest Shackleton and others that it does not exist. If it is a low *"cluster of islands,"* it would not have been seen at all; the party may have drifted on the floe to the west of it.

Sir Ernest Shackleton's appendix on the lists of provisions and gear in the McMurdo Sound huts is most useful and important for future expeditions.

Finally, the drift party reached Elephant Island, which was one of the places the Admiralty had planned to search. But several landings were made there a century ago, and Sir Ernest Shackleton's expedition is not the first to land there, as he quite excusably supposes. The voyage to South Georgia was a wonderful piece of seamanship and endurance, and Sir Ernest Shackleton has again shown that he can lead men. The story of the *Aurora* with MacIntosh and Stenhouse is another disaster. Spencer Smith unfortunately died while doing land work, which included, however, successful depôt laying, under MacIntosh. The absence of scurvy, on the Weddell Sea side, shows what is possible if fresh meat is mainly adhered to.

MacIntosh and Hayward lost their lives in a blizzard while attempting to cross from Hut Point to Cape Evans on thin ice, and were blown out to sea.

Capt. Stenhouse, of the *Aurora*, handled that vessel with marked ability during her ten months' drift beset in the ice. No mention is made of any systematic scientific work having been accomplished by the Ross Sea party. W. S. B.

TELEPHONING BY LIGHT.

TELEPHONY by means of light is a particular case of wireless telephony. It differs from what is generally understood as wireless telephony in no essential respect. In both cases electromagnetic waves are used, but whereas in ordinary wireless the waves are very long, in the case of light they are very short. As a consequence, telephony by light is easily directed by means of lenses or mirrors, and constitutes a secret means of communication—a state of affairs not yet attained in what is popularly known as Marconi wireless transmission. At the same time, the use of light imposes definite limits on the possible range of light telephony. An uninterrupted straight line is essential between the sending and receiving stations, and the extreme range is therefore determined by the curvature of the earth and the altitudes of the stations.

The transmission of speech by light is rendered possible by the well-known property possessed by selenium (and certain other substances) of changing its electrical conductivity when subjected to varying illumination. Selenium thus acts as a sort of electric valve controlled by light. It is capable of responding to some extent to light

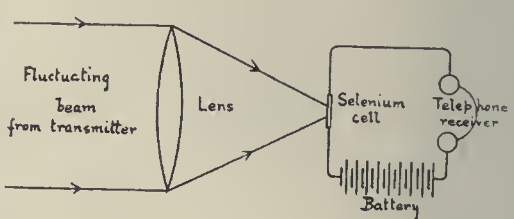

FIG 1.

fluctuations of comparatively high frequency. If a selenium cell is connected in simple circuit with a battery and a telephone receiver—as shown in Fig. 1—fluctuating currents are obtained possessing the same characteristics as the variations of the incident light, and if the latter are of audible frequency the corresponding sounds are heard in the receiver. The problem of light telephony is thus reduced to the production of a beam of light fluctuating in intensity in accordance with the vibrations constituting the speech sounds.

The construction of the first transmitter of this kind was due to Graham Bell, who in 1880 succeeded in transmitting speech by means of a beam of sunlight over a distance of about 200 yards. Telephony by light is, indeed, almost as old as ordinary telephony, and Graham Bell was the inventor of both. It is difficult to account for the difference in the rate of development of the two systems; the fact remains that ordinary telephony is now in common use, whilst telephony by light is still a novelty. Graham Bell's first photophone—as it was called—consisted of a large diaphragm, silvered so as to become a mirror. Upon this mirror a beam of light was projected and thence reflected to the distant selenium receiver. Speech sounds, falling on the diaphragm, set it in vibration, thus causing its curvature to change. The result was that the reflected beam became alternately more and less divergent, so that the amount of light incident on the selenium executed fluctuations of the original frequency and amplitude, and the speech sounds were reproduced in the telephone receiver. Other forms of transmitter are also described by Graham Bell, but it is doubtful whether they were actually successful in practice.

Little further work on the subject appears to have been done until about 1900, when Ernst Ruhmer carried out for the German Government a long series of experiments. He approached the problem from a different point of view. Instead of seeking to impose fluctuations of intensity on a beam of light from a constant source, as Graham Bell had done, he arranged to control the brightness of the source itself by means of the vibrations of speech. The sensitive or speaking arc was already known, and Ruhmer improved it for the purpose of light telephony. Briefly, the principle amounts to this. The current in an electric arc controls the brightness of the arc. Variations of current produce variations of brightness. By means of a transformer, the fluctuations of current in a microphone actuated by speech can be introduced into the arc circuit, and thus produce changes of brilliancy corresponding to the speech vibrations. Ruhmer succeeded in perfecting this system, and claims to have communicated speech over several miles by projecting the beam from the fluctuating arc, by means of a searchlight reflector, on to a distant selenium cell.

This method suffers from several disadvantages, of which the chief is that it is limited to the arc as a source of light, and rules out the use of that much more efficient source—the sun. It is difficult also to maintain the arc in the necessary sensitive condition; it requires continual adjustment. It was these considerations which caused the present writer, in working for the British Admiralty on the subject in 1916, to revert to the general method adopted by Graham Bell—namely, to interrupt the light after it had left the source. The essential point which had to be borne in mind was that the vibrations which it is possible to impart by speech to a diaphragm are of very small amplitude—a few thousandths of an inch only. In order to use these vibrations for producing large fluctuations of intensity in a beam of light, magnification is necessary. In the transmitter about to be described, it will be seen that the magnification is optical. There are many possible variations of the apparatus, but the essential features are shown in Fig. 2. Speech sounds enter the trumpet and fall upon the diaphragm of a gramophone sound-box. To the lever of this sound-box, at the place which the needle ordinarily occupies, is attached a small galvanometer mirror. The vibrations of the diaphragm cause this mirror to execute small *angular* oscillations about an axis perpendicular to the plane of the diagram. Light from a suitable source, such as an arc, or, it may be, the sun, is focussed by means of the first lens upon the vibrating mirror; thence it is reflected through the second lens. The focus of this lens coincides with the vibrating mirror, so that the emergent beam is a parallel one.

A grid consisting of equal and parallel strips alternately opaque and transparent is placed close to the first lens, and a second equal grid near the second or projecting lens. The result is that the light from each point of the source is split up into segments indicated by the unshaded portions, and the extent to which the light penetrates the second grid depends on the momentary position of the vibrating mirror. As shown in Fig. 2, about 50 per cent. of the maximum is being projected, but evidently if the mirror turns through a small angle in a clockwise direction the reflected segments will turn also, and the light penetrating the second grid will increase; a counter-clockwise movement of the vibrating mirror will, on the other hand, diminish the light projected.

Thus, in so far as the mirror copies the vibrations of speech, and provided that the amplitude is not allowed to be greater than that corresponding to the width of one space of the grids, a fluctuating beam of the desired character is ob-

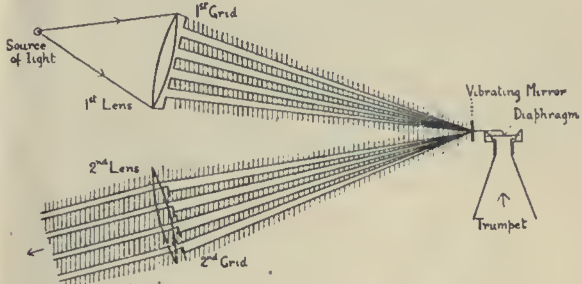

FIG. 2.

tained. It may be projected on to the receiving apparatus shown in Fig. 1 and used for the transmission of speech. By making the width of the grid spaces small in comparison with the distances between the grids and the vibrating mirror, adequate control of the light intensity is secured, even though the movements of the diaphragm are so small. It is, in fact, easy to reach the stage when the grids must be made no narrower, otherwise the amplitude of movement of the segments of light is excessive, and the frequency of interruption becomes doubled or even trebled—to the detriment of articulation in the received speech. It should be pointed out that the diagram shows only the light proceeding from a single point of the source. Actually, every source is finite in size, and in order to provide for this it is necessary to use as the vibrating mirror a *concave* reflector, the radius of curvature of which is equal to the distance between the grids and the mirror. A real image of the first grid is thus obtained on the second, and this image moves in the manner of a shutter when the mirror oscillates.

Fig. 3 is a photograph of a transmitter arranged for use with sunlight, and mounted so that it can be directed as desired. The lenses are 6 in. in diameter, and the range with sunlight, when a 6-in. collecting lens is also used, is about 8 miles. It is impossible at present to say what the ultimate limit of range may be. It depends on the apertures of the projecting and receiving optical systems, the brilliancy of the source, and the extent to which amplification by means of thermionic valves may be possible in reception. The selenium cells which the author has used were made by Dr. Fournier d'Albe, and they have given very satisfactory results, the articulation of the speech heard being extraordinarily perfect. Their special sensitivity to red light perhaps accounts for the fact that a small amount of mist between the sending and receiving stations has been found not to interfere greatly with transmission.

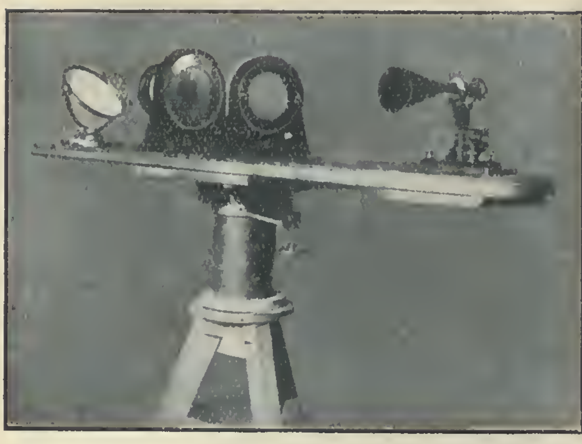

FIG. 3.

In this short article it has not been possible to give more than a brief description of essential points. Fuller details both of the photophone and of its application to the photographic recording and reproduction of sounds may be found in the Proceedings of the Physical Society of London.[1]

A. O. RANKINE.

AUSTRALIAN RAINFALL AND WHEAT YIELD.

UNTIL large schemes for the conservation of water supply with a view to irrigation have been carried out, the incidence of drought at frequent intervals is bound to have a great influence, not only on the sheep runs of the Australian Commonwealth, but also on its wheat crop. It is perhaps surprising that the relation between rainfall and wheat yield should be to a great extent directly traceable, when we consider to how many indirect influences the yield is exposed. The seed varies in such obvious characteristics as size and hardness, as well as in power of resistance to disease, partly modified by the conditions under which the crop producing the seed has been raised. There is, moreover, no constancy in the soil, which differs from place to place in composition, in aspect, elevation, and slope, from farm to farm in the amount and choice of fertilising agents, and from district to district in the dates of weather changes and precipitation. There is possible loss by barrenness of seed, by ground pests before germination, by vermin during growth, by storms, birds, insects, and disease when the grain is in the ear, and much may be shaken out when ripe if the harvest weather be very hot and dry.

In spite, however, of all these disturbing factors we find from the latest official publication on the subject strong evidence of direct correlation between the wheat yield per acre and the rainfall of the previous winter. For South Australia and the Northern Territory the correlation coefficient works out at 0·61, with a probable error of 0·07. It must be admitted that the data are far from being homogeneous, comparatively few of the stations yielding figures for the whole period. The publication is entitled "Results of Rainfall Observations made in South Australia and the Northern Territory, including all available annual rainfall totals from 829 stations for all years of record up to 1917, with maps and diagrams, also appendices presenting monthly and yearly Meteorological Elements for Adelaide and Darwin" (Green, Acting Government Printer, Melbourne, 1918), and is the fourth of a series. Previous volumes dealt with the Eastern Provinces (Queensland, New South Wales, and Victoria), and two more are contemplated to complete the set by including Western Australia and Tasmania.

There is a wealth of detail contained in the four hundred or so pages, to say nothing of the seasonal maps and diagrams. The territory covered is large, more than 900,000 square miles, and the annual rainfall varies from 4·07 in. at Mulloorina in the centre to 61·37 in. at Darwin in the Northern Territory and 45·91 in. at Stirling West in South Australia. The mean annual rainfall for the Northern Territory (four-sevenths of the whole) is 19·52 in. (thirty-seven years' average), the extremes being 30·28 in. in 1904 and 12·20 in. in 1905. For South Australia the mean is 9·39 in., and the extremes, curiously enough also in consecutive years, 15 in. in 1889 and 5·88 in. in 1888. Of forty-seven counties with a long record, twenty-eight had their driest year in 1914, and twenty-five their wettest in 1916. In quite a large number of districts, accordingly, the wheat yield per acre was lowest in 1914 and highest in 1916. The most conspicuous dry periods were 1895 to 1902 and 1911 to 1915. It may be noted that rainfall was deficient at Greenwich also for each year of the first of these periods, but not for the second.

Conditions at Adelaide, which has the longest meteorological record in the district, are very different from those at Greenwich, but there is some similarity in the rainfall. The wettest day at Adelaide in seventy-seven years was March 5, 1878, with 3·50 in., the number of daily falls

[1] Proc. Phys. Soc., vol. xxxi., p. 242, and paper read December 12, 1919.

of at least an inch being 130. The wettest day at Greenwich in seventy-eight years was July 27, 1867, with 3·67 in., and the number of daily falls of at least an inch was 113.

A much more interesting comparison, however, is afforded by the tables relating to Adelaide in the south and to Port Darwin in the north. Darwin is 11° within the Tropics and Adelaide 11° outside, but while Darwin is on the coast, Adelaide is six miles from the nearest point of the sea. The mean height of the barometer, corrected to sea-level, is 0·225 in. (or nearly 8 millibars) higher at Adelaide than at Darwin, the extreme readings being at Adelaide 29·204 in. and 30·704 in., and at Darwin 29·017 in. and 30·151 in. The temperature contrasts are striking. The mean temperature at Darwin is 82·7° F., with a monthly mean daily range of 16·8°, and at Adelaide 63·0° F., with a mean range of 19·7°. Darwin, being a tropical station, has a range of only 8° F., or rather less, between the warmest and coldest months. Adelaide, on the other hand, has a corresponding range of 22½°. Again, the highest temperatures recorded at Adelaide were 116·3° in the shade and 180·0° in the sun; at Darwin, 104·9° in the shade and 168·5° in the sun. It is therefore not surprising to find that readings of at least 100° in the shade occur much oftener at Adelaide—13·5 per annum, as against 1·6 per annum at Darwin. It is otherwise with readings of at least 90° in the shade, where the annual numbers are 43·6 at Adelaide, and 237, or nearly two days out of three, at Darwin. The lowest reading at Darwin was 55·8°, and at Adelaide 32·0°, for air temperature. Terrestrial radiation readings are not given for Darwin, but a minimum of 22·9° occurred at Adelaide. Darwin also seems to be unprovided with a sunshine recorder, but at Adelaide the annual average is 2531·5 hours, a maximum of 2829·9 hours having been measured in 1898, in which year also the sunniest month occurred, 374 hours being recorded in January.

Many other matters besides rainfall are included in the main part of the volume, as indicated in the following list of tabulations: aurora, bush fires, drought, earthquakes, floods, fog-bows, frost, hail, heat waves, high tides, meteors, mirages, mock moon, plagues and pests and live-stock diseases, heavy rainfall, thunder and lightning, volcanic dust-clouds, water-spouts, hurricanes, cyclones, heavy gales, dust-storms, etc.

W. W. B.

NOTES.

With the assistance of the Air Ministry and the co-operation of Messrs. Vickers, Ltd., Lord Northcliffe has been able to arrange, on behalf of the *Times*, for an attempted flight from Cairo to Cape Town, a distance of more than five thousand miles. This journey from one end of the continent of Africa to the other, and traversing country the nature of a large part of which is little known, is of particular interest to the scientific world in view of the fact that Dr. P. Chalmers Mitchell, secretary of the Zoological Society of London, is taking part in it as passenger and observer. The enterprise will thus not only test the practicability of the air route from Cairo to the Cape, but also doubtless lead to valuable scientific observations being made during the flight. The aeroplane left England on January 24 and arrived in Cairo on February 3. The machine is a Vickers-Vimy commercial aeroplane similar to those used for the flights across the Atlantic and to Australia, and it carries a crew of four in addition to the passenger. Dr. Chalmers Mitchell is carrying an autograph letter from the King to Lord Buxton, Governor-General of South Africa, and we hope that he will be able to deliver it in twelve days or so after a successful end to what is a pioneer effort in scientific exploration from the air.

The *Kew Bulletin* (1919, p. 399) records the appointment by the Government of South Africa of an Advisory Committee to carry out and supervise a Botanical Survey of the territories included in the Union. Dr. J. B. Pole-Evans, chief of the Division of Botany in the Department of Agriculture, will act as Director of the Survey, and he will be assisted by a small committee, including several prominent South African botanists and representatives of Government Departments interested. The objects of the survey are to continue and extend the work of the Division of Botany on the systematic study of the vegetation of the country and of the plant parasites of the indigenous vegetation; that of the Division of Veterinary Research on the relation of the vegetation to stock diseases; and that of the Forestry Department on the composition of the indigenous forests, the value of their products, and their industrial possibilities. Also to study the vegetation from the various points of view of industry, agriculture, and pastoral development; to study plant distribution and the influence of South African conditions on the structure and physiology of the native plants; and to compare and correlate the South African flora and its associated animal and plant diseases with those existing in other parts of the world under somewhat similar conditions. For the purpose of the survey the country will be divided into a convenient number of areas each under the control of a botanist, and a qualified assistant has been appointed at Kew to aid in the critical examination of the plants collected.

By a melancholy coincidence the announcement of the appointment by the Egyptian Government of an International Commission to consider the proposals for the extension of irrigation works in Egypt and the Sudan is followed by the news from Bombay of the death of Sir Michael Nethersole, who had been selected for the chairmanship of the Commission, but had felt impelled to decline the offer by reason of the claims of his work in India. Born in 1859, Sir Michael passed in 1880 from the Royal Indian Engineering College at Coopers Hill into the Public Works Department, and, rising through the grade of executive engineer, he became in 1900 Chief Engineer and Secretary to Government in the United Provinces. In this position he remained for a dozen years until his appointment as Inspector-General of Irrigation in India. He retired in 1917 with a knighthood, having been created C.S.I. in 1914. Retirement from public service, however, was only followed by professional activity of another kind, and until his death Sir Michael occupied the position of chief hydro-electric engineer to the Tata Co. at Bombay, under the auspices of which he recently completed the tunnelling work for the Andhra Valley scheme of water-power.

WE regret to announce the death on February 1, in his seventy-ninth year, of Mr. C. E. Groves, F.R.S.

DR. W. McDOUGALL, Wilde reader in mental philosophy in the University of Oxford, has been elected president of the Society for Psychical Research, in succession to the late Lord Rayleigh.

SIR DANIEL HALL, K.C.B., F.R.S., Permanent Secretary of the Board of Agriculture, has been elected a member of the Athenæum Club under the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

SIR NORMAN MOORE, president of the Royal College of Physicians, has appointed Dr. F. W. Andrewes to be Harveian orator and Dr. R. C. Wall to be Bradshaw lecturer for this year. The council has appointed Dr. Martin Flack to be Milroy lecturer for 1921, and the Censors' Board has awarded the Oliver-Sharpey prize for 1920 to Prof. Emil Roux, of the Pasteur Institute, Paris.

PROF. E. B. TITCHENER, Cornell University, Ithaca, N.Y., informs us that the prize of 100 dollars offered for the best paper on the availability of Pearson's formulæ for psychophysics (NATURE, vol. xcii., p. 508, January 1, 1914) has been awarded to Dr. Godfrey H. Thomson, of Armstrong College, Newcastle-upon-Tyne, for a paper entitled "On the Application of Pearson's Methods of Curve-fitting to the Problems of Psychophysics."

Symons's Meteorological Magazine came to an end with the January number, which completed vol. liv. This month it will appear as the *Meteorological Magazine*, with which the *Meteorological Office Circular* will be incorporated. In order to preserve the continuity, the new magazine will be issued as No. 1, vol. lv. The editors will be Mr. Carle Salter and Mr. F. J. W. Whipple. The change is the outcome of the British Rainfall Organisation becoming part of the service of the Meteorological Office.

THE death is announced, in his fifty-second year, of Mr. Robert Hollister Chapman, who had been connected with the U.S. Geological Survey since 1880, with the exception of the period from 1909 to 1912, during which he was engaged on topographical work in Canada. Mr. Chapman made extensive explorations in the principal Western and Southern States, and was the author of maps of Death Valley and adjacent deserts and of the high Sierras. He was secretary of the American Alpine Club. His published work includes many articles and bulletins on topographical subjects, and a book entitled "Personal Explorations in the Northern Selkirks."

THE Elizabeth Thompson Science Fund has been serviceable for many years in giving aid, by small grants, to research which otherwise might not be readily undertaken. The grants are made only for scientific investigations, and must be applied to actual expenses of the research, *i.e.* they are not made to support an investigator or to meet the ordinary expenses of publication. The trustees give preference to researches involving international co-operation. The grants are not made for researches of narrow or merely local interest, nor are they available for the equipment of private laboratories or for the purchase of apparatus ordinarily to be found in scientific institutions. Applications for grants from this fund should be made to Prof. W. B. Cannon, secretary of the trustees of the fund, Harvard Medical School, Boston, Mass.

THE Secretary of State for the Colonies has appointed a Committee to consider whether the staffs of the Veterinary Departments in the various Colonies and Protectorates are adequate, and, if necessary, to recommend increases of staff; to consider whether the rates of salary offered to the veterinary staff are adequate, and, if necessary, to suggest improvements; and to make recommendations for improving the arrangements for recruiting veterinary staffs for the Colonies and Protectorates. The members of the Committee are:—Sir Herbert Read, K.C.M.G., Assistant Under-Secretary, Colonial Office; Sir J. M'Fadyean, Principal of the Royal Veterinary College, London; Sir S. Stockman, Chief Veterinary Officer, Ministry of Agriculture; the President of the Royal College of Veterinary Surgeons; Prof. O. C. Bradley, Principal of the Royal (Dick) Veterinary College, Edinburgh; Prof. J. Share-Jones, Director of Veterinary Education and Professor of Veterinary Anatomy, University of Liverpool; and Major R. D. Furse, Assistant Private Secretary (Appointments), Colonial Office. Mr. A. Cooke, of the Colonial Office, is secretary of the Committee.

IN *Folk-lore* for December last (vol. xxx., No. 4) Dr. W. Crooke discusses the cults of the mother goddesses in India, in the hope that these may throw some light on their somewhat obscure sister goddesses in the West. The cult of Mother Earth prevails widely in India. Beginning with the type of a local fertility spirit of the village, she rapidly becomes anthropomorphised, and is supposed to enjoy a periodical rest after her labours, and to be strengthened for her benign offices by a sacred marriage with a male consort and by animal sacrifice. But in the Vedas and in the later Brahmanical Hinduism goddesses play only a subordinate part. It is among the Dravidians of Southern India that the goddess cult attains its highest development. The Earth Mother is no doubt the parent in India of many of the local goddesses, but it is going too far to assume, as some writers on the mythology of the West have done, that goddess-worship in general originated in the Earth Mother culture. Even in India many of the local goddesses come from the pre-agricultural stage, the Jungle Mothers, or they are the deified spirits of women who died in some heroic way.

Little has hitherto been known about the Stone ages in Ceylon, but the first steps towards a solution of the problem have been taken in a paper by Mr. E. J. Wayland, late Assistant Mineral Surveyor to the Government of Ceylon, published in *Spolia Zeylanica* (vol. xi., part 41, 1919). In opposition to other authorities, Mr. Wayland believes that there is no evidence that the Veddas passed through a Stone-age phase in Ceylon; they are assumed to be immigrants from the Indian peninsula, and the Palæolithic age dates from a period long antecedent to their arrival in the island. The Ceylon implements fall into two groups, that of the hills and that of the lowlands. Pigmy flints are abundant, and the author believes that they were used mainly in boring bone needles. The Chellean type is represented by the hand-axe, the Mousterian by scrapers, and the Aurignacian by pointed implements with edge trimming. An important feature of this paper is the correlation of the various types with the local geological features. Mr. Wayland has given a good introductory sketch of the subject, and by means of his large collection, which, however, needs much addition, the problem of the Stone ages in Ceylon, where the material is abundant, seems to be approaching a solution.

We welcome the reappearance of *The Mariner's Mirror,* the journal of the Society for Nautical Research. Mr. T. Sheppard contributes an article on the Hull whaling trade, once of great importance, from which the present great fish and oil trades may certainly be said to have developed. Mr. C. Pickering has made a fine collection of objects connected with the business, and presented a large museum devoted to the fishing industry. Mr. Sheppard in his article describes and illustrates many interesting exhibits—"flensers" for cutting the blubber into strips; the seal picks used by men working in masses of ice; a wrought-iron gun-harpoon bent by the speed with which the whale dragged the boat after it; one of the old explosive harpoons, known as Balchim's patent; and harpoons and gun-spears, with a collection of old guns. He also reprints an interesting journal describing the wreck of the whaler *Thornton,* which was lost in 1821. The city of Hull is honourably distinguished for the zeal and enterprise shown in the preservation of relics of its former industries.

Dr. J. W. H. Harrison has tested the effect of alcohol on a Geometrid moth, *Selenia bilunaria,* and finds the resulting offspring superior in many respects (*Journal of Genetics,* vol. ix., No. 1). In broods from treated parents the development was quicker, the mortality lower, and the mean weight of the pupæ greater. This is in agreement with Prof. Pearl's studies of the effects of alcohol on fowls, and is to be interpreted as the result of elimination of the weaker germs and individuals. The offspring from a cross between a treated male and an untreated female was superior to that from the reverse mating. Contrary to expectation, it was found that treatment with alcohol did not lead to the production of germinal variations.

In a valuable discussion of phylogenetic degeneration in the ostrich (*Journal of Genetics,* vol. ix., No. 2), Prof. Duerden, who is in charge of ostrich-breeding investigations in South Africa, concludes that over its whole continental range this bird has long been undergoing progressive degenerative changes. The toes have undergone gradual reduction as in the horse, until of the original five only the third and a much reduced fourth remain. Even the third, which is the functional toe, shows signs of further reduction. Similar retrogressive tendencies are found in the structure of the wing and in many features of the plumage. These changes are looked upon as orthogenetic in nature, pursuing a continuous course independent of natural selection or adaptation, and certain to lead ultimately to the extinction of the species. In certain cases well-marked steps in variation are taken, as in the bald spot of the North African ostrich, which behaves as a Mendelian dominant character, and is believed to have originated as a mutation. On the other hand, reduction in the wing-coverts and in the scutellation of the toes is a more gradual process, occurring by a series of steps. Contrasted with this is the down of the legs, which begins to disappear when each chick is about six months old, and is thus an ontogenetic phenomenon. In all these cases it seems clear that the seat and origin of the change is in the germ-plasm. The point of view arrived at agrees in many respects with that of Whitman (see Nature of January 29, p. 566) concerning orthogenetic evolution in pigeons.

The first part of a "Flora Arabica," by Prof. Ethelbert Blatter, is issued as vol. viii., No. 1, of the Records of the Botanical Survey of India. Prof. Blatter's work on the Indian flora, and more recently on the flora of Aden, renders him especially well equipped for the systematic study of the botany of Arabia, and he has been able also to work through the rich collections at Kew and the British Museum (Natural History). He divides the area into four natural botanical regions—the extra-tropical west, the tropical west, the tropical east, and the extra-tropical east or Persian Gulf region. Part i. comprises a systematic list of thirty-eight families of dicotyledonous flowering plants, the arrangement adopted being that of Bentham and Hooker's "Genera Plantarum." The habitats and general distribution of each species are recorded, also the vernacular names and, where known, the uses of the plants. The chief elements of the flora are the Mediterranean and North African desert.

We learn from the *Geographical Journal* for January (vol. lv., No. 1) that a new topographical map of New Zealand is in course of publication. The basis of the map is a triangulation, which already existed for cadastral surveys, supplemented by a secondary triangulation. The new map is on a scale of 1/125,000, with contours at 100-ft. intervals, and hill-shading in neutral tint. Roads, water, and wooded lands are shown in colour.

The rainfall over England in 1919 was nearly everywhere in excess of the average, according to an article in *Symons's Meteorological Magazine* for January (vol. liv., No. 648). The excess was nowhere large, exceeding 10 per cent. only in scattered patches across the southern Midlands, and reaching 20 per cent. apparently only in parts of Leicestershire. North Wales had a 10 per cent. excess, but in South Wales the summer and autumn drought resulted in many places in a 10 per cent. deficiency. Parts of the east and north of Scotland, notably northern Aberdeenshire and the Orkneys, had more than the average fall, but in central and southern Scotland there was a deficiency culminating in 20 per cent. below the average in central Inverness-shire and Perthshire. Almost the whole of Ireland had less than the average rainfall, the deficiency being greatest in counties Cork, Galway, and Kerry, where it reached 20 per cent. below the mean. Taking the British Isles as a whole, the year, although by no means exceptional, was probably the driest since 1908—a result largely due to the shortage of rain in summer and autumn.

COL. J. TILHO announced some important discoveries in the Sahara in a paper read before the Royal Geographical Society on January 19. The Tibesti highlands prove to be an enormous triangular massif twice the area of Switzerland, with summits more than 10,000 ft. in height. Emi Kussi, the culminating point of the region, is the largest of a series of extinct volcanoes. This volcano has a well-formed crater, which in the past was occupied by a lake, but now has a thick deposit of sodium carbonate on the floor. The population of Tibesti is considerable, and is devoted to camel-rearing and brigandage. Col. Tilho claims to have disproved the possibility of former river connection between Lake Chad and the Nile. His explorations show an extension of the highlands formerly known to occur between the southern borders of Tripoli and Darfur. With regard to the economic development of the Sudan and the Sahara, Col. Tilho advocates an east-and-west transcontinental railway. That this would facilitate the pilgrimage to Mecca is an important consideration for great Mohammedan Powers like Britain and France.

DR. G. F. KUNZ, the well-known authority on the subject of jewelry in all its aspects, contributes to *Mineral Industry* (New York: McGraw-Hill Book Co., Inc.; London: Hill Publishing Co., Ltd., 1919, vol. xxvii., pp. 604–28) his customary chapter on the production of precious stones for the previous year. It may be remarked that this annual volume is written from the point of view of the United States. Rather more than two-thirds of this chapter is devoted to diamond, pre-eminently the precious stone. The jewelry trade is such a sensitive barometer of general trade conditions that we are not surprised to read that the incidence of heavy war expenses and the increase in taxation had sensibly checked the import of precious stones into the United States in the year 1918; the initial figures for 1919 show, however, that the setback was only temporary. We note that in the United States, just as in this country, successful attempts appear to have been made to develop the diamond-cutting industry. We are told that the output of gem material in the Rangoon district of Burma for the year 1917, which is the latest year dealt with, was of much higher value than that of the previous year, although the quantity produced was slightly less. The jade output in North Burma, which is wholly exported to China, where it is highly prized, remains as prosperous as ever. The United States does not produce much gem material, what there is being confined mainly to ruby, sapphire, turquoise, quartz, and tourmaline, although diamonds are being mined in Arkansas.

IN a paper on the factors controlling climate, which appears in the December, 1919, issue of the Journal of the Franklin Institute, Prof. W. J. Humphreys, of the United States Weather Bureau, discusses the theories which have been propounded to account for the existence in the past of "Ice ages," which, after enduring for a time, were succeeded by long periods during which the conditions were again normal. Solar variation, eccentricity of the earth's orbit, and carbon dioxide in the earth's atmosphere are shown not to be capable of affording satisfactory explanations, while the presence of volcanic dust in the atmosphere for any considerable period is proved to be capable of accounting for a fall of temperature of a few degrees Centigrade. The finest dust from Krakatoa probably reached an altitude of 40 to 80 km., and took nearly three years to fall through the isothermal layer of the atmosphere to the level of the upper clouds. If the coefficient of absorption of solar radiation by the dust is greater than its coefficient for terrestrial radiation, the value of the pyrheliometric constant will be diminished. The author shows that there is abundant evidence of this diminution after every considerable volcanic eruption.

AT the meeting of the Illuminating Engineering Society on January 27 a discussion on colour-matching by natural and artificial light took place. Mr. L. C. Martin, in opening the discussion, gave a summary of existing methods of producing artificial daylight. One of the most convenient devices has been the use of a special tinted glass transmission screen used with electric incandescent lamps to remove the excess of red and yellow rays. With the gas-filled lamp the efficiency of such units is considerably improved, 33 per cent. being claimed for a sunlight unit and 19 per cent. when light from the blue sky is imitated. A communication from Mr. M. Luckiesh, read later in the evening, showed how widely such units are being used in the United States. Mr. Martin exhibited the Sheringham daylight lamp, and explained that the overall efficiency of the blue-sky unit was not widely removed from that obtained with similar units using blue transmission screens. On the other hand, the diffusion of the light from the extensive coloured reflector surface used with the Sheringham lamp is considered a distinct advantage. Mr. Martin also showed some very striking colour changes in dyed fabrics seen successively under artificial daylight and light from a tungsten lamp. Mr. Bawtree exhibited a form of colorimeter for the analysis of colour, and Miss F. E. Baker, in showing the tintometer testing apparatus, also described some experiments on a new form of daylight lamp. A communication from Prof. Gardner, of Bradford Technical College, was also read. The production of artificial daylight is exciting keen attention, and several speakers emphasised the need for a systematic comparison of the various existing units and the establishment, if possible, of a standard of so-called "white" light.

WHILST the chemistry of gelatin has been investigated with much care, less attention has been given to that of glue. Both gelatin and glue are hydrolytic products of the collagen present in hides, but they represent different phases of the hydrolysis, and the details of the manufacture of glue have largely been kept secret. Crucial points are, first, the stage at which the process of hydrolysis must be stopped and the degree of concentration necessary in order to obtain a glue solution which will "set" to a jelly; and next, the method of drying this jelly into the finished glue. A low temperature has been considered necessary for successful drying, and also for avoiding bacterial action during the process. Hence the making of glue in warm countries, such as India, has hitherto not been found practicable. A paper by Mr. K. C. Srinivasan, of the Department of Industries, Madras ("The Manufacture of Glue in the Tropics"), describes how the foregoing points have been investigated by the Department, and the difficulties overcome. It is claimed that by a study of the chemical principles involved, and by laboratory and factory experiments, the details of manufacture have been successfully adapted to the climatic conditions prevailing even in the hottest parts of India.

MR. D. BROWNLIE gives some further exact data on the running of steam-boiler plants in *Engineering* for January 16. The subject dealt with is that of steam jets under or over the fire-bars, and out of the 250 typical steam-boiler plants examined no fewer than 93 plants, or 37 per cent., were fitted with steam jets. The makers of the various types of furnaces so fitted confess, as a rule, to a modest 1 to 3 per cent. of the steam production being used in the jets. Mr. Brownlie finds that the average steam consumption for the 93 plants is 5·6 per cent. of the total steam produced, and that the figure varied from 1 to 20 per cent. In the present article the results derived from 130 plants are considered, including 437 boilers both hand- and mechanically-fired. The averages are 6·6 per cent. for hand-firing and 6·7 per cent. for mechanical-firing. The lowest figure was 0·50 per cent., and the highest 21·4 per cent. If a given plant were taken in hand and scientific methods of control adopted, figures like 7½ to 15 per cent. of the steam production could be cut down to 3 or 4 per cent. with most types of steam-jet apparatus. Some of the apparatus in use is of crude and unscientific design, and incapable of giving good results. Mr. Brownlie estimates that a saving for the whole country of from 1,025,000 to 1,345,000 tons of coal per annum could be effected, partly by proper control and partly by getting rid of steam jets working under unsuitable conditions.

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just issued a list of secondhand books (many of which are from their circulating library) in medicine and allied subjects which should be seen by all in search of books of this character at bargain prices. The reductions in many cases are very great. Messrs. Lewis have also sent us a list of the new books and new editions added to their medical and scientific circulating library during the months October to December last.

Messrs. Cassell and Co., Ltd., promise for February a book of travel by Sir Martin Conway entitled "Mountain Memories: A Pilgrimage of Romance," illustrated by the author. The new list of *Messrs. Constable and Co., Ltd.*, includes "Elementary Mathematics," H. E. J. Curzon; "Electric Welding and Welding Appliances," H. Carpmael (*Engineer* Library); "Paper-making and its Machinery," T. W. Chalmers (*Engineer* Library); "Calculation of Electrical Conductors," W. T. Taylor; "Low Grade and Waste Fuels for Power Generation," J. B. C. Kershaw; "Reinforced Concrete Diagrams," J. Williamson; "The Measurement of Steady and Fluctuating Temperatures," R. Royds; "Heat Transmission," R. Royds; "The Efficiency of Pumps and Ejectors," E. C. Bowden-Smith; "Oil-Firing for Kitchen Ranges," E. C. Bowden-Smith; "Storing," H. B. Twyford; "Public Health Chemical Analysis," R. C. Frederick and A. Forster; "Human Psychology," H. C. Warren; "Wild Creatures of Garden and Hedgerow," F. Pitt; and new editions of "The Propagation of Electric Currents in Telephone and Telegraph Conductors," Prof. J. A. Fleming; "The Theory of Electric Cables and Networks," Dr. A. Russell; and "Ship Form Resistance and Screw Propulsion," G. S. Baker.

THE February list of *Messrs. Longmans and Co.* contains announcements of many books relating to science and education. Among those not already alluded to in NATURE we notice "The Valuation of Mineral Property," Sir R. A. S. Redmayne and G. Stone; "Cement," B. Blount; "Plantation Rubber," G. S. Whitby; and "Margarine and Butter Substitutes," W. Clayton (Monographs on Industrial Chemistry); "The Principles and Designs of Printing Telegraph Systems and Mechanisms," H. H. Harrison; "Telephone Exchanges: Automatic Equipment," B. O. Anson; "Telephone Exchanges: Manual Equipment," H. S. Thompson; "Subscribers' Telephone Equipment," H. S. Thompson; "Overhead Construction," J. W. Atkinson; "Underground Construction," A. O. Gibbon; "Inland Telegraph and Submarine Cable Office Equipment," E. Lack; "Railway Telegraphs," C. W. Slingo; and "Testing of Lines, Apparatus, and Material," F. L. Henley (Manuals of Telegraph and Telephone Engineering); "Applied Naval Architecture," W. J. Lovett; "Industrial Administration," a series of lectures by B. S. Rowntree, T. H. Pear, A. E. Berriman, Dr. J. M. Legge, Prof. L. Hill, T. B. Johnstone, and St. George Heath; "Forage Crops in Denmark," H. Faber; "The Fireman's Handbook and Guide to Fuel Economy," C. F. Wade; "An Essay on Mediæval Economic Teaching," G. O'Brien; and a new edition, in two parts, of "Optical Projection: A Treatise on the Use of the Lantern in Exhibition and Scientific Demonstration," Lewis Wright, rewritten by his son, R. S. Wright, part 1, illustrated.

OUR ASTRONOMICAL COLUMN.

COMETS.—The object announced last week as comet 1920*a* appears to be a minor planet. It was so described by the discoverer, but through some telegraphic confusion was reported as a comet.

Two comets were discovered in December. The first, 1919*f*, was recorded on two plates taken on December 10 at Bergedorf, Hamburg, by Dr. Baade. It is probably identical with Holmes's comet, for which a search ephemeris had been calculated. If so, perihelion passage occurred about November 22.

Comet 1919*g* was discovered by Mr. J. F. Skjellerup at the Cape of Good Hope on December 18, and was also observed by Mr. Woodgate at the Cape Observatory. Dr. Halm sends the following provisional elements:

$$T = 1920 \text{ January } 2{\cdot}674 \text{ G.M.T.}$$
$$\omega = 276^\circ\ 35'$$
$$\Omega = 315^\circ\ 36'$$
$$i = 123^\circ\ 10'$$
$$\log q = 9{\cdot}47376$$

The elements bear some resemblance to those of the comet of 1797, also to 1808 I.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	S. Decl. ° ′	Log r	Log Δ
Feb. 10 ...	20 31 52	4 34	0·0189	0·2869
		N. Decl.		
20 ...	20 34 28	0 7	0·0934	0·3095
March 1 ...	20 36 8	4 29	0·1541	0·3245
11 ...	20 36 42	8 43	0·2049	0·3337

The comet is now rather close to the sun, but should be visible in the morning in March.

THE MOTION OF THE MOON.—Dr. J. K. Fotheringham contributed a paper on this subject to the Royal Astronomical Society in January. He showed, as others have done, the necessity for applying an empirical term to the moon's longitude, and the impossibility of determining both that term and the value of the secular acceleration from modern observations alone. Accordingly, various periods were assumed for the empirical term, and the corresponding values of the acceleration deduced. The period 254 years is preferred, as this gives the same value 10″ for the acceleration as that deduced from ancient eclipses. Prof. Turner had found a period of about 240 years from a discussion of Chinese earthquakes and Nile floods. It was suggested that the two periods might be identical, and that the apparent oscillation in the moon's motion was really a change in the earth's period of rotation.

The observations used extend to the end of 1918, ten years later than those used by Drs. Brown and Cowell. These additional observations have considerable influence on the result.

STARS OF HIGH VELOCITY.—In most studies of stellar motions the stars with abnormally high velocities are excluded, which is doubtless a sound principle. Nevertheless, an examination of these motions is of great interest, and was undertaken by Messrs. W. S. Adams and A. H. Joy (Proc. Nat. Acad. Sci., Washington, July, 1919). The highest velocity in space found for any star is 494 km./sec. for the 9th mag. star A.G. Berlin 1366. On the average, the two components of the velocity in the galactic plane are about equal, and 2½ times the component perpendicular to the plane. Nearly a hemisphere in galactic longitude is devoid of apices, the values all lying between 131° and 322°. The centroid of the thirty-seven stars examined has a velocity exceeding 74 km./sec., almost exactly in the galactic plane. These facts seem to establish that the velocities have been generated within our own star system, and that the stars are not mere visitors from outside, as has sometimes been suggested. They are probably mostly of small mass, but this can scarcely be the case with Arcturus, the high velocity of which remains an enigma. It is noted that twenty-six out of the thirty-seven stars are of spectral types F and G.

THE ST. LOUIS MEETING OF THE AMERICAN ASSOCIATION.

THE seventy-second meeting of the American Association for the Advancement of Science was held in St. Louis, Mo., on December 29 to January 3, under the presidency of Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, New York City. The meeting was a most successful one, the attendance of scientific men reaching approximately twelve hundred. St. Louis is the fourth city of the United States in size, and is an extremely progressive centre, paying much attention to educational matters and possessing two universities, two admirable medical schools, an academy of science, the great Missouri Botanical Gardens, and an extraordinarily advanced system of institutions for secondary education. All the meetings (and there were thirty-two distinct organisations meeting at the same time, twelve of them being sections of the association) were held in the single building known as the Soldan High School. In this building there are very many large lecture-rooms with lantern and laboratory facilities, one auditorium with a seating capacity of more than two thousand, and a dining-room with about the same accommodation, and thus the necessity of meeting in distinct and sometimes widely separated buildings, as has occurred in other cities, was avoided.

The opening session was held on Monday night, December 29. Chancellor Hall, of Washington University, St. Louis, delivered an address of welcome, and the retiring president, Prof. John Merle Coulter, gave his address (published in NATURE of January 29, p. 581) on "The Evolution of Botanical Research."

On the following night a lecture, complimentary to the citizens of St. Louis, was delivered by President Simon Flexner on the general subject of the medical outlook in research. The trend of the address was optimistic, and the subjects especially mentioned were influenza, yellow fever, poliomyelitis, and cancer.

During the week addresses by chairmen of sections were delivered as follows:—Section A, "Recent Progress in Dynamics," George D. Birkhoff; Section B, "Some Aspects of Physics in War and Peace," Gordon F. Hull; Section D, "Science and Modern Engineering," Ira N. Hollis; Section E, "Geology as Taught in the United States," David White; Section H, "The Relations of Anthropology and Psychology," Ales Hrdlička; Section I, "New After-the-War Phases of Practical Pan-Americanism," John Barrett; Section K, "The Untilled Fields of Public Health," C. E. A. Winslow; Section L, "The Part Played by Heredity and Maturity as Factors Conditioning the Effects of Training," Stuart A. Courtis; and Section M, "The Organisation of Research," Henry P. Armsby.

There were also a number of symposia, which attracted much attention, as follows:—"World Standardisation" and "Education and Practical Work on the Metric Basis," under the auspices of the American Metric Association; "The Life-cycle in Insects," under the auspices of the Entomological Society of America; "The Relation of the Use of Power and Labour-saving Machinery to Agricultural Progress," under the auspices of Section M; "The Adjustment of Agricultural Teaching and Research to Changing Conditions," under the auspices of the Society for the Promotion of Agricultural Science; and "The Effects of the War upon Experimental Medicine and Physiology," under the auspices of Section K.

It was an important meeting from the point of view of association business, since the revised constitution was adopted, a copy of which has been published in the journal *Science*. The principal changes in the constitution which will be of interest to members of the British Association are the raising of the annual dues from three dollars to five dollars and of the life-membership fee from fifty dollars to a hundred dollars, the re-lettering of some of the old sections and the adding of new sections. The old Section A, *Mathematics and Astronomy*, has been divided, and A is now *Mathematics* and D *Astronomy*. The old Section H, *Anthropology and Psychology*, has been divided into two sections: H, *Anthropology*, and I, *Psychology*. *Social and Economic Science* becomes Section K; the Section of *Engineering* becomes Section M, and that of *Medical Science* Section N; *Agriculture* becomes Section O, and *Education* Section Q. The titles of the old Sections F and G, namely, *Zoology* and *Botany*, have been changed to *Zoological Sciences* and *Botanical Sciences*. Two new Sections—L, *Historical and Philological Science*, and P, *Manufactures*—have been established, although they will not be organised at present.

The work of the old office of the permanent secretary has been divided, and it has been arranged that a general secretary shall take charge of all features of organisation, while the permanent secretary shall be simply an executive officer to have charge of meetings and of the current finances of the association.

Chicago was chosen for the place of the next annual meeting during holiday week 1920–21, and a schedule of future meetings was tentatively drafted as a guide for affiliated societies in forming their plans for future meetings. This tentative programme includes Toronto or Buffalo for 1921–22, Boston for 1922–23, Cincinnati for 1923–24, and Washington for 1924–25. The Chicago meeting next year will be one of the large fourth-year meetings, that in Washington in 1924–25 being another of these specially large meetings. It is hoped that all the affiliated societies, and, in fact, all scientific men in America who can do so, will make a special effort to attend these fourth-year meetings, and that men of science from other countries also will be able to attend.

Arrangements were made for the establishment of geographical branches of the association and for the affiliation of State and city academies of science.

The newly established American Meteorological Society and the Southern Educational Society were admitted to affiliation.

A committee on international auxiliary languages was authorised to co-operate with a corresponding committee of the British Association and with the International Research Council.

The following affiliated societies met with the association:—American Mathematical Society, Mathematical Association of America, American Physical Society, American Meteorological Society, Society for Promotion of Engineering Education, Association of American Geographers, National Council of Geography Teachers, American Society of Zoologists, Entomological Society of America, American Association of Economic Entomologists, American Nature-Study Society, Botanical Society of America, American Phytopathological Society, American Pomological Society, Ecological Society of America, American Society for Horticultural Science, Association of Official Seed Analysts, Society for Promotion of Agricultural Science, American Metric Association, and Wilson Ornithological Club.

The election of officers by the general committee resulted in the selection of Dr. L. O. Howard, of Washington, as president for the coming year. The following vice-presidents (chairmen of sections) were elected: Section A—D. R. Curtis, Northwestern University; Section B—J. C. McLennan, Toronto University; Section C—S. W. Parr, University of Illinois; Section D—Joel Stebbins, University of Illinois; Section E—Charles Schuchert, Yale University; Section F—J. S. Kingsley, University of Illinois; Section G—R. H. True, Bureau of Plant Industry, Washington, D.C.; Section H—G. B. Gordon, American Museum of Natural History, New York; Section I—E. K. Strong, jun., Carnegie Institute of Technology, Pittsburgh; Section M—C. L. Mees, Rose Polytechnic Institute, Terre Haute; Section N—J. Erlanger, Washington University, St. Louis; and Section Q—C. H. Judd, University of Chicago.

The election of the chairmen of Sections K, L, O, and P was deferred for the present. Prof. E. L. Nichols, of Cornell University, was elected general secretary, and the selection of a permanent secretary to succeed Dr. Howard, who has held office for twenty-two years, was referred to the council, with power to act.

PIONEERS IN THE SCIENCE OF THE WEATHER.[1]

THE year 1919 will be memorable in the annals of meteorology. It witnessed the completion of the process of co-ordination of the national meteorological work in the operations of a single institution by the incorporation of the work of the British Rainfall Organization with the Meteorological Office. Beginning with the meteorology of the sea alone in 1854, when it was a department of the Board of Trade, in 1867, after FitzRoy's death, the Office undertook the mapping and the study of the daily sequence of weather, and on that account was placed in charge of a director with a "grant in aid" from Parliament under the control of a committee appointed by the Royal Society. In 1879, under a directive council, also appointed by the Royal Society, it became generally responsible for the publication of the national contribution of climatological data in accordance with an international scheme laid down by the Meteorological Congresses of Vienna in 1874 and Rome in 1879. In discharge of this duty it was authorised to obtain the aid of the Royal and Scottish Meteorological Societies and of the British Rainfall Organization; it was also empowered to recognise the duty of development of meteorological science by experiments and special investigations.

From the early years of the twentieth century the collection of the climatological data of private observers became more and more associated with the Office, until now, by the transfer of the British Rainfall Organization, the co-ordination is completed, and the compilation of information of all kinds about weather is recognised as a common public duty centred in the Meteorological Office.

At the same time, in the course of the year, by a decision of the War Cabinet on May 8, 1919, the Office itself has been "attached" to the Air Ministry; and, instead of deriving the public funds for its maintenance directly from Parliament through the Treasury, it will receive them through the Air Council, and the Air Minister will be responsible to Parliament for them. What modifications of procedure are involved in the change are not yet known.

Since the year marks so important an epoch in meteorological history, the anniversary meeting of the

[1] Abstract of the presidential address delivered to the Royal Meteorological Society on January 21 by Sir Napier Shaw, F.R.S.

society is an occasion on which we may commemorate those of our countrymen who have contributed to the organisation and development of meteorological science. From the time of the invention of the barometer by Torricelli in 1643, proceeding in chronological order, we find examples of the experimental investigation of the properties of air in the work of the Hon. Robert Boyle (1627), natural philosopher and philanthropist; of the design of meteorological instruments in Robert Hooke (1635), the first demonstrator of the Royal Society; of the compilation of observations at sea in the remarkable discourse on winds by William Dampier (1652), sailor and buccaneer; of meteorological theory in Edmund Halley (1656), natural philosopher and Astronomer Royal; in George Hadley (1686), a lawyer who explained the trade winds; and James Hutton (1726), a physician who developed a theory of rain.

Next come Richard Kirwan (1733), a weatherwise Irish gentleman, "consulted about the weather by half the farmers of Ireland," with ideas about the meteorology of the globe on the basis of the distribution of temperature; Charles Wells (1757), physician of St. Thomas's Hospital, who elaborated the theory of dew; John Dalton (1766), famous for his atomic theory, teacher of mathematics and natural philosopher of Manchester, who put the theory of water-vapour in the atmosphere upon a physical basis, a lifelong meteorological observer, and a student of the aurora, the height of which he measured successfully; Luke Howard (1772), a successful manufacturing chemist, an assiduous meteorologist who classified clouds, introduced automatic records of the barometer, discoursed on the climate of London, and studied the influence of the phases of the moon; Admiral Sir Francis Beaufort (1774), Hydrographer of the Navy, who devised the Beaufort scale of wind-force and the Beaufort alphabetical notation for weather at sea; Sir Edward Sabine (1788), Royal Engineer, secretary and, later, president of the Royal Society, and also general secretary of the British Association, who obtained the co-operation of those three great agencies in the magnetic survey of the British Isles, the trigonometrical survey of India, and the establishment of magnetic observatories in Toronto, St. Helena, the Cape, India, and elsewhere in the British Dominions, and of meteorological observations at all the foreign and Colonial stations of the Royal Engineers and Army Medical Department, and who lived long enough to become the first chairman of committee of the Meteorological Office; John Frederic Daniell (1790), professor of chemistry, the inventor of the Daniell cell and the Daniell dew-point hygrometer, a meteorological essayist, and a writer on artificial climates for horticulture; and, finally, William Reid (1791), major-general of the Royal Engineers, and Henry Piddington (1797), merchant seaman, author of "The Sailor's Horn Book," who made most notable contributions to the analysis of the phenomena of what the latter first called "cyclones," and are now in their various forms the familiar elements of interest in the daily charts of weather prepared by meteorological offices all over the world. William Whewell (1796), the omniscient Master of Trinity, may perhaps be added as representing anemometry, thus carrying on the story of weather science as developed by those born before the end of the eighteenth century, and so bringing the history to the middle of the nineteenth, when the society was founded.

These names and histories show from what various sources meteorology has derived its ideas, its initiative, and its support. In the future, as in the past, the science must preserve its wide outlook.

THE REDUCTION OF WAVE ACTION IN HARBOURS.

THE important question of the best means of effecting the maximum reduction of wave action in harbour areas formed the subject of four papers read before the Institution of Civil Engineers on January 13. Next to affording the readiest and safest accessibility under extremely adverse conditions of weather and tide, the exclusion of storm waves, or rather their reduction within limits of harmlessness, is the most pressing concern of the harbour engineer. Unfortunately, the conditions essential to the attainment of the former desideratum are not often conducive to the realisation of the latter. The criticism has been passed on at least one modern harbour of importance that in tempestuous weather the sea is as rough inside as outside. Where large areas have to be enclosed in order to afford the necessary accommodation for shipping, it is a matter of considerable difficulty to provide simultaneously the equally necessary degree of shelter.

Four river harbours—those at the mouths of the Tyne, the Wear, the Esk, and the Blyth, all on the north-east coast of England—were under consideration. In the first two the principle of wide encircling piers had been adopted, with an entrance width on the Tyne of 1200 ft. and on the Wear of 700 ft.; in the second two there is the contrast of a comparatively narrow way or passage from 200 ft. to 400 ft. in width between fairly, or roughly, parallel piers, with intercepting jetties, or wave-traps, at intervals in their lengths. The semicircular arms afford expanding areas of large proportions, wherein the entering waves are diffused and a large amount of their energy dissipates itself harmlessly on spending beaches flanking the entrance to the inner harbour. On the other hand, the openings provided in the overlapping sides of parallel piers deflect a certain portion of the wave from its course and pass it out again to sea. Both systems have their merits, and all the authors claimed that the desired results had been obtained by the method adopted in the particular cases. At Blyth sea-waves of 10 ft. to 12 ft. in height at the pierheads are reduced to 6 in. to 24 in. in mid-harbour, while at Sunderland the factor of wave-reduction is 65 per cent.

In forming a judgment on the respective claims, it must be borne in mind that much depends on the character of the port. Obviously, an internal wave action which might be without prejudicial effect on a large mercantile liner might be fatal to small fishing craft. It is difficult also to detach the problem from the particular conditions of site and coastal configuration. Spending beaches are no doubt admirable adjuncts to a harbour, but they are not always available, nor are the financial resources of ports always commensurate with bold and ample schemes of accommodation. With the means at his disposal, the task of the engineer is to secure the best compromise possible: an adequate degree of tranquillity combined with a serviceable entrance width. Circumstances may favour one method or the other. Even after general lines have been laid down, it will certainly be found wise to proceed tentatively and cautiously in the execution of the design. Much useful information can be gained during the progress of the work, and the exact position and width of the entrance may often be left to a late stage of the operations.

BRYSSON CUNNINGHAM.

ST. ANDREWS INSTITUTE FOR CLINICAL RESEARCH.

THE recent opening of an institute for clinical research in St. Andrews marks the beginning of a new era in the scientific development of the art of medicine. The enterprise has been initiated and brought to a happy stage of working order by Sir James Mackenzie, who is the director and controlling mind of its endeavours.

Briefly, the object of the institute is to investigate the early symptoms of disease before structural alterations in the body have had time to take place. Hitherto research has been mainly concerned with disease and its more advanced forms when structural and chemical changes can be detected by ordinary laboratory methods. But at the beginnings of disease symptoms of various kinds, often seemingly trivial, do occur. They become familiar to many general practitioners, though no serious attempt has been made to determine their cause and significance and to draw up a classification which will enable the medical man to appreciate their real meaning and thus put him into the position of being able to detect and arrest incipient disease.

For such purposes a small centre of population, where the same patients can be seen frequently and observed over long periods of time, is preferable to the larger centre with its rapidly moving population. St. Andrews should provide an ideal site, and has the further advantage of possessing a university and medical school with all that these imply. A suitable building has been secured overlooking the bay and in close proximity to the historic golf course.

The institute is affiliated to the University. Its staff consists of a director, a director of laboratory research, a trained biological chemist, a bacteriologist (to be appointed), a whole-time clinical assistant, and several part-time clinical assistants who are also practitioners in the town.

Three days a week patients are examined, and two days are given over to general discussions. The latter are wide in scope, and are freely opened to anyone who has anything to contribute. The trained logician and psychologist are especially welcome, and not infrequently join in the debate.

The institute is also educative, and aims at the training of the practitioner in the methods of research.

The institute has now been at work for some months, and is already bearing fruit. It has promoted harmony and goodwill and a keen interest in their work among its members. It provides an excellent model for the development of other centres, and shows how a spirit of co-operation can be fostered among medical men which is of mutual benefit to themselves and to their patients. The scientific results will follow.

P. T. Herring.

FISHERY INVESTIGATIONS IN SOUTH AFRICA.

THE Marine Biological Report of the Province of the Cape of Good Hope (No. 4) for the year ending June 30, 1918, has recently been received. The report is signed by Prof. J. D. F. Gilchrist, and although it appears that his department has been greatly restricted by lack of funds, it is clear that much useful work was done during the year under review. It is well known that a valuable industry in canning and exporting the local crawfish has been developed successfully at the Cape in recent years, and perhaps the most interesting feature of the report is an account of the habits of the different larval stages of this crustacean. The first larva of *Jasus lalandii* is small, somewhat opaque, and swims at the surface by its feather-like antennæ, the other appendages being folded close to the body and not used. This first stage, known as a "naupliosoma," continues for only a few hours, when it passes into the flattened "phyllosoma" stage. The larvæ in this stage are able to swim in a horizontal direction, but their natural habitat is still the surface waters. They were successfully reared, and after three or four days at most they passed into the third larval stage, in which they descend to the bottom and seek out the darkest corners. They then feed actively on the small animal and vegetable particles in the mud and sand, and are comparatively free from the attacks of their enemies. After undergoing a series of moults, which do not yet appear to have been followed in detail, the larva enters the "puerulus" stage, which has hitherto been found only close inshore.

Details of a number of experimental hauls for crawfish in different localities are given in the report, as well as an account of some marking experiments, which have thrown light upon the migrations of this crustacean. A useful list is added of the different species of lobsters and crawfishes found in South African waters, with short, popular descriptions drawn up by Mr. K. H. Barnard. Prof. H. B. Fantham contributes a short article on parasitic protozoa found in South African marine fishes, and the third and final list of Cape fishes, drawn up by the late Mr. W. Wardlaw Thompson, is included in the report. The strong recommendation of Prof. Gilchrist that the scientific fishery investigations, which have been suspended for a number of years, should now be resumed is one which will have the hearty support of all marine biologists, who know the valuable work which was formerly carried out under his direction.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Birmingham.—At the meeting of the council held on January 29, the Pro-Vice-Chancellor in the chair, Mr. C. Grant Robertson received a cordial welcome as Principal of the University.

The thanks of the council have been accorded to Mr. Arthur Serena for his generous offer to provide a sum of 5000*l.* towards the endowment of a department of Italian studies and a chair of Italian. Also to Mr. John Smith, of Edgbaston, for his offer to endow a prize for students in metallurgy in some educational establishment or establishments in Birmingham, to commemorate the contributions made by Prof. Turner to the science of metallurgy, to be known as "the Thomas Turner prize (or prizes) in metallurgy."

Lt.-Col. J. E. Dixon (Messrs. Rabone Bros.), Mr. Frank Gower (the Birmingham Aluminium Casting Co.), and Mr. Donald Hope (Messrs. Kynochs, Ltd.) have been appointed members of the Commerce Advisory Board.

Prof. John Robertson and Dr. C. J. Lewis have been appointed representatives of the University at the Congress of the Royal Sanitary Institute to be held in Birmingham in July next.

Mr. James Young has been appointed an assistant lecturer in the department of physics.

Cambridge.—The offer of a fund to endow a John Couch Adams astronomership in the University is announced. The offer was made by the late Mrs. Adams, widow of Prof. Adams, the discoverer of Neptune. The post, if established, is to be held by the director of the observatory unless he be at the same time a professor of the University, in which case it should be held by a duly qualified person of skill and experience in astronomy not necessarily a member of the University. The income of the fund is about 300*l.*

A further offer is made by the family of the late Dr. E. G. Fearnsides to endow an E. G. Fearnsides scholarship to further clinical research among the organic diseases of the nervous system. The scholarship would be held by Cambridge men for two years between the ends of their fourth and eleventh years. The award is biennial, and the income 50*l.* a year.

Mr. H. M. Fox, Mr. F. Debenham, and Mr. C. N. H. Lock have been elected fellows of Gonville and Caius College for research work in zoology, geology, and mathematics respectively.

LONDON.—Dr. Samuel Smiles has been appointed to the Daniell chair of chemistry tenable at King's College in succession to Prof. A. W. Crossley. Last year Dr. Smiles was appointed professor of organic chemistry at Armstrong College, Newcastle, and since 1913 he has been senior honorary secretary to the Chemical Society.

Dr. H. E. Roaf has been appointed to the University chair of physiology tenable at the London Hospital Medical College. From 1902 to 1905 Dr. Roaf held the Johnston Colonial fellowship in the University of Liverpool, where he has also been assistant lecturer on, and senior demonstrator of, physiology and histology and lecturer on chemical physiology. Since 1911 he has been lecturer on physiology at St. Mary's Hospital Medical School. For three years during the war he was in charge of the pathological laboratories at Cairo.

Prof. T. Swale Vincent has been appointed to the University chair of physiology tenable at the Middlesex Hospital Medical School. Prof. Vincent was formerly demonstrator of physiology in the University of Birmingham and Sharpey scholar and assistant professor of physiology at University College, London. Since 1904 he has been professor of physiology and biochemistry in the University of Manitoba.

The cordial thanks of the Senate have been voted to the general committee formed to promote the institution of degrees in commerce and the organisation of commercial education in the City of London and throughout the Empire for a gift of 50,000*l.* to be devoted to the extension of the buildings of the London School of Economics upon land provided for this purpose at a nominal rent by the London County Council.

A resolution was adopted by the Senate on January 28 expressing appreciation of the generosity of Messrs. S. B. and J. B. Joel in presenting 20,000*l.* for the endowment of a University chair of physics tenable at the Middlesex Hospital Medical School. Steps are being taken immediately for the appointment of the first incumbent of this professorship, which will bear the name of the donors.

The Franks studentship in archæology is open to a student qualified to undertake research or to prepare for the same. It is for the period of a year, and of the value of 50*l.* Full particulars are obtainable from the Academic Registrar of the University of London, South Kensington, and applications for the studentship must be received by, at latest, the first post of March 2.

The following doctorates have been conferred:—*D.Lit.*: Mr. R. E. M. Wheeler, an internal student, of University College, for a thesis entitled "Comparative Notes on Rhenish Pottery of the Roman Period." *D.Sc.* (*Engineering*): Mr. Marcel Tolkowsky, an internal student, of the Imperial College, City and Guilds College, for a thesis entitled "Diamond Grinding, Abrading, and Polishing."

MANCHESTER.—Mr. Frank Watts has been appointed lecturer in psychology in the University. Mr. Watts is the author of the recently published book, "Echo Personalities," a study of the contributions of abnormal psychology towards the solution of some problems of normal education.

OXFORD.—On February 3 Convocation resolved that Mr. E. S. Goodrich should be constituted professor of comparative embryology for so long as he holds the appointment of Aldrichian demonstrator in comparative anatomy. The resolution was proposed by the Rev. G. B. Cronshaw, Queen's College, and supported by Prof. Gilbert C. Bourne, Linacre professor of zoology and comparative anatomy.

The amended statute making the study of the Greek language optional for all students will come before Congregation on February 10. At a later date not yet fixed it will be submitted to Convocation. Opposition may be expected, as in many quarters it is not considered desirable that candidates for honours in such schools as that of "Literæ Humaniores" should be exempted from the study of Greek. If Prof. Gilbert Murray's amendment, exempting all science men, mathematicians, and passmen, had been carried, it is probable that no opposition would have been offered to the statute on the part of the advocates of Greek.

COMMDR. C. HAWKES has been appointed to succeed Prof. R. L. Weighton in the chair of engineering at Armstrong College, Newcastle-upon-Tyne.

DR. T. F. SIBLY, at present professor of geology at Armstrong College, Newcastle-upon-Tyne, has been appointed principal of the University College of Swansea.

SIR ARCHIBALD GARROD will deliver the Schorstein memorial lecture at the London Hospital Medical College on Friday, February 20, at 4 o'clock. The subject will be "Diagnosis of Disease of the Pancreas."

THE Women's Medical Association of New York City is offering the Mary Putnam Jacobi fellowship of about 200*l.* for post-graduate study in any country to any woman physician for work in any branch of medical science. Particulars are obtainable from Dr. Murrell, 86 Porchester Terrace, W.2.

THE lectures for teachers on recent developments in science arranged by the London County Council include a lecture on "Aviation" to be given by Mr. F. Handley Page at King's College, Strand, W.C.2, on Saturday, February 28, at 11 a.m. The chair will be taken by Sir Arthur Duckham, K.C.B.

A REUNION dinner of Old Centralians—the first to be held for six years—will take place on Saturday, February 21, at the Waldorf Hotel, Aldwych, W.C.2, tickets for which may be obtained from Mr. G. W. Tripp, Lyndhurst, Hayes Road, Bromley, Kent. We understand that Prof. Armstrong, Sir Alfred Keogh, and Prof. Unwin have accepted invitations to be present.

A CORRESPONDENT informs us that the New South Wales Parliament, in the session that closed in December last, passed an Act granting the University of Sydney a sum of 300,000*l.* for building purposes, the grant to consist of six annual instalments of 50,000*l.* The grant is in addition to the statutory endowment, and is called for by the rapid growth of all the departments of the University. It will allow the University to devote the whole of the McCaughey bequest to the extension of the present resources in staff and equipment, and the encouragement of research.

A SCHEME for the establishment of a University Bureau in the City of London in connection with the University of London commerce degree is described in the *Times* of January 30. It is proposed that the bureau shall assist in the suitable and wide employment of commerce degree students and graduates in all branches of trade and commerce throughout the country and assist employers in all matters affecting the training and employment of all such students and graduates. An initial sum of 50,000*l*. has been set aside for the purpose of establishing the bureau on a proper footing.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 22.—Sir J. J. Thomson, president, in the chair.—Prof. E. G. **Coker** and K. C. **Chakko**: The stress-strain properties of nitro-cellulose and the law of its optical behaviour. The physical properties of nitro-cellulose are studied from its behaviour in tension, whereby values of Young's modulus and Poisson's ratio are obtained and the form of the load-extension curve is determined. The optical properties of the transparent material are observed, with special reference to its behaviour under load; and it is shown, by observations with a comparison beam not stressed beyond elastic limit, that the relative retardation produced between the two components of a polarised beam is consistent with a linear optical stress law, which holds up to stresses of about twice those at the elastic limit. These results are confirmed by observations of the retardation bands produced in a polarised spectrum by a beam under uniform bending moment. The stresses and strains are deduced on the assumption of a linear stress-optical law, and stress-strain curve so obtained is found to agree with purely mechanical measurements of a tension member.—S. **Marsh**: Alternating-current electrolysis. The behaviour of platinum, gold, and nickel electrodes during the passage of an alternating current of 25 to 80 cycles per second has been examined. The electrolytes employed were dilute sulphuric acid and barium hydrate solution. Curves representing the relation between volume of gas evolved and time of passage of current are of two distinct types: (*a*) One type resembling "saturation-current" curves in radio-activity. This effect is shown clearly in the cases of platinum and gold in an acid electrolyte. (*b*) A second type in which the rate of evolution of gas falls off with time until ultimately a steady rate of evolution sets in, *decreasing* in value with *increasing* frequency of the alternating current. Two possible explanations of the phenomena are discussed: (*a*) Adsorption of hydrogen at an electrode during one half-period, followed by recombination with oxygen in the succeeding half-period. (*b*) Oxidation of the electrode by the oxygen of one half-period, followed by reduction of the oxide by the hydrogen of the succeeding half-period. Evidence is given that the oxidation theory successfully explains the effects with gold and nickel. In the case of platinum it is believed that oxidation plays a prominent *rôle*, though adsorption also may be effective in this case. It is shown that the electrodes have an initial surface activity in promoting recombination, which activity increases (*a*) with frequency of alternation, and (*b*) up to a maximum value with the time of passage of the current. If the current density is less than that corresponding to this maximum activity, then sooner or later evolution of gas ceases. If the current density is greater, then after a time gas is evolved at a steady rate.—W. H. **Eccles** and J. H. **Vincent**: The variations of wave-length of the oscillations generated by three-electrode thermionic tubes due to changes in filament current, plate voltage, grid voltage, or coupling. When electrical oscillations are sustained in a circuit comprising inductance and electrical capacity by aid of a three-electrode thermionic vacuum tube of the kind used in wireless telegraphy, the frequency of the oscillations and the wave-length of the radiation depend principally upon the values of the inductance and the electrical capacity, but also partly upon the resistance in the oscillatory circuit; upon the voltages of the various batteries in use; upon the temperature of the filament supplying the electrons; upon other properties of the vacuum tube; and upon the coupling between portions of the circuit associated with the grid and the anode. The object of the present investigation was to study experimentally the effects of altering each of the chief variables, with the view of finding the conditions most favourable for the production of continuous oscillations of constant frequency. For this purpose two circuits were sustained in oscillation at nearly the same high frequency, namely, about 120,000 vibrations per second, and the audible beat between these frequencies was observed. Then changes made in one circuit alone caused variations of frequency that were measurable by acoustic observation of the beat-note. The preliminary investigations showed that variation of the heating current of a filament was the most fertile source of erratic changes of frequency, and resulted in the discovery that increase in the filament current of one tube produced at low values of current a decrease of frequency, and at higher values an increase of frequency, while at a certain value of filament current the frequency had a stationary value. This phenomenon provides a method of setting an oscillation generator so as to produce a vibration of frequency constant to less than one part in 100,000. Provided with this knowledge, the other problems enumerated above were attacked. In an apparatus in which the inductance was eight millihenries, the electrical capacity 250 electrostatic units, and the wave-length 2750 metres, it was found that raising the voltage of the anode battery from 130 to 140 increased the wave-length by 6 metres, and raising the grid voltage by 1 increased the wave-length about 10 metres. The coupling in the circuit produced large effects by its variation.—S. D. **Carothers**: Plane strain: the direct determination of stress. It is pointed out in the first part of the paper that in plane strain the stresses, if determined directly, are usually obtained by the aid of the well-known stress function method. The problem is usually that of finding a function χ satisfying $\nabla_1^4\chi=0$ throughout the body, with suitable values of χ over the various boundaries. The most general value of χ in Cartesian co-ordinates appears to be

$$\chi = A\theta + Bx\theta + Cy.\theta + D(x^2+yY\theta),$$

where A, B, C, and D are any constants and θ is any plane harmonic function. It is shown that for any orthogonal co-ordinates the stresses derived by the stress-function method when applied to $\chi=(x^2+y^2)\theta$ can always be resolved into two distinct sets, while in the case of Cartesian co-ordinates the stresses can be split up into four distinct sets. In view of the foregoing, the present paper has for its object the determination of the various sets of stresses which might legitimately occur in a state of plane strain, expressed in the simplest possible terms, with the view of rendering the building up of a given state of stress a manageable operation. The paper sets forth the usual stress equations of equilibrium, and gives the identical relation between the strain components expressed in the various systems of co-ordinates. The various possible stress sets in rectangular and polar co-ordinates are then set forth in order, after which the solutions in orthogonal curvilinears are obtained in such a manner as generally to show their connection with those formerly given. The second part of the paper applies the results obtained to the solution of some examples.—F. **Horton** and Ann C. **Davies**: An investigation of the effects of electron collisions with platinum and with hydrogen, to ascertain whether the production of ionisation from platinum is due to occluded hydrogen. The effects of bombarding a platinum surface by electrons the velocity of which could be gradually increased have been investigated by methods in which these effects were detected when superposed on the original electron current, and also when they were measured independently. It has been found that a genuine ionisation by electron impacts is produced at a minimum electron velocity of 13·0 volts, but that up to electron velocities of 30 volts no detectable amount of radiation capable of acting photo-electrically on platinum is obtained. In order to ascertain whether the ionisation produced at a minimum electron velocity of 13·0 volts arises from the platinum or from hydrogen attached to its surface, the effects of electron collisions with hydrogen were investigated in the same apparatus. A radiation was detected from this gas at a minimum electron velocity of 10·5 volts, and a second type of radiation at a minimum electron velocity of 13·9 volts. Three types of ionisation were also detected, beginning when the electrons acquired velocities of 13·0 volts, 14·4 volts, and 16·9 volts respectively. The first of these types is the ionisation obtained in a high vacuum, and experiments described in the paper show that this is not due to hydrogen, but arises from the platinum itself. From the experiments in hydrogen it is concluded that the minimum electron velocity for the production of radiation from a hydrogen atom is 10·5 volts, the minimum electron velocity for ionisation of the atom 14·4 volts, and the minimum electron velocity for ionisation of the molecule 16·9 volts. These results are in general agreement with the deductions from Bohr's theory. The second type of radiation, beginning at an electron velocity of 13·9 volts, is attributed to the hydrogen molecule.—L. **Bairstow**, R. H. **Fowler**, and D. R. **Hartree**: The pressure distribution on the head of a shell moving at high velocities. This paper describes a first attempt to measure the pressure distribution on a body moving through a gas at velocities equal to or greater than the velocity of sound a in the gas. The body in question is a spinning shell, moving along its axis of symmetry, and the gas, air. The pressure at a given distance from the nose is communicated to a chamber in the head of the shell, and deduced from the time of burning a train of powder in this chamber, which is a quantity that can be directly observed. By a series of such observations the pressure at a given point of the head is determined as a function of the velocity ratio v/a, where v is the velocity of the shell relative to the air. Curves are obtained showing the variation of the pressure for values of v/a from 0·04 to 1·4, and for four different positions on the head of the shell.

PARIS.

Academy of Sciences, December 29, 1919.—M. Léon Guignard in the chair.—G. **Bigourdan**: The work of Lalande and his pupils at the Mazarin College.—H. **Deslandres**: Remarks on the constitution of the atom and the properties of band spectra. Completing four earlier communications on the same subject.—P. **Termier** and G. **Friedel**: The foldings and drift which have broken the Gard coal basin; probably Alpine movements of Miocene age.—A. **Blondel**: Graphical study of the working of audions with resonating circuit as sensitised receivers or as dampers.—C. **Sauvageau**: The parasitism of a red alga, *Polysiphonia fastigiata*.—F. **Carlson**: A property of polynomials of one variable.—M. **Mesnager**: Method of determination of the internal strains existing in a circular cylinder. The method employed by M. Portevin in a recent communication on the same subject, due to Heyn and Bauer, is faulty, as it only takes into account the tensions parallel to the axis of the cylinder. An outline of a more exact method is given.—J. **Amar**: A machine for cutting out brushes. This instrument has been specially designed for use by the blind.—E. **Kohn-Abrest**: Aluminium spontaneously oxidisable in the air. M. Guillet has recently described some aluminium alloys which undergo oxidation in the air. Some years ago the author found that aluminium could be volatilised in a vacuum at 1100° C., and the portion remaining unvolatilised sometimes proved to be spontaneously oxidisable. No satisfactory explanation of the phenomenon could be found.—N. R. **Dhar** and G. **Urbain**: The polarisation electromotive forces of iron in solutions of complex salts. Relation between these electromotive forces and the disappearance of the analytical characters of ferric ions. Measurements are given for ferrous and ferric salts, ferrocyanides, ferrioxalates, ferricyanides, and nitro-prussides.—E. **Wourtzel**: The dissociation constant of nitrogen peroxide.—L. **Vallery**: The estimation of arsenic in tin and in tinned articles. The arsenic is first separated by distillation as chloride and reduced to colloidal arsenic, and determined in a colorimeter. The determination of arsenic in tin by Marsh's method is liable to serious error.—A. **Meyer**: The estimation of thiophen in benzene.—A. **Kling** and D. **Florentin**: The production of carbon monoxide in flames of different gases. Carbon monoxide is mainly produced by sudden cooling of the flame; the amount is increased by contact with the mantle of an incandescent burner.—M. **Zeil**: Correlations between the Quaternary terraces, glacial recurrence, and upward movements of the earth's crust.—J. **Bourcart**: Cretacean and Lower Eocene formations and their extension in central and southern Albania.—Ph. **Glangeaud**: The reconstitution of a long lake depression which during the Oligocene period occupied the great coal cut of the Central Massif.—Ch. **Pussenot**: Glacial recurrences later than the "Néowürmien" in the massifs of the Aiguille de Polset (Tarentaise), of Mont Thabor, and of the Aiguille de Scolette (Maurienne).—W. **Kilian** and Ch. **Pussenot**: The age of the tufa-bearing human remains at Villard de Bozel (Savoie).—Ch. **Maurain**: The wind velocity in the stratosphere. There is a maximum mean wind velocity (14·55 metres per second) at a height of about 11,000 metres, falling to 8·04 metres per second at 19,000 metres altitude.—MM. **Stapfer** and **Moleski**: Remarks on snowfalls. Two cases are considered, the first when the snow has already been formed in the northern regions and the second when it is formed near where it falls. The conditions existing on the occasion of the fall of snow at Paris on November 3 are examined, and found to confirm the views expressed in earlier communications.—P. **Carles**: The blue *casse* of wine. Criticisms on a recent communication by M. Piedallu.—M. **Gard**: Biology of a new species of Euglæna (*E. limosa*).—L. **Lapicque**: Seasonal variation in the chemical composition of marine algæ. There is a great variation in the amount of soluble carbohydrate in *Laminaria flexicaulis*. These attain a maximum in August and September, and fall to a minimum at the end of the winter. The changes in ash are in the inverse direction.—MM. G. **Bertrand**, **Brocq-Rousseu**, and **Dassonville**: Comparative action of chloropicrin on the weevil and on Tribolium. The two parasites possess unequal resisting powers towards chloropicrin vapour, the Tribolium requiring longer exposure for its destruction.—M. **Caullery** and F. **Mesnil**: *Ancyroniscus Bonnieri*, a new species, parasite of *Dynamene bidentata*.—M. **Nicolle**, E. **Debains**, and E. **Césari**: The mutual precipitation of toxins and their antitoxins. Application to the titration of antidiphtheritic and antitetanic sera. The method of titration *in vitro*, for which great economy of time and money is claimed, has been proved to correspond with tests made *in vivo*.

MELBOURNE.

Royal Society of Victoria, December 11, 1919.—Mr. F. H. Wisewould, vice-president, in the chair.—F. **Chapman**: Tertiary fossils from Ooldea: Additional note. The author records a further series of fossils from this locality, collected by F. A. Cudmore, which confirms his earlier determination of their Miocene age.—Ellinor **Archer**: Longevity of cut flowers. Preliminary observations were made on Acacia blossoms and other plants. A solution of lead nitrate gave good results in preventing the vessels from being blocked, allowing the blossoms to last for weeks instead of days. Silver nitrate also acted in the same way, but not so efficiently.—E. **McLennan**: The endophytic fungus of Lolium: its development, distribution, and function. Instead of being parasitic, this fungus is now an essential part of the plant and plays an important *rôle* in the ripening of seed. In the ripe seed the remains of the hyphæ persist mainly in the resting endospermic combium (aleurone layer).—Jean **Shannon**: The structure of *Megascolex Fletcheri*, sp.nov. This is one of the few Australian earthworms which have been carefully worked out in detail.—J. T. **Jutson**: Notes on dust-whirls in sub-arid Western Australia. The author has had good opportunities of studying these and other æolian agencies. The occurrence of dust-whirls is practically confined to the summer months. Their general mode of rotation is counter-clockwise, although some are observed to take place in the opposite direction.—A. V. E. **James**: The physiography and geography of the Bulla-Sydenham area. In this paper a detailed account is given of the palæography of the Saltwater River and Deep Creek, the age and fossiliferous contents of the sedimentary rocks between Bulla and Keilor, and the occurrence of the igneous rocks in this area, including basalt and kaolin.

BOOKS RECEIVED.

Penrose's Annual. Pp. x+112+plates. (London: P. Lund, Humphries, and Co., Ltd.) 10*s*. 6*d*. net.

Elementary Practical Chemistry for Medical and Other Students. By Dr. J. E. Myers and J. B. Firth. Second edition. Pp. viii+194. (London: C. Griffin and Co., Ltd.) 4*s*. 6*d*.

Insect Life in Sewage Filters. By Dr. W. H. Parkinson and H. D. Bell. Pp. viii+64. (London: The Sanitary Publishing Co., Ltd.) 3*s*. 6*d*. net.

A Night Raid into Space: The Story of the Heavens told in Simple Words. By Col. J. S. F. Mackenzie. Pp. 143. (London: H. Hardingham.) 2*s*. 6*d*. net.

A Practical Handbook of British Birds. Part vi. Pp. 337–400+2 plates. (London: Witherby and Co.) 4*s*. net.

Ferrari's Dioptric Instruments: Being an Elementary Exposition of Gauss's Theory and its Applications. Translated by Dr. O. Faber. Pp. xxxi+214. (London: H.M.S.O.) 4*s*. net.

The Engines of the Human Body. By Prof. A. Keith. Pp. xii+284+ii plates. (London: Williams and Norgate.) 12*s*. 6*d*. net.

A Synoptical List of the Accipitres. By H. Kirke Swann. Part iii. (London: J. Wheldon and Co.) 4*s*.

Man: Past and Present. By A. H. Keane. Revised and largely rewritten by A. H. Quiggin and Dr. A. C. Haddon. Pp. xi+582+xvi plates. (Cambridge: At the University Press.) 36*s*. net.

Engrais: Amendements Produits Anticryptogamiques et Insecticides. By Dr. E. Demoussy. Pp. xi+297. (Paris and Liége: Ch. Béranger.) 15 francs.

Aliments Sucrés. By Dr. E. Roux and C. F. Muttelet. Pp. vi+474. (Paris and Liége: Ch. Béranger.) 12 francs.

W. and A. K. Johnston's Orographical Atlas. Pp. 32. (London: Macmillan and Co., Ltd.) 1*s*. net.

The Working of the World. By J. Houston. Pp. iii+108. (London: Macmillan and Co., Ltd.) 9*d*.

The Chemistry and Technology of the Diazo-Compounds. By Dr. J. C. Cain. Second edition. Pp. xi+199. (London: E. Arnold.) 12*s*. 6*d*. net.

A Geography of Asia. By J. Martin. Pp. viii+298. (London: Macmillan and Co., Ltd.) 5*s*.

The Chemistry of Coal. By J. B. Robertson. Pp. viii+96. (London: Gurney and Jackson.) 3*s*. 6*d*. net.

Religion and Culture. By Dr. F. Schleiter. Pp. x+206. (New York: Columbia University Press; London: H. Milford.) 8*s*. 6*d*. net.

The Principles of Anatomy as Seen in the Hand. By Prof. F. Wood Jones. Pp. viii+325+2 plates. (London: J. and A. Churchill.) 15*s*.

Science and Life: Aberdeen Addresses. By Prof. F. Soddy. Pp. xii+229. (London: J. Murray.) 10*s*. 6*d*. net.

Springtime, and Other Essays. By Sir Francis Darwin. Pp. vii+242+viii plates. (London: J. Murray.) 7*s*. 6*d*. net.

Military Psychiatry in Peace and War. By Dr. C. S. Read. Pp. vii+168. (London: H. K. Lewis and Co., Ltd.) 10*s*. 6*d*. net.

Modern Geometry: The Straight Line and Circle. By C. V. Durell. Pp. x+145. (London: Macmillan and Co., Ltd.) 6*s*.

The Land of Goshen and the Exodus. By Sir Hanbury Brown. Third edition. Pp. 189. (London: E. Stanford, Ltd.) 7*s*. 6*d*. net.

Essays on Wheat. By Prof. A. H. R. Buller. Pp. xv+339. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 2.50 dollars.

Applications de la Photographie Aérienne. By L.-P. Clerc. Pp. vi+350+plates. (Paris: O. Doin et Fils.) 7.50 francs.

Chemistry for Public Health Students. By E. G. Jones. Pp. ix+244. (London: Methuen and Co., Ltd.) 6*s*. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. E. Conrady: Recent Progress in Applied Optics.

ROYAL SOCIETY, at 4.30.—J. H. Jeans, Prof. A. S. Eddington, Sir F. Dyson, Prof. A. Fowler, E. Cunningham, Prof. H. F. Newall, Prof. F. A. Lindemann, and possibly Sir J. Larmor: Discussion on the Theory of Relativity.

LINNEAN SOCIETY, at 5.—Dr. R. Ruggles Gates: The Existence of Two Fundamentally Different Types of Characters in Organisms.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. E. C. Morland: Climate in Tuberculosis.

CHEMICAL SOCIETY, at 8.—(Ordinary Meeting, followed by an Informal Meeting.)

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. Goodall: The Origin of Tumours of the Ovary.—G. Ley: A Statistical Report of Carcinoma of the Ovary as met with in the Pathological Institute of the London Hospital between the years 1907–1919 inclusive, showing the Relative Frequency of Primary and Secondary Ovarian Carcinoma.

FRIDAY, FEBRUARY 6.

GEOPHYSICS COMMITTEE (at Royal Astronomical Society), at 5.—Sir Charles Parsons and Others: The Practicability of, and Scientific Advantages to be derived from, a Deep Boring.

ROYAL COLLEGE OF SURGEONS, at 5.—V. Z. Cope: The Surgical Aspect of Dysentery.

CONCRETE INSTITUTE (at Denison House, 296 Vauxhall Bridge Road), at 6.—H. J. G. Bamber: The Practical Testing of Cement.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—F. R. Housden: Electric Lifts and Cranes.

JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—Capt. J. Bradford: Tank Work in the Army.

TECHNICAL INSPECTION ASSOCIATION (at the Royal Society of Arts), at 7.30.—J. Waite: The Treatment of Steel.

ROYAL SOCIETY OF MEDICINE (Anæsthetics and Laryngology Sections), at 8.30.—Dr. F. S. Rood and Others: Discussion on Anæsthesia in Throat and Nose Operations.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Sir Walter Raleigh: Landor and the Classic Manner.

SATURDAY, FEBRUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation. II. Displacement of Solar Spectral Lines.

MONDAY, FEBRUARY 9.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Capt. H. Alan Lloyd: Characteristics of the Ground as seen from the Air.

ROYAL COLLEGE OF SURGEONS, at 5.—H. T. Gray: The Influence of Nerve Impulses on Gastro-intestinal Disorders.

BIOCHEMICAL SOCIETY (at Imperial College of Science and Technology, Botany Building), at 5.30.—H. Chick and E. M. Hume: Production in Monkeys of Symptoms closely Resembling Pellagra, by prolonged Feeding on a Diet of Low Protein Content.—C. C. Wood and S. B. Schryver: Demonstration of Method of Determining the Methoxyl Groups in Plant Tissues.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Sir Wilmot Herringham and Others: Discussion on Gas Poisoning.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association), at 8.—Dr. C. C. Carpenter: Fuels.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. H. Drinkwater: The Clinical or Naked Eye Diagnosis of Diphtheria and other Infections of the Fauces.—Dr. T. B. Hyslop: Some New Methods of Illustration.

TUESDAY, FEBRUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. G. Elliot Smith: The Evolution of Man and the Early History of Civilisation. III. The Search for Gold.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. A. D. Waller: The Measurement of Human Emotion and of its Voluntary Control (Occasional Lecture).

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—P. M. Crosthwaite: Experiments on the Horizontal Pressure of Sand.—Dr. A. R. Fulton: Overturning Moment on Retaining-Walls.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions made to the Society's Menagerie during the months of November and December, 1919.—R. I. Pocock: Exhibition of Photographs of a Chinese Serow.—H. R. Hogg: Some Australian Opiliones.—Dr. C. F. Sonntag: Description of the Larynx and Œsophagus of a Common Macaque, exhibiting several unusual Features.—R. E. Turner and J. Waterston: A Revision of the Ichneumonid Genera Labium and Pœcilocryptus.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Annual General Meeting.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Annual General Meeting.

WEDNESDAY, FEBRUARY 11.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Col. F. C. Fuller: The Tank Corps.

ROYAL SOCIETY OF ARTS, at 4.30.—Lieut.-Comm. N. Wilkinson: Naval Camouflage.

ROYAL COLLEGE OF SURGEONS, at 5.—J. Sherren: The Late Results of the Surgical Treatment of Chronic Ulcers of the Stomach and Duodenum (Hunterian Lecture).

THURSDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. E. Conrady: Recent Progress in Applied Optics.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: J. W. McBain and C. S. Salmon: Colloidal Electrolytes. Soap Solutions and their Constitution.—C. C. Farr and D. B. Macleod: The Viscosity of Sulphur.—C. V. Raman and B. Banerji: Kaufman's Theory of the Impact of the Pianoforte Hammer.—Commander T. Y. Baker, R.N., and Prof. L. N. G. Filon: A Theory of the Second Order Longitudinal Spherical Aberration for a Symmetrical Optical System.—Dr. S. Chapman: A Note on Dr. Chree's Discussion of Two Magnetic Storms (Title only).—Dr. C. Chree: An Explanation of the Criticisms on Dr. Chapman's Recent Paper "An Outline of a Theory of Magnetic Storms" (Title only).—Prof. J. W. Nicholson: The Lateral Vibrations of Sharply Pointed Bars.—R. E. Slade: A New Method of Spectrophotometry in the Visible and Ultraviolet and the Absorption of Light by Silver Bromide.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. C. W. Kimmins: The Dreams of Children in Blind, Deaf, and Industrial Schools.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Major K. Edgcumbe: The Protection of Alternating-current Distribution Systems without the Use of Special Conductors.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street), at 7.—Dr. R. S. Morrell: Colloid Chemistry of Paints and Varnishes.

OPTICAL SOCIETY, at 7.30.—J. W. French: The Surface Layer of an Optical Polishing Tool.—Mrs. C. H. Griffiths: Aberration Effects in Star Images.—R. W. Cheshire and W. Shackleton: The Testing of Heliograph Mirrors.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (at 28 Victoria Street), at 8.—F. R. Cowell: Steering Gears.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. Rows: Anxiety States.

FRIDAY, FEBRUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 5.—Prof. C. H. Lees: Presidential Address.—Sir Arthur Schuster: Atmospheric Refraction during Total Solar Eclipses.—To be followed by the Annual General Meeting.

ROYAL COLLEGE OF SURGEONS, at 5.—W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery.

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. M. Bayliss: The Volume of the Blood and its Significance.

SATURDAY, FEBRUARY 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation. III. Deflection of Light in the Sun's Gravitational Field.

CONTENTS.

PAGE
The Need for Aircraft Research . . . 589
Physiology of Muscular Exercise . . . 590
Theories of Sound Perception. By J. G. M. . . . 591
Kashmir and Indian Silks . . . 591
A Great Industrialist . . . 592
Farming in the New Era. By Dr. E. J. Russell, F.R.S. . . . 592
Our Bookshelf . . . 594
Letters to the Editor:—
The Nature of the Katmai Volcanic Gases and Encrustations. (*Illustrated.*)—J. W. Shipley . 595
The Control of Scientific and Industrial Research.—Dr. Morris W. Travers, F.R.S. . . . 597
The Predicted Shift of the Fraunhofer Lines.—James Rice; Prof. A. S. Eddington, F.R.S. . . 598
The Straight Path.—Dr. A. A. Robb . . . 599
Entente Scientific Literature in Central Europe during the War.—Prof. Bobuslav Brauner . . . 600
Percussion Figures in Isotropic Solids.—W. J. Lewis Abbott . . . 600
Change of Colour in Plumage of Captive "Sun-birds" or "Honey-suckers."—Harold Millar . 600
Mathematics in the United States. By G. B. M. . 601
Shackleton's Last Antarctic Expedition. (*Illustrated.*) By W. S. B. . . . 602
Telephoning by Light. (*Illustrated.*) By Prof. A. O. Rankine . . . 604
Australian Rainfall and Wheat Yield. By W. W. B. 606
Notes . . . 607
Our Astronomical Column:—
Comets . . . 612
The Motion of the Moon . . . 612
Stars of High Velocity . . . 612
The St. Louis Meeting of the American Association . . . 612
Pioneers in the Science of the Weather. By Sir Napier Shaw, F.R.S. . . . 613
The Reduction of Wave Action in Harbours. By Dr. Brysson Cunningham . . . 614
St. Andrews Institute for Clinical Research. By Prof. P. T. Herring . . . 615
Fishery Investigations in South Africa . . . 615
University and Educational Intelligence . . 615
Societies and Academies . . . 617
Books Received . . . 619
Diary of Societies . . . 619

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THURSDAY, FEBRUARY 12, 1920.

ASSET AND OBLIGATION.

WE referred in our issue of January 29 to an appeal made by University College, London, for 100,000*l.* for the extension of its engineering school. The work done there since its foundation in 1828 has been of such outstanding value that it should stimulate a ready response in the form of generous subscriptions to the amount required for the desired extension. The need is now very urgent, as the college, like others, has been compelled to refuse a large number of applications for admission by well-qualified candidates owing to lack of accommodation in the lecture rooms, drawing offices, and laboratories.

University College was the first in London to establish a school of engineering, soon after its foundation in 1826, and it has maintained its courses of study in this branch of applied science ever since as a potent and living force. It has always had the advantage of the guidance of distinguished engineers for its teaching, and they have greatly assisted the advancement of engineering by their inventions and contributions to applied science, as well as by their distinction in practical engineering affairs. Among these in its early days were three Fellows of the Royal Society—Eaton Hodgkinson, a great authority on the strength and testing of materials, notably in connection with columns, and C. B. Vignoles, also widely known on questions relating to railways, while William Pole exercised a great influence on contemporary engineering as secretary of the Institution of Civil Engineers. Other distinguished men of a somewhat later period are George Fuller, the inventor of a well-known form of slide-rule, and the eminent electrician, Fleeming-Jenkin, who for a short period was professor of civil engineering.

The advent of Prof. A. B. W. Kennedy (now emeritus professor) in 1874 marked a new epoch in its influence on contemporary thought in engineering science, since it was mainly due to his efforts that engineering laboratory training on a practical scale was initiated, and this has now become universal. Besides this notable achievement, Prof. Kennedy's activities during his fourteen years as professor there were remarkable for their extent and variety; he was famed alike for his work as an original investigator in such matters as riveted joints, marine engines, boilers, and kinematical science, and as an authority on a wide range of civil engineering practice, and still later as one of the foremost electrical engineers of his time. The keynote to his success as a teacher was mainly derived from his clear exposition of principles and their application in well-devised experiments in the laboratory. The effect of his teaching may be traced in the successful careers of his many students, of whom perhaps the best known are Sir Ernest Moir, Bart., a leading authority on harbours and tunnels, and Sir Alexander Gibb, whose firm is responsible for the construction of H.M. Dockyard at Rosyth. Municipal engineering, under the fostering care of the late Prof. Osbert Chadwick, has now become an important department. In the field of electrical science Dr. J. A. Fleming, the present professor of electrical engineering, has, for more than thirty years, had a far-reaching influence, not only by his great gifts as a teacher, but also as an investigator of rare capacity, particularly on alternating currents and on wireless telegraphy and telephony. Especially important are the services which Dr. Fleming has rendered to telephony by the invention of the thermionic valve, but these are too well known to need recapitulation to scientific readers.

The engineering school at University College is an element, and an important one, in the University of London, the largest university of the Empire, in the richest city, and probably the least well off when its size is taken into consideration. In University College alone there are more than 2200 students, without taking into account the medical students in University College Hospital. There will be many more if its buildings can be enlarged, as they must be if the University is to do its proper work.

During the war the staff and buildings of the college, like those of similar institutions, were utilised to their fullest extent in scientific work of the highest importance to the effective prosecution of the conflict, and now that it has come to a successful conclusion the men who guide public opinion are unanimous in declaring that one of the most important duties is to provide our universities with adequate means for the scientific training of our most precious asset, "brains," for the future guiding and directing of one of our greatest industries. Civic pride in the University will, we hope and believe, be sufficient to ensure that the engineering students of University College do not lack the modest range of buildings and equipment required to give them their chance in life, and for which its engineering committee now confidently appeals to the citizens of London to provide.

A very good start has been made by a contribution of 10,000*l.* from Lord Cowdray, with a promise of another 10,000*l.* when 70,000*l.* has been reached. The members of the family of the late Mr. Charles Hawksley have contributed 3000*l.* towards the extension of the hydraulic laboratory. Other gifts bring the total up to about 30,000*l.*, apart from Lord Cowdray's contingent promise. London is now offered an excellent opportunity of showing its appreciation of the asset it possesses in the engineering department of the college, and of discharging its obligations to an essential factor of modern progress. We look to men of means in the City and county of London to respond readily and generously to the appeal. Donations should be sent to H.R.H. Prince Arthur of Connaught, who is president of the Equipment and Endowment Fund, at his residence, 42 Upper Grosvenor Street, W.1.

INDUSTRIAL CHEMISTRY.

(1) *Industrial Gases.* By Dr. Harold Cecil Greenwood. (Industrial Chemistry.) Pp. xvii+371. (London: Baillière, Tindall, and Cox, 1920.) Price 12*s.* 6*d.* net.

(2) *The Condensed Chemical Dictionary: A Reference Volume for all requiring Quick Access to a Large Amount of Essential Data regarding Chemicals and other Substances used in Manufacturing and Laboratory Work.* Compiled and edited by the editorial staff of the Chemical Engineering Catalog. Pp. 525. (New York: The Chemical Catalog Co., Inc., 1919.) Price 5 dollars.

(1) A MELANCHOLY interest attaches to this book, which of itself would disarm any adverse criticism, even if such were called for. Its author, a comparatively young man, died on the eve of its publication. After a brilliant career at the University of Manchester, of which he was a Beyer Fellow, and where he graduated as a Doctor of Science, Dr. Greenwood worked as an 1851 Exhibition scholar for some years under Prof. Haber at Karlsruhe on the synthetic production of ammonia. During the war he became connected with the research laboratory of the Ministry of Munitions, and was engaged in the inquiry initiated by the Munitions Inventions Department on the industrial manufacture of synthetic nitrogen products. His services were recognised by the O.B.E. awarded to him in 1919. In a foreword to the book, Dr. J. A. Harker, under whom the author served, pays a graceful tribute to his memory.

Dr. Greenwood's published work and experience rendered him exceptionally well qualified to undertake the preparation of the book under review. We can unreservedly commend it. It is a well-written, scholarly production, judiciously put together with a conscientious determination to make it an accurate presentation of contemporary knowledge. As the author points out in his preface, its title implies a more comprehensive treatise than it actually is; many industrial gases, such as chlorine, hydrochloric acid, ammonia, acetylene, etc., find no place in it, as these are treated in other books in the same series. He confines himself to the gases of the atmosphere, hydrogen, the oxides of carbon, sulphur dioxide, nitrous oxide, and certain substances which have been used in gas-warfare, and he devotes a special section to fuel gases, on account, as he states, of the intimate connection of their methods of production with the general question of industrial gases.

The main subject of the book is introduced in a chapter on the more important fundamental physical and physico-chemical principles forming the basis of technical gas reactions, although no attempt is made to give a detailed theoretical treatment of the various generalisations to which reference is necessarily made. In this chapter the gases in general are treated comprehensively, and the numerical values of their various constants are grouped together in a series of tables. This method, no doubt, has certain advantages, as it enables rapid comparison to be made between individual gases, but when we come to their detailed study it involves a good deal of turning backwards and forwards. It would have added little to the size of the book, and would certainly have increased the convenience of handling it, if the various constants and factors had been repeated in the special accounts of the several gases. The author would seem to have been primarily concerned with the general principles of gas technology and their elucidation rather than with the minute treatment of individual gases. As might be expected from his experience, which had been latterly almost wholly directed to problems arising out of the war, such questions as the manufacture of hydrogen for aeronautical purposes and for the synthetic production of ammonia naturally receive special attention. Naturally also, he devotes much consideration to the question of gaseous equilibria and to that of heterogeneous catalytic gas reactions, without doubt among the most important matters in modern chemical technology. The entire chapter is worthy of the serious study of all engaged in the technical production of gases and in the working of processes depending upon their reactions. The superintendence of such processes is frequently left wholly to the engineer, who is often imperfectly acquainted with the physico-chemical principles on which they are based. Modern methods involving thermodynamical and thermochemical principles are becoming of so complex a character that their satisfactory working can be assured only when they are under the joint control and co-operation of both chemists and engineers.

A chemist, like the present writer, whose memory goes back some fifty years, will read this book with a special interest, and, if his scientific imagination is not dulled with age, he will experience a grateful sense of satisfaction that he has lived to see the extraordinary development it records. The whole story, indeed, reads like a romance; even Jules Verne in his wildest flights never imagined anything so astonishing as is revealed in this sober, matter-of-fact account which Dr. Greenwood has put together. Compare, for instance, the non-metallic section of an early or even of a late edition of Miller's "Inorganic Chemistry"—an excellent book in its day—with the present volume. One thus acquires an impression almost startling in its intensity of the changes which the last half-century has witnessed, even in matters of which the scientific history seems completed. The liquefaction of the so-called permanent gases; the industrial application of the Joule-Thomson effect; the manufacture of liquid air, its commercial application, and the fractional separation of its constituents; the discovery of argon and its allies—no longer the "tramps" of the chemical elements "who never did an honest day's work in their lives," but now turned to useful account—the isolation of terrestrial helium, its manufacture, and its use in aeronautics; the direct transformation of the "inert" nitrogen into products which serve to increase the food of man, and thus stave off the catastrophe which the late Sir William Crookes foreshadowed; the application of hydrogen in the production of fats: all this and more is set forth with the precision, impartiality, and unimpassioned detail of the man of science—"the matter of fact being barely stated without any prefaces, apologies, or rhetorical flourishes," to quote the words of the old statute of the Royal Society.

One closes this book with profound regret that its author's untimely death should have ended a career so full of promise.

(2) "The Condensed Chemical Dictionary," published by the Chemical Catalog Co., of New York, is a characteristic American production. To parody Thackeray's well-known phrase, it is written—or, rather, compiled—by hustlers for hustlers. It is one of those books which "Elia" would have stigmatised as "no book." It has no valid claim to be regarded as a contribution to chemical technology. It is apparently intended for the office-desk of the wholesale distributor or forwarding agent of chemical products who may wish to know something—but not too much—of the nature of the substances with which he deals; how they are made; what are their "grades" and uses; how they should be packed; what is their "fire hazard"; and what regulations the shipping and railroad companies impose on their transit. It makes ample allowance for the ignorance of clients, and does everything possible to facilitate business. Should further information be needed it is suggested that reference should be made to other works of a similar character published by the "Catalog Company."

The plan of the Dictionary may best be illustrated by an example:—

"Acetamide * (acetic acid amine), CH_3CONH_2.
Color and properties: Colorless crystals; mousy odor.
Constants: Specific gravity, 1·139; melting-point, 82° C.; boiling-point, 223° C.
Soluble in water and alcohol.
Derivation: By the interaction of ethyl acetate and ammonium hydroxide.
Method of purification: Crystallisation.
Grades: Technical.
Containers: Wooden barrels.
Uses: Organic synthesis.
Fire hazard: None.
Railroad shipping regulations: None."

The asterisk signifies that the substance is made in America.

All the entries, together occupying more than 500 pages of a large octavo volume, are arranged in this manner. The cast-iron uniformity of the plan imposed upon the compilers occasionally gets them into trouble. Thus in the case of fluorine, which the Dictionary informs us is manufactured in the States for organic synthesis, no practical container has been devised, as all ordinary substances are attacked by it. Nevertheless, a green label is directed to be attached to the vessel which holds it should it be sent by rail.

Standard works have been consulted in the compilation, and care appears to have been used in the selection of recent and accurate numerical data. A number of useful tables are given in an appendix, together with a list of definitions of physical and other units in common use, and the whole concludes with a statement of the regulations governing the transportation of dangerous articles, other than explosives, by freight and express.

THE ORIGIN OF PLANT LIFE ON LAND.

Thalassiophyta and the Subaerial Transmigration. By A. H. Church. (Botanical Memoirs, No. 3.) Pp. 95. (London: Oxford University Press, 1919.) Price 3s. 6d. net.

MR. CHURCH has produced a very serious contribution to the discussion of the sources of plant life on land. No one interested in this question can neglect his work. The statement is attributed to Weismann that the birthplace of all animal and plant life lies in the sea. Mr. Church circumscribes that thesis in his opening words, "The beginnings of botany are in the sea"; and his essay has as its object to demonstrate that the land flora originated, as the primal land-surfaces rose gradually above the ocean, from a marine flora already fixed upon its shores. He designates as "Thalassiophyta" the whole of the salt-water vegetation, and as "Xerophyta" the whole of the land flora. The former he divides again into Plankton and Benthos, pointing out that Plankton responds to the single factor of water, Benthos to the two factors of water and substratum, while Xerophyton responds to the three factors of water, substratum, and air. His main thesis is that the last was derived from the higher types of Benthos. "Processes of conduction and absorption involving roots and tracheides are initiated, and such departures superimposed on a seaweed soma." "The tetraspores of the sea become 'homosporous,' air-dried, and wind-borne" (p. 44).

Thus the evolution of a land flora was a phase of transition *in situ* rather than involving a preliminary landward migration, *via* fresh water. The successful transmigrant algæ of the first land migration combined the best and highest factors of marine equipment, as illustrated in many surviving groups. At the outset Mr. Church separates the problem of this migration from the origin of a cytological cycle, maintaining that the latter was already established before the migration took place. For these conclusions argument is produced rather than fact; indeed, there appears to be no new body of fact in the whole memoir. The author remarks incidentally that homoplasy and convergence have been much neglected. We agree; but may not they explain much of what he interprets as evidence of a direct migration?

Two serious omissions appear in the memoir. There is no reference to the important discoveries of Lower Devonian fossils in the Rhynie Chert, though the description of Rhynia was published early in 1917. Kidston and Lang give positive fact as to the structure of one of the earliest known land-plants; and secure fact is worth a vast amount of surmise and argument. Nor does Mr. Church refer to the question of transference of the tetrad-division in the course of descent to a fresh position in the life-cycle, though Svedelius had raised that question in 1916, and adduced facts very pertinent to it. Such facts, and the arguments that may be based upon them, might, if they had been taken into account, have materially affected Mr. Church's statements.

Notwithstanding such omissions, the memoir is a real contribution to morphological thought. It may be that Mr. Church has over-accentuated the directness of the origin of land-plants from marine forms. But he has carefully protected himself by saying that "no Phæophycean or Floridean passed on to higher autotrophic land-flora" (p. 42). The cautious philosopher, while sympathising with Mr. Church's general thesis, would probably prefer to give greater elasticity to it, seeing in the modern marine flora suggestions upon which to base hypotheses rather than those blunt statements of conclusion which find their place in Mr. Church's pages. However that may be, the effect of "Thalassiophyta" will be to direct attention, which was already swinging that way, more definitely towards marine rather than to fresh-water algæ, as a probable source of land vegetation. Though some of Mr. Church's conclusions may not find wide acceptance, the memoir is the most thoughtful contribution to the question in recent years, and it is full of originality and of interesting though bluff criticisms.

F. O. B.

NORMAL AND MORBID PSYCHOLOGY.

Mind and its Disorders: A Text-book for Students and Practitioners of Medicine. By Dr. W. H. B. Stoddart. Third edition. (Lewis's Practical Series.) Pp. xx+580. (London: H. K. Lewis and Co., Ltd., 1919.) Price 18s. net.

A REVIEW of the new edition of this well-known text-book is justified by extensive modifications corresponding to the author's conversion to the doctrines of Freud. The volume contains in 572 pages an account of normal and morbid psychology—including the tracing of all mental processes in psychological terms to their original elements and their correlation with their neural equivalents—of the clinical forms of all the neuroses and psychoses and their investigation and treatment, of the diseases to which the insane are specially liable, and of the legal relations of insanity.

Most modern problems in all these subjects are touched upon, and the book provides the sort of knowledge required by the student and general practitioner and a starting point from which the serious study of one of these branches might be begun.

Necessarily the accounts given are summary, and perhaps dogmatism is also necessary, but some of the matter included might give way to at least a brief statement of the other side of the case. The enunciation of the James-Lange theory of emotion at the present day without reference to any opposition except a footnote controverting deductions from Sherrington's dog is somewhat misleading.

A similar lack of proportion in what is intended to be a text-book is noticeable throughout. Undue prominence is given to observations and theories in which the author is specially interested, but which are by no means universally accepted. As a single example, three pages are devoted to the enumeration of many specific tendencies and actions as separate instincts, some of which it would be very difficult to bring within any modern definition of instinct known to the present writer. On the other hand, there is no reference to McDougall's grouping of such actions under a limited number of heads as instincts with associated emotions. The usefulness of the latter concept is sufficiently widely recognised to deserve mention.

Dr. Stoddart, in his adherence to the doctrine of Freud, shows all the devoutness of the convert. He accepts the literal truth of the whole gospel, including such generalisations as that dreams are invariably distorted wish fulfilments, and that neuroses and psychoses are without exception the results of repression of sexual impulses.

Surely the battle dreams of the war neuroses have rendered the former statement untenable except by the exercise of the most perverse ingenuity. As to the second, the employment of the usual evasion that Freud and his followers use the term "sexual" in a much wider sense than is usual renders discussion meaningless. The sexual instinct is not a phenomenal reality, but a concept; the extent to which it is useful to group observed phenomena of conduct under the term is a question, not of fact, but of opinion. However, in practice Dr. Stoddart, like other extreme exponents, refers all abnormalities of thought and conduct to the crudest anomalies of this instinct in its narrowest sense.

The reviewer accepts most of Freud's description of the manner in which thinking is distorted by "complexes" in the normal and the neuropath, in dreams and similar states. But he failed to repress a smile on comparing two statements in this book, first, that in psycho-analysis suggestion is most scrupulously avoided, and secondly, that with sufferers from anxiety neurosis, terrified by an air raid, the most superficial analysis—presumably to elicit the meaning of the terror—revealed the phallic significance in their minds of Zeppelins, aeroplanes, and bombs! It is the ill-concealed satisfaction of the psycho-analyst with this type of association that evokes them.

The description of the clinical forms of the neuroses and psychoses is excellent apart from a few examples of the disproportion and excessive dogmatism referred to. But with the author's change of views it requires more careful revision to render it consistent.

ASPECTS OF MODERN SCIENCE.

The Realities of Modern Science: An Introduction for the General Reader. By John Mills. Pp. xi+327. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 10*s.* 6*d.* net.

Modern Science and Materialism. By Hugh Elliot. Pp. vii+211. (London: Longmans, Green, and Co., 1919.) Price 7*s.* 6*d.* net.

(1) THE first of these works is evidently that of an enthusiastic scientific student, rather than teacher, who has found the systems of school and college instruction in physical science prevailing in America unsatisfactory. He desires, commendably enough, to see them replaced by courses based fundamentally upon the modern conceptions which have been arrived at only within the last two or three generations, not only for the few specialist, but also for general, students. This praiseworthy motive is, however, not likely to be much furthered by the book under notice. The author would have done better to write a book for science teachers and to assume throughout a knowledge equal to that obtainable from the despised college courses. As it is, it is difficult to understand for whom exactly the book is intended. In the first half the reader is assumed to be the veriest tyro in science, and there is much gilding of the philosophic pill. The beginnings of knowledge, of machinery, and of experimentation, weights and measures, the molecular theory, the "realities of science," electrons, the nucleus and energy are discussed rather desultorily. Then follow three chapters on the most obvious and elementary algebra, to which the non-mathematical reader is advised to give only cursory and mechanical reading in order to reach the second part of the book.

Then the author lets himself go. The reader is absolutely forgotten, or at least he must have had, in an interim, the advantage of several years of serious study of science sufficient to enable him to understand, if not to profit by, the particular parts of the last half-century's advances in physics, physical chemistry, and chemistry which the author reconstructs in terms of the present day. The kinetic theory of gases, the conduction of electricity through gases, liquids, and solids, the phenomena of electromagnetism, the van der Waals equation, solutions, electrolytic dissociation, chemical equilibria and their displacement, le Chatelier's theorem, Brownian movement, electronic and molecular magnitudes, with something about X-rays and radio-active substances, are the subjects which the tyro, who may not be able to comprehend an algebraic relation, is asked to assimilate in the remaining 150 pages. The aid of the merely verbal acquaintance he has made with the few ultimate conceptions of physics is not likely to fit him for the task. For these conceptions—matter, energy, radiation, the electron, the nucleus, the quantum, and so on—are the end-products of scientific philosophy, not the starting points, and cannot replace, at all events yet, the body of experimental and actual scientific knowledge out of which they have grown. It is true that they may be the "realities of modern science," but a universe reconstructed out of them *ab initio* without other guide would bear as little resemblance to reality as that created by the end-products of mythological and religious philosophy.

(2) This work is of a totally different character, and though it represents the same desire to synthesise and bring within the comprehension of the individual a vast range—in fact, in this case, the whole—of knowledge by means of a few generalised conceptions, it is written and intended for the serious student and mature thinker. The author upholds the extremest doctrines of materialistic philosophy. To him there is no real distinction between an engine and an engine-driver. In such philosophical discussions it is well to remember the mathematical adage that what is got out in the proof is no more and no less than what was put in at the enunciation. The first two chapters, on the (inanimate) universe and on matter and energy, give an excellent account of scientific materialism, as now universally accepted for the inanimate world. The rest of the book, on life and consciousness, on the fallacy of vitalism, and on materialism and idealism, seeks to extend this doctrine of the inanimate universe to the animate, with results as outrageous to common sense surely as any philosophical system ever devised.

The main, if not the only, issue of scientific interest, the difference between a complex organic compound and a living organism, or, for that matter, between the same organism alive and dead, is ignored. Living protoplasm is just a complex organic compound, so very complex that it nourishes itself by internal secretion, reproduces itself, and, gradually, throughout geological time modifies itself in constitution, so that, originally an amœba, it finishes as a man. To the chemist, who may be supposed to know something at least about chemical compounds, if not to the biologist, the view that living protoplasm is no more than a very complex compound is fantastic.

Laplace's doctrine of rigid determinism, applied to this monism of the animate and inanimate, leads the author to deduce that what he is now writing and the sentiments his words will convey to his readers could have been known and predicted a myriad years ago by a being of infinite knowledge and mathematical power from a study of the distribution of matter and energy in the original nebula. Events of great consequence to the future are frequently decided by men on the spin of a coin. Leave out the inanimate world and whether from his nebula the omniscient being could predict the fall of the coin, though the modern mathematical physicist would probably give reasons for an answer to this question totally different from Laplace's view. Leave out the question of moral judgments, and how they originate, altogether. Here is a man on the point of calling "Heads or Tails?" to decide the course of the future—but with the decision still untaken—with a certain distribution of energy and matter in his brain. We are asked to believe that this matter and energy will be differently distributed in a manner obvious to an omniscient being—that one distribution will make him call "Tails" and another "Heads." A scientific materialism that calmly accepts positive answers to such unsolved problems as these concerning free-will and the nature of life is scientific surely only in name.

F. SODDY.

OUR BOOKSHELF.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College and Papers in Elementary Engineering for Naval Cadetships for the Years 1909–18. Edited by R. M. Milne. (London: Macmillan and Co., Ltd., 1919.) Price 7*s*.

A RECENT issue of this collection of examination papers has been reviewed in NATURE. It remains only to say that the papers added in the new issue maintain the standard of excellence already noticed. The questions are remarkably suitable for the discovery of what the candidates know.

Mesures Pratiques en Radioactivité. By Dr. W. Makower and Dr. H. Geiger. Traduit de l'Anglais by E. Philippi. Pp. vii+181. (Paris: Gauthier-Villars et Cie, 1919.) Price 8 francs.

A GOOD French translation of this well-known and admirable work.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Euclid, Newton, and Einstein.

SINCE the results of the Eclipse Expedition of May last have been made public a very great deal of general interest has been displayed in a theory which, until a few weeks ago, was known only to mathematicians and physicists. Even among these, not many could offer any adequate explanation of the new view of space and time and their mutual relations, while some regarded the whole question as a mathematical joke which led to interesting results of no practical value; and probably not a few thought that a non-Euclidean system of geometry was inadmissible in any physical theory of the universe. On the other hand, there are some who have gone so far as to advocate that non-Euclidean geometry should be taught to boys and girls in secondary schools. The published books on this subject do not come into touch with any ordinary experience, and the whole subject, consequently, has been regarded as a mathematical fiction. So far from this being so, most people have actually seen the ordinary operations of life proceeding in non-Euclidean space, though they have not realised the meaning of all they have seen. In the space behind a plane mirror objects are reversed right and left (perverted), though in all other respects they correspond precisely to the real objects in front of the mirror of which they are the images, but in the space behind a convex mirror this is not the case. The geometry of this space and the behaviour of moving bodies therein, as viewed by the external observer and as studied by an intelligent being within the image space, say, the image of the external observer, who applies to the images and their movements the same standards of measurement as the external observer applies to the real objects in his own space, introduce us to a non-Euclidean space which is the subject of common observation, and prepare the mind for the reception of many of the conclusions of the now famous theory of relativity. In the discussion of that theory two observers are supposed to be moving relatively to one another, each with his own set of measuring instruments and each living in his own world or system, and the differences between the phenomena which occur in each system as measured by the dweller in that system and by the external observer form the basis of the theory. Corresponding to these two observers we propose to consider the actual observer outside the convex mirror and his supposed intelligent image behind the mirror, and to consider how the images behind the mirror, treated as real objects, appear to behave to both observers.

In the first place, it is necessary to consider the size and shape of the objects, or, in other words, the geometry of the space. To save repetition it will be convenient to call the external observer A and his intelligent image B. The line joining the middle point of the mirror with the centre of the sphere of which the surface of the mirror is a part is the axis of the mirror, and may be supposed to be extended indefinitely outside the mirror. The image of an infinitely distant star on the axis of the mirror will be formed at a point half-way between the surface of the mirror and the centre of the sphere. This point is called the principal focus, and its distance from the mirror is the focal length, which is half the radius. It will be convenient to call this point F. A series of lines drawn from the circumference of the mirror outwards and all parallel to the axis encloses a cylindrical space to which the external objects considered are to be confined. All these lines produced indefinitely will at length meet the star on the axis of the mirror. Their images will, therefore, all converge to the principal focus F, and the whole of the infinite cylinder in the external world will correspond to a cone behind the mirror having F for its vertex and the mirror for its curved base. If an object outside moves away to infinity its image will never get beyond F, and the images of straight lines meeting the mirror and extending parallel to the axis as far as the distant star will all meet at F. We shall suppose the radius of curvature of the mirror to be very large as compared with the dimensions of the mirror itself or of the observer.

There is a very simple geometrical law connecting the distance of an object from the mirror and the distance of its image from F. This law need not concern us except to point out that as the object recedes from the mirror its image approaches F, and, as seen by the external observer, the dimensions of the image in all directions at right angles to the axis are proportional to its distance from F, but the dimensions parallel to the axis are proportional to the square of the distance from F of the image. This is the peculiar property of convex mirror space. If a cricket-ball is placed in front of the mirror at a distance equal to the focal length, its image will be half-way between the mirror and F, but the image will not be spherical. In all directions at right angles to the axis the dimensions will be reduced to one-half, but along the axis they will be reduced to one-quarter, so that the sphere will be represented by an oblate spheroid (an orange) with a polar axis one-half of the equatorial diameter. If the ball moves farther from the mirror the oblateness of the spheroid will be increased, and when the image is three-quarters of the way between the mirror and F the polar axis will be only one-quarter of the equatorial diameter of the spheroid, which will itself be only one-quarter of the diameter of the cricket-ball. If a circular hoop is placed with its plane at right angles to the axis its image will be circular, but if it is turned round so that its plane is parallel to the axis the image will be an ellipse, which will become more and more eccentric as the hoop recedes from the mirror and the image diminishes on approaching F. A top set spinning with its axis perpendicular to the axis of the mirror will appear in its image to the external observer to be elliptic, with its axes fixed in space, so that as any line of particles in the top approach parallelism to the axis of the mirror they will be squeezed together and expand again as they recede from parallelism. Midway between the mirror and F the density of the top will appear to A to be twice as great in the direction of the axis as in any direction at right angles to the axis, for the same number of particles will be squeezed into half the length.

All this has been written from the point of view of A, the external observer. But how will all these things appear to B, who is living and moving in the mirror space? Like A, the observer B may use a foot-rule for measuring length, breadth, and thickness, and a protractor for measuring angles. As A proceeds to measure the real object, B proceeds to measure the image, but as he approaches the focus his foot-rule, like himself and the image he is going to measure, gets smaller and in precisely the same proportion, so that if the image measured 6 in. in height when close to the mirror, it would always appear to measure 6 in. in height, for, as seen by A, the foot-rule would contract just as the image contracted, though B would be unconscious of the contraction. Moreover, half-way between the mirror and the focus B's foot-rule will appear to A to be only 6 in. long when held perpendicular to the axis, but when turned parallel to the axis it will appear to A to be only 3 in. long, and if it is turned round it will contract in exactly the same way as the image which it is used to measure. B, therefore, will be quite unable by means of his foot-rule to ascertain that the cricket-ball is no longer spherical, or the top or hoop no longer circular. The judgment of A and that of B will therefore be entirely discordant.

If a circle divided by radii, say 5° apart, into equal angles is held with its plane perpendicular to the axis, the image will appear to both A and B to be circular and the angles equal, but if it is turned with its plane parallel to the axis the image to A will appear an ellipse and the angles in each quadrant unequal, but B will have no means of detecting these inequalities, and he will place implicit faith in the accuracy of his protractor.

The question will naturally be asked: Cannot B see that his circle has become an ellipse? When the plane of the circle is at right angles to the axis and B looks straight at it, the image on B's retina, as it appears to A as well as to B, is circular, but when the circle is turned round and B turns round to look at it, B's retina undergoes precisely the same changes as the circle itself, and still the image occupies the same portion of B's retina as before, and therefore produces the same mental impression of a circle on B, though A recognises the ellipticity of B's retinal image (which A is supposed to see in the mirror).

If A walks straight away from the mirror to an indefinite distance, B will walk towards the focus, but as A can never reach the star, so B, walking, as he thinks, uniformly, can never reach F. In fact, his speed of walking as seen by A appears to diminish in proportion to the square of his distance from F, as all small distances measured along the axis diminish in this ratio, but B can never discover this, for he always appears to walk the same number of feet in a minute, as measured by his own diminishing foot-rule. It is true that when B's height and the length of his legs appear to A to be reduced to one-half, the length of his step appears to be reduced to one-quarter, and the angle between his legs as he walks to be reduced correspondingly; but if B tries to measure this angle, his protractor suffers the same distortion, as recognised by A, and B thinks he is walking always in precisely the same way.

It appears, then, that to B the principal focus F is infinity. He can never reach it, however long or however quickly he walks; and there is nothing in his world beyond it. All straight lines drawn from F to the mirror appear to B to be parallel, for they meet only at infinity, and he can never reach their point of meeting. They correspond to parallel lines in the Euclidean space outside the mirror. The image of a square held with its plane perpendicular to the axis will appear to both A and B to be square, but, held with two of its sides parallel to the axis, the angles of the square will appear to A to be unequal, for the two sides parallel to the axis will converge to F, and the dimensions of the square along the axis will be less than its dimensions at right angles, but neither the foot-rule nor the protractor in the hands of B will detect these irregularities. In convex mirror space straight lines which meet at F are parallel.

If two of the straight lines which appear to B to be parallel are cut by a third line, and the figure is examined by A, the two interior angles on the same side of the cutting line do not appear to be equal to two right angles, and the exterior angle does not appear to be equal to the interior and opposite angle. This is the essential feature of convex looking-glass space, but B will not agree with A on either question. To B, Euclid's propositions respecting parallel straight lines will appear to hold. He will think that he is living in Euclidean space, though A knows better, or thinks he knows.

To the external observer, then, convex looking-glass space has different properties as the focus is approached, or, in technical phrase, it is not homoloidal, and it has different properties in different directions, like a uniaxial crystal—that is, it is not isotropic, but differs from the crystal since its lack of isotropism increases as the focus is approached. The image of a metre rod nine-tenths of the distance from the mirror to the focus will appear to the external observer to measure a decimetre when at right angles to the axis, but only a centimetre when parallel to the axis.

This "distortion" of space is precisely what happens according to the theory of relativity in the neighbourhood of a gravitating body, though the distortion is very small even at the surface of the sun. In the direction of the gravitation pull space is contracted, and a foot-rule is actually shorter than when it lies at right angles to the force to the extent of about 43 parts in 10,000,000 at the sun's surface. The effect is greater the greater the intensity of gravitation, and, consequently, it increases on approaching a gravitating body.

If space is supposed to be occupied by points, and the length of a line to be measured by the number of points in it, then in space free from gravitation the points are equally distributed in all directions, but when gravity acts the points are closer together in the direction of gravity than in other directions, as soldiers in column are closer together from right to left than from front to rear, or as the images of evenly distributed points in space are more closely packed along the axis of a convex mirror than in other directions. This representation of the effect of gravity is due to Prof. Eddington. Light always goes from one point to another in the shortest possible time. This principle leads to the ordinary laws of reflection and refraction. In passing through space in the presence of gravitation it will take the path which necessitates passing through the smallest number of spatial points, and this means refraction similar to that produced when it passes into a denser medium in which its velocity is reduced. The effect on light in passing near to the sun will be the same as if the sun were surrounded by an atmosphere extending to a distance of many millions of miles, and diminishing in density as the distance from the sun is increased. This will act like a convex lens refracting the light, which will travel more slowly as it approaches the sun. A comet approaching the sun with the velocity of light would, according to the laws of Newton, travel more quickly as it approached, but its orbit would be bent towards the sun as the light is bent, but only to one-half the extent. If light from a star were passing the sun close to its limb, and behaved like a comet under the sun's attraction, it would be deflected about seven-eighths of a second of arc. On the theory of relativity it would be deflected through $1\frac{3}{4}$ seconds. It was this deflection which the Eclipse Expedition set out to measure. The behaviour of comets shows that there is no solar atmosphere to account for the refraction at distances from the sun at which the refraction was observed.

In all that has been said respecting the space behind a convex mirror the size of the mirror is supposed to be very small as compared with its radius of curvature, and the objects and images much smaller still. If a complete spherical mirror is suspended in free space the geometrical images of the stars will be distributed over a sphere of half the radius of the mirror, and this spherical surface is infinity to all the dwellers in the mirror space. The image of an object which subtends a large angle at the centre of the mirror will be bent. In Fig. 1, *ab*, *cd*, and *ef* are the images of straight

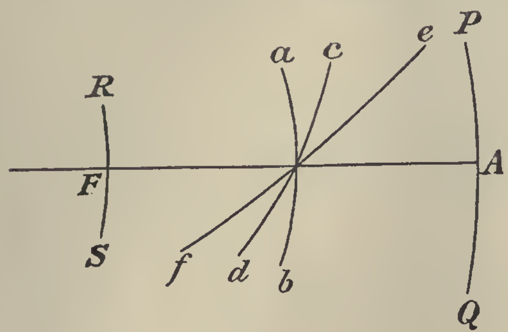

Fig. 1.

lines all passing through the same point distant half the radius from the face of the mirror. These lines are all curved and concave to the centre of the mirror, but they are straight lines in convex mirror space, and pass through the smallest number of spatial points of any line joining the extreme points. They are the paths which would be taken by rays of light in space in which the spatial points were packed as in convex mirror space. In every case the light is refracted towards the portion of space in which the point density is greatest. In the figure PQ represents the mirror, RS the focal sphere of half the radius, while the images correspond to straight lines cutting FA produced in the same point at 90°, 45°, and $22\frac{1}{2}$° respectively. It will be seen that the curvature of *ab* enables it to pass through a region in which the points are less closely packed than along the line joining *a* and *b*, which appears to the external observer to be straight. On the Einstein theory, light passing a gravitating body like the sun is refracted in the same way. In convex mirror space strings stretched between the points *a* and *b*, *c* and *d*, and *e* and *f* would take the forms shown. A person in a hurry and endeavouring to pass through a crowd will make a detour to avoid the more densely packed portions of the crowd.

According to the theory of relativity, motion and force, involving time, change the properties of space. In convex looking-glass space position and direction only are involved, so that the problem is much simpler, while many of the results are very similar.

If the two great mechanical principles of the conservation of momentum and the conservation of energy are applied to the movement of bodies in B's space a consistent system of dynamics can be constructed, and B with his measuring instruments will be quite unable to detect any divergence from Newton's laws of motion. To A, however, the laws will appear very different. For example, a body under the action of no external force moving along the axis of the mirror will move with a velocity varying as the square of its distance from F. This means that the apparent mass will vary inversely as the square of the distance of the body from F, and as the body approaches F the mass appears to increase indefinitely. This corresponds to the increase of mass according to the theory of relativity when the velocity of a body increases, becoming infinite as the velocity of light is approached. According to the theory of relativity, the mass of a body is greater in the direction of its motion than in directions at right angles to its direction of motion. In convex looking-glass space the mass is greater, when measured by the accelerative effect of a force, in the direction of the axis than in directions at right angles to the axis, and greater the nearer the focus. The reason why B cannot detect any of these changes is that all his standard units change in the same way; and, as all physical measurements ultimately reduce themselves to a comparison with standard units, if the units change a corresponding change in the quantity measured cannot be detected. We cannot, for instance, detect the variation in the weight of a body between the equator and the poles by means of standard weights and a pair of scales, though we may detect it by a spring-balance or a pendulum. It is always the looker-on, A, who sees most of the game.

Some thirty or more years ago a little *jeu d'esprit* was written by Dr. Edwin Abbott entitled "Flatland." At the time of its publication it did not attract as much attention as it deserved. Dr. Abbott pictures intelligent beings whose whole experience is confined to a plane, or other space of two dimensions, who have no faculties by which they can become conscious of anything outside that space and no means of moving off the surface on which they live. He then asks the reader, who has consciousness of the third dimension, to imagine a sphere descending upon the plane of Flatland and passing through it. How will the inhabitants regard this phenomenon? They will not see the approaching sphere and will have no conception of its solidity. They will only be conscious of the circle in which it cuts their plane. This circle, at first a point, will gradually increase in diameter, driving the inhabitants of Flatland outwards from its circumference, and this will go on until half the sphere has passed through the plane, when the circle will gradually contract to a point and then vanish, leaving the Flatlanders in undisturbed possession of their country (supposing the wound in the plane to have healed). Their experience will be that of a circular obstacle gradually expanding or growing, and then contracting, and they will attribute to *growth in time* what the external observer in three dimensions assigns to motion in the third dimension. Transfer this analogy to a movement of the fourth dimension through three-dimensional space. Assume the past and future of the universe to be all depicted in four-dimensional space and visible to any being who has consciousness of the fourth dimension. If there is motion of our three-dimensional space relative to the fourth dimension, all the changes we experience and assign to the flow of time will be due simply to this movement, the whole of the future as well as the past always existing in the fourth dimension.

The theory of relativity requires a fourth dimensional term to be introduced into its dynamical equations. This term involves time and the velocity of light. Generally, the easiest method of expressing algebraically position and motion in three-dimensional space is by reference to three directions mutually at right angles, like the edges of a cube which meet at one corner. These lines may, for example, be drawn through the observer north and south and east and west, like the reference lines on a map, while the third line is up and down. The observer's point of reference is where these three lines meet. In four-dimensional geometry there is a fourth direction at right angles to each of the three. Most of us are unable to form any clear picture of such a direction as a purely geometrical conception. To us the only figure which is at right angles to every straight line drawn through a point O is a sphere, or any number of spheres, having O as centre. As stated above, the fourth co-ordinate involves time and the velocity of light together. Imagine these spheres to be always moving inwards towards O with the velocity of light, and then to expand again from O with the same velocity, and this to take place quite uniformly, however O may move in relation to other points of observation, so that the centre of the system of contracting and expanding spheres travels with the observer, and each observer has his own system of spheres. The approaching and contracting spheres contain within them the whole future; the receding and expanding spheres contain the past. The present is the passage of a sphere through O, the observer, when that sphere is concentrated on a point. This conception of a fourth dimension is thus not that of a simple spatial dimension like the other three, but, as required in the theory of relativity, it is intimately associated with time and motion, and the observer's experience of it is simply the happening of events with the flux of time. It is very like the Flatlander's conception of the third dimension derived from the invading sphere. It will be noticed that to different observers the impressions of the present are not quite the same. We observe an event in a star. It is present to us. To an observer in the star it happened years ago.

The theory of relativity involves a change in the unit of time, according to the motion of the observer relative to the object observed. This complication did not enter into the consideration of the space behind the convex mirror, so that the dynamical problems in that space were relatively simple. According to the theory of relativity, if the observer is moving with the velocity of light, time remains unchanged. This must have been the case with the Mad Hatter. With him it was always six o'clock, and always tea-time.

W. G.

Thermionic Valves on Aircraft.

In a paper just published in the Proceedings of the Royal Society (A, vol. xcvi.) Drs. W. H. Eccles and J. H. Vincent give an account of some experiments on the small variations of wave-length introduced when changes are made either in filament temperature or plate voltage of a thermionic valve supplying oscillating energy to a wireless circuit. It may be of interest to readers of NATURE to know how this effect influenced the design of wireless aircraft generators used in the war.

In 1916, when experimenting with continuous-wave telegraphy and telephony from aircraft, I noticed a small outstanding variation of wave-length radiated from an aeroplane, which variation seemed to depend mainly on the speed of flight, and therefore, possibly, on the voltages supplied by the windmill-driven generator.

Following up this clue, I found in the Air Force Laboratory that the changes of wave-length introduced by variations of filament temperature and plate voltage were more considerable than I had thought, especially on short wave-lengths.

It was the knowledge of this fact which led to the inclusion of special regulating devices in the aircraft dynamo circuits, so that the wave-length variation, at the best of times noticeable owing to aerial sway, banking, etc., should be reduced, at any rate, to a minimum.

R. WHIDDINGTON.

The University, Leeds, February 5.

Popular Science.

I SHOULD like to be allowed to underline a few remarks that occur in a review entitled "Scientific Biography" in NATURE for January 29. The writer urges that science has neglected the populace and offered its wares for popular edification in a highly unedifying way. I believe this is very true. I am old enough to remember different times, and can recall with truth and gratitude the feeling of enthusiasm, and even of exaltation, which I had in early days on hearing or reading popular science lectures. I think of Huxley, Tyndall, Clifford, W. B. Carpenter, Lockyer, Roscoe, and some others. Science lectures then were aimed at showing how science did its work, and they brought into view something of the personality of the real scientific worker.

Remembering how much I had gained, I endeavoured in my turn to carry on the good work within the much-restricted range of my own powers, but in the same spirit. In time I realised two things: one, the debilitating tendency of publicity and easily won applause; the other, the invasion of the science platform by the mere entertainer and his *entrepreneur*. The work became suspect to all self-respecting people. The degenerated Press has completed the havoc.

Is it not possible to improve matters? I believe it is. No doubt some knowledge of science is more prevalent than it was, but there is yet ample room for the simple, popular lecture of the genuine kind by men who are the real workers. It is a serious tax, but I am inclined to think a justifiable one, on the time of these men to give, say once a year in some large city, a really popular account of their latest discoveries and have it printed to sell at a popular price. That, and a vocal public opinion in the world of science against comic, pyrotechnic, mystic, or other profane tickling of the groundlings, might do much in a good cause.

VICTORIAN.

Mirage Effects.

THE mirage effect noticed by Mr. Quilter and Miss Botley is very common on Woolacombe Sands, especially on hot, sunny days when the observer is looking south. The apparently wet patch keeps at a half to three-quarters of a mile's distance from the eye, but does not persist up to the southern limit of the bay, which is bounded by high ground. I cannot remember whether it is visible when the observer is facing north.

SPENCER PICKERING.

MIRAGE effects similar to those referred to in NATURE of January 29 (p. 565) have been noticed by me several times in Birmingham on tarred macadam or wood-block roads. The effect on a hot, sunny day is of a layer of water from 2 in. to 4 in. deep on the surface of the roadway, immersed in which are the feet of pedestrians and the wheels of vehicles about a hundred yards from the observer. The effect is best seen when the line of sight nearly coincides with the surface of the roadway, as, for instance, just before one breasts the summit of a slight rise, when the eye is practically level with the ground beyond the top of the rise. Stooping would produce a similar effect.

L. N. NORRIS-ROGERS.

I FIRST saw a mirage on a road in Colombo, and wondered how I was going to cross the apparent sheet of water in front of me. Since then I have seen it repeatedly in England, and instinctively look for it when the conditions are right. For the best effects these conditions are three: (*a*) Tarred roads (the reason is obvious); (*b*) bright sun; and (*c*) a slight gradient rising from the observer.

In very hot weather (*c*) may not be so necessary. At other times the mirage appears where the gradient reaches towards the level of the eyes. It is very clear, and reflections are as sharp as in water, especially of objects crossing near the further edge.

HARRY HILLMAN.

117 Colmore Row, Birmingham.

THE THEORY OF RELATIVITY.

THE meeting of the Royal Society on February 5 was devoted to a discussion on the theory of relativity. It was opened by Mr. J. H. Jeans, who said it was a better analogy to liken the new principle, not to a key of the universe, but to a ward in its lock, which gave direction to the efforts made to open it, admitting some and excluding others. In this respect it resembled the doctrine of the conservation of energy and the second law of thermodynamics. Where any of these gave a positive result it was because a process of exhaustion showed that anything else would be impossible.

The foundation of the theory may be considered to have been laid by Einstein's hypothesis, put forward in 1905, that light from any source appears to any observer to travel with the same velocity C; this hypothesis was founded on the Michelson-Morley experiment, and has since been confirmed by that of Majorana; it also explains a number of physical phenomena. It can best be visualised by the idea that to each observer the wave-surface is spherical in the four-dimension continuum. Then $x^2+y^2+z^2+(i\mathrm{C}t)^2$ (radius for the first observer) transforms into an identical expression with accented letters (radius for the second observer) by a rigid-body rotation. Such a rotation would resolve pure time into partly time, partly space, and *vice versa*. The following is an example of this: Suppose that a man lives seventy-five years, and dies 1000 miles from his birthplace; then to an observer on a rapidly receding star he might appear to have lived seventy-six years and travelled billions of miles. (In reply to Prof. Newall, who imagined paper screens to be erected at a distance of 100 light-seconds from the origin, from which a flash of light is emitted, and from which one of the observers moves while the other remains, Mr. Jeans admitted that the former would not see the reflections simultaneously, the reason being that the screens would not lie on a four-dimensional sphere to him.) This conception was preferable to that of the Lorentz contraction, which presented grave difficulties in the case of a rotating wheel, the axis of which is at rest in the æther; the rim would undergo contraction, while the spokes would remain unaltered.

Mr. Jeans used the following analogy to explain the nature of Einstein's latest theory. Imagine a race of men who had spent all their lives in caves. They would be in ignorance of the earth's rotation, and would consider gravity as a force constant in direction; however, two experiments might reveal the fact of rotation to them. If they set a ball swinging in an ellipse, by a long string, the apse of the ellipse would move; moreover, delicate measures would show that the course of rays of light was not quite straight relatively to their rotating framework. This is closely analogous to the observed progression of Mercury's perihelion and to the deflection of light-rays by the sun; in each case "we have tacitly assumed fixed axes where nothing is fixed: we have formed wrong ideas of the nature of gravitation, and our definition of a straight line is interwoven with the ideas of an untrue system of geometry."

The reason why the new law of gravitation cannot be put in simple form is that there is no *force* of gravitation; the laws of *motion* can be put in the simple form $\delta\int ds=0$. There are, however, two ways of defining ds. Einstein defines it as a line-element in a distorted space-time continuum. This necessarily involves the spectral shift to the red, and an objective curvature of space. It may also be simply defined as a conventional algebraical symbol given by Einstein's equation, but without assuming his physical interpretation; in this manner it is possible to deduce the two astronomical effects already verified, while leaving the shift of spectral lines undetermined. Decisive evidence for or against the spectral shift would be a guide as to the adoption of one or other definition of ds.

Prof. Eddington compared Euclidean space to a picture in a framework of rectangular co-ordinates, and Einstein's space to a map with curved lines of latitude and longitude. Just as the map could not accurately represent the earth's surface, unless it was made on a curved surface, so Euclidean space could not contain an accurate representation of the space-time continuum. We could look on Einstein's law of gravitation as giving instructions for the joining together of successive elements of space. The law must include all the laws of mechanics, including the conservation of energy and momentum.

Space and time could be explored in two ways—either by using clocks and measuring scales, or by observing moving particles and light-waves. The second method was both more elementary and more sensitive. An example of it was the search for the spectral shift. The reason for the shift might be briefly given thus. The time of vibration of a particle involves the factor $\left\{1-\frac{2m}{r\mathrm{C}^2}\right\}^{-\frac{1}{2}}$ which clearly increases as r diminishes, so that the vibration is slower on the sun than on the earth.

Sir F. W. Dyson spoke on the motion of the perihelion of Mercury; the observed centennial motion exceeds that calculated on the Newtonian law by 43″, which is much the largest unexplained quantity in planetary theory. Various attempts have been made to explain it. An excess of ½″ of the sun's equatorial radius over the polar would suffice; this amount is considered to be in excess of what observation will admit; the latter suggests a slight excess of the polar radius; moreover, such an equatorial excess would produce a shift of the orbit-plane of Mercury too great to be admitted. An unknown planet is excluded, since it could not fail to have been seen or photographed at some of the total eclipses when such a body has been specially looked for. A ring of small planets would have to be in the plane of Mercury's orbit, or it would produce an effect on its node and inclination. This puts the zodiacal light out of court, even if its mass were sufficient, which seems unlikely. Prof. Asaph Hall suggested that the law of attraction should be modified, the index of r being taken, not as -2, but as $-2(1+d)$, where d is a small fraction, chosen empirically so as to fit the case of Mercury. This is the law adopted in Newcomb's tables, and therefore in the Nautical Almanac. It would give a centennial shift of the moon's perigee of $135''$. (The discussion of Dr. E. W. Brown seems to establish that there is no such excess of motion in the perigee, which discredits the Hall hypothesis.)

Einstein's theory perfectly explained the excess of motion of Mercury's perihelion, without introducing any arbitrary constant, or having any other perceptible effect on the planetary or lunar motions. By the method of exhaustion it seemed to hold the field. There remained a small excess of motion in the case of the node of Venus, but it was only $2\frac{1}{2}$ times the probable error, and so was not unreasonable.

Prof. A. Fowler spoke on the attempts that had been made to detect the shift towards the red in the sun's spectral lines, and on the difficulties in the way, which arose from the effect of varying pressure, the rotation of the sun, and possible convection currents in its atmosphere. A series of cyanogen lines was selected for the test, as they were not subject to shift through pressure; care was necessary to choose isolated lines, as adjacent lines might influence the measures. The sun's rotation could be eliminated by observing opposite points of the limb. The results of the measures of Evershed, St. John, Schwarzschild, and recent Bonn observers were shown on the screen. The mean of all gave a shift towards the red of 0·003 Å. at the sun's centre and of 0·004 Å. at the limb, Einstein's predicted value being 0·008 Å. Prof. Fowler inclined to the view that the observed shift was due not to the Einstein effect, but to cooler descending convection currents at the sun's centre, and to the "limb effect" at the limb.

Mr. E. Cunningham gave the following example to show that the spectral shift need not necessarily occur on the equivalence hypothesis: Imagine two atoms each emitting light-vibrations in a non-gravitational field, the periods of vibration being the same. Referring them to a set of accelerating axes, we simulate a gravitational field. The synchronism between the two sets of waves is not destroyed; and on the equivalence hypothesis the relation of physical sequences in the simulated field is the same as in the real field. There is the qualification that the atoms must be free to fall—*i.e.* not constrained by neighbouring atoms; Mr. Cunningham doubted whether this was the case on the sun's surface. He went on to say that relativity did not necessarily imply the abandonment of the æther; a unique æther could be constructed on a mechanical basis; if it transmitted light, it must also transmit stress and energy.

Prof. A. F. Lindemann spoke of the observed average recession of 4 km./sec. in the B-stars; even those in the Orion nebula, which presumably were at rest relatively to it, showed this differential shift; he concluded that it was not a Doppler effect, and might be the Einstein one. He noted as a difficulty in the quantum theory of light that to an observer at rest the mass of a quantum would be infinite; moreover, he considered that since the mass of an electron changed with its speed, its period of vibration should also change. Speaking of Prof. Eddington's statement that a sphere of water of radius 500 million km. would fill all space, he preferred to say that to an observer on the sphere it would appear to do so, since all rays from it would be bent back to it by its attraction; but he thought there was nothing to prevent other space from existing outside it.

Prof. A. N. Whitehead showed a mathematical method by which Einstein's first two astronomical predictions might be satisfied without introducing time as the fourth dimension. The method left it uncertain whether the spectral shift would take place or not. Should the latter be finally proved not to exist, we might fall back on this method, which agreed with the facts at present observed.

A. C. D. CROMMELIN.

THE FLIGHT FROM CAIRO TO THE CAPE.

(1) AVIATION AND EXPLORATION.

THE enterprise of the *Times* in organising a flight from London to Cape Town *via* Cairo, Khartum, the Upper Nile, the interior of East Africa, Northern and Southern Rhodesia, and the Transvaal will certainly, if successful, greatly advance the theory and practice of travelling through the air from one distant part of the world to another.

The bearing of the whole question—air travel *versus* railway, ocean steamer, or road-motor transit—was well put a few days ago by Capt. Frederick Shelford in his address to the African Society. There is no real cause for rivalry or hostile competition between all four forms of rapid transport. Air travel by aeroplane or airship will for a long time to come be far more dangerous to life than road or rail transit, and a little more dangerous than sea voyages; but it will be very much quicker than all other methods. It will be impossibly expensive for the transport of goods or of many passengers. Sea travel by boat is the cheapest mode of conveyance; railways, on the whole, and especially in wild, little-developed countries, are as cheaply made as motor roads, and are much less expensive to maintain. For mails and for passengers in a great hurry, aeroplanes should have no rival, especially when meteorology is better understood, and when the great air routes of the world are duly provided with aerodromes at convenient distances.

It may seem to be stating too obvious a fact when I point out that the chief difficulty in the way to complete success on the part of aviation is the coming down safely from the air to the solid earth. No air pilot can view without grave apprehension a forced descent on an uneven or merely a slightly irregular surface. The passengers might not be more than shaken or bruised, but the delicate machine might be so injured as to be unable to resume its flight. But for this trouble about *descent* and *ascent*, the exploration of the world's land surface would now be proceeding at a tremendous rate. Soon the whole of the continents and islands would be made known in all their details.

I have always hoped myself that there may be some wonderful development in mechanics or in physics by which heavier-than-air machines might be enabled (1) to rise direct from the ground into the air *vertically*; and (2) to descend vertically and slowly, under control, making use of air-brakes in some way. The latter process may read as an impossibility, but it is not more improbable than many a feat in aviation would have sounded to the scientific theorist twenty years ago.

Then, again, I am sure we have neglected another safety apparatus: the devising of clothing that might be so inflated with air that the wearer would float to earth as gently as thistle-down.

The original mind of Dr. Chalmers Mitchell may well come back from his great air journey with new conceptions as to the future solution of these and other difficulties in aviation. Few people know as much as he does about bird-structure, and he may, when he is "up against it," be inspired to apply to the theory and practice of aviation some bright ideas—as yet overlooked—to be derived from the bird's development of the art of flying, especially the efforts made by heavy birds (cranes, storks, swans, peafowl, bustards, and large vultures) to rise into the air, to maintain themselves resting (floating) in the air, and to descend from a great height to the ground uninjured.

As to Dr. Mitchell's experiences and those of his companions on this actual journey, my impressions are: that by rising to eight or nine thousand feet they will ascend above the dangerous storms or violent winds of Central Africa; that they will nowhere run any serious danger from wild or savage men, except among the Dinkas of the Nile Valley (east of the Bahr-al-Ghazal); that they have very little to fear from any wild beast except a chance rhinoceros in East Africa; and that in seeing the desert yield to the Nile marsh-lakes, the marshes give place to mountains—even snow-mountains—and grandiose forest, the forest thinning out into parklands, the parklands passing into steppe, the steppe into desert, and the desert into the cornfields, orchards, vineyards, and gardens of South Africa, they will have had an unforgettable lesson in physical geography. I wish them the most complete success and a happy return.

H. H. Johnston.

(2) Scientific Aspects of the Route.

The expedition which started from Cairo on February 6 should be memorable as the first use of long-distance aeroplane flight for scientific and geographical research. Thanks to the enterprise of the *Times*, a Vickers' "Vimy" aeroplane is traversing Africa from Egypt to the Cape, with Dr. Chalmers Mitchell as scientific observer and Capts. Cockerell and Broome as pilots. The expedition will test the value of long aerial journeys for scientific purposes, and as it is under a man of such width of knowledge and scientific imagination as Dr. Chalmers Mitchell, we may be confident that the opportunity will be used to the best advantage.

The expedition is to travel leisurely, at moderate elevations, and never flying at night, so as to enable Dr. Chalmers Mitchell to obtain a clear survey of the country traversed. The route is from the aerodrome at Heliopolis, near Cairo, up the Nile, past Assuan, to Wadi Halfa, and thence, along the railway line, across the Dongola bend of the Nile, to the river again past Atbara to Khartum; then up the White Nile past Mongalla and Gondokoro and over the Nile rapids to Nimule. Thence the most direct route would be to leave the river and cross the Fatiko country to Lake Kiogo, and there rejoin the Nile, following it to its outflow from the Victoria Nyanza at the Ripon Falls. The expedition will fly over the lake to Kisumu, at the end of the Uganda Railway, skirt the irregular eastern coastlands to Mwanza, on the southern shore of the Victoria Nyanza, and cross "German" East Africa to Abercorn at the southern end of Tanganyika. Thence the route will be above north-eastern Rhodesia to the mining fields of the African Broken Hill, and along the railway past the Victoria Falls on the Zambezi to Wankie coalfield and Bulawayo; it will continue in sight of the railway another 182 miles southward to Palapye, where it will bend eastward across the northern Transvaal to Pretoria, and by following the railway past Johannesburg, Bloemfontein, and Beaufort West end its journey, of 5206 miles by the route projected, at Cape Town.

This journey must naturally be direct, long distances must be covered daily, and deviations to follow up interesting clues may be inadmissible, for the main object of this flight is to demonstrate the practicability of the aeroplane in the next stage of African research and development. The prospects are promising, for a bird's-eye view from a moderate elevation would reveal much of interest and practical value regarding the geography, geology, and botany of those parts of Africa composed of arid plains like the East African Nyika. One difficulty with their investigation is that, owing to the covering of scrub, travellers by foot or on horseback may march for days and see nothing beyond a few hundred yards beside the route, while any useful plane table survey is impossible. A view from above would, however, show all the essential features; the valuable areas are on the volcanic rocks or on limestones, both of which produce good soils and often maintain permanent wells, whereas the metamorphic rocks, which form the foundation of the country, yield a barren sandy soil and may have no permanent water.

The contrasts between the types of country on these three kinds of rock are so striking that an aeroplane observer would soon learn to distinguish them and thus discover potential oases on lava or limestone in the wastes of sandy scrub. In such countries travel to a physiographer is often as exasperating as the sudden interruptions of view along a railway by lines of obstructive trees, cuttings, and tunnels, which led Ruskin to renounce railway travel, on the ground that he would as soon thus hasten a journey across interesting country as an epicure would compress his meal into a single pill. Moreover, the traverse of these arid plains in the dry season is hazardous, as a caravan strong enough for necessary transport and defence is liable to disaster by failure to find water; whereas an accompanying aeroplane scout would at once discover any remaining waterholes, which might be concealed from a caravan passing a short distance from them. Aeroplane guidance might thus enable an expedition to cross an area which otherwise it would be foolhardy to enter.

The motor-car is no doubt of great service on these plains in dry weather, but its use is attended with the serious danger that a sudden fall of rain may convert the country into a sea of mud, in which the motor is immovable. A premature rainstorm before the normal rainy season may leave a party dependent on motor transport as completely isolated in the desert as a shipwrecked party on an oceanic island.

African geography is in a stage when bird's-eye views may be very instructive. For example, south-west of Lake Stefanie different explorers have reported lines of hills and scarps the interpretation of which is at present uncertain; but to an aeroplane observer surveying the country, especially when helped by the long shadows of early morning or late afternoon, these lines would appear in such diagrammatic outline as to give him an insight into their relations, which would cost a traveller on foot an arduous season's campaign. Similarly, there is much difference of opinion as to the connection between Lake Nyasa and the southern end of the Rift Valley in central "German" East Africa near Kilimatinde; the Ruaha Valley overlaps with a relief line to the north-west of it, but no connection between them has been recognised. An aeroplane survey of this region under suitable illumination would demonstrate the structural relations between the chief features in the relief of the area with a speed, an ease, and an economy which no other method could approach. Again, in the area which the *Times* expedition will skirt in going from Tanganyika to the mines at Broken Hill, the structural geography is complex, including valleys and scarps of different dates and plateaux of sandstone of various undetermined ages. The traverse of this district is arduous, and comprehensive views across it are difficult to obtain. But a survey or looking down on it, especially if able to hover over it at leisure and see it from different angles and under various conditions of illumination, would probably contribute greatly to the solution of its leading tectonic problems.

Dr. Chalmers Mitchell's traverse, being an experimental journey, will probably be unable to make many deviations for scientific study, but it is following a route of exceptional interest, and we may expect light from him on some East African physiographic problems, such as the controversy as to whether the Lower Nile Valley is a down-folded basin or a down-faulted trough, or as to the relations of the young valley which the Nile is excavating north of Khartum to the older river which drained that area. His survey of the northern face of the plateau north of Uganda, seen from a distance which will blot out the minor irregularities, may throw light on its origin; and during his flight from Nimule to the Victoria Nyanza he may discover some line of depression continuing the tectonic subsidence north-east of the Albert Nyanza towards Lake Rudolf. In addition to work of this character, enabling Africa to be studied like a great relief model, the value of the aeroplane in scientific work will probably be mainly as a means of rapid transport to centres for study or help in emergencies.

The cost of aeroplane transport may seem large when compared with railway rates of a penny per ton-mile; but it is insignificant in comparison with that of a caravan across a foodless territory, when each porter can carry so little in addition to his food that the cost of the carriage of goods from Mombasa to Uganda was reckoned at 300*l.* a ton. The aeroplane will doubtless enable the arid areas in East Africa to be investigated at a much cheaper rate than any other available method.

In the political administration of Africa, Dr. Chalmers Mitchell's mission may lead to ultimate economy in many districts. Thus, in northern British East Africa, garrisons are so isolated, and so liable to sudden calls to control the nomads or to resist Abyssinian raids, that they must be maintained at costly strength; but a periodic aeroplane inspection of the desert lands on the borders of British East Africa would reveal the whereabouts of the tribes and discover whether there were any concentrations of men and camels which threatened mischief; and thus it would add greatly to the efficiency of the frontier guard.

From its bearing on African administration, on an accelerated postal service, on quicker and cheaper transport of officials and investigators, as well as for its direct observations, the journey of Dr. Chalmers Mitchell and his companions may mark the beginning of a new epoch in African travel.

J. W. GREGORY.

(3) CIVIL AVIATION.

THE lecture by Major-Gen. Sir F. H. Sykes on "Imperial Air Routes," which was delivered before the Royal Geographical Society on February 2, will be eagerly read by all interested in the future of civil aviation. Sir F. H. Sykes spoke upon the great advantages to be gained by the establishment of a complete system of aerial routes linking up the widespread portions of the Empire, with Egypt as the "Clapham Junction" of the India, Australia, and Cape routes. The last route was discussed at some length, and an account given of the work which has been done in establishing a chain of aerodromes from Cairo to Cape Town. The great usefulness of the aeroplane as a means of reaching outlying places near the route which have at present no rapid means of conveyance was commented upon.

The main outline of the lecture is summed up as follows:—

"It is not enough to believe—as I firmly do—that aerial transport being right is bound eventually to succeed. The seasoned tree can stand alone; the shooting sapling must be stayed. Some of the requirements of aviation on an Imperial basis are:—

"(1) The maintenance of a highly efficient fighting force.

"(2) The expansion of commercial aviation to promote British trade and to supplement the fighting force when necessary by a reserve of *personnel* and material, knowledge and experience.

"(3) The co-ordination and co-operation of aerial communication throughout the Empire, and its relations to other countries.

"(4) The organisation of routes, aerodromes, ground communication, and meteorological services on an Imperial basis.

"(5) The energetic promotion of research and the encouragement of design.

"(6) Money to assist the institution of experimental mail services.

"(7) The encouragement of land survey, forest patrol, and other work in which aircraft can be utilised.

"This year will, I hope, go down to history as marking the birth of a sound, virile, and truly Imperial air policy."

As a practical commentary on the lecture comes the projected *Times* flight by a Vickers' "Vimy" aeroplane from Cairo to the Cape, referred to last week, over the route described by Sir F. H. Sykes. The machine left Cairo at 9.45 a.m. on February 6, and reached Khartum on February 8, leaving there on February 10. Should the flight along the African continent prove a success, the feat will be the third great triumph for this type of aeroplane, the present machine being practically identical with those which accomplished the Atlantic and Australian flights. The crew consists of two pilots, one mechanic, and a rigger, while the well-known zoologist, Dr. P. Chalmers Mitchell, is passenger and scientific observer. The object of the flight is primarily to determine the possibilities of the new route, but it is also to be regarded as the first attempt at exploration from the air, as much of the country to be crossed is at present unsurveyed. The result of this experiment will be awaited with interest. If success is achieved, a new proof of the commercial possibilities of the aeroplane will have been established—a proof that should convince the most sceptical.

THE DEVELOPMENT OF SPITSBERGEN.[1]

IN view of the increased public interest in Spitsbergen on account of the revival of mining activity and the recent political settlement, Dr. R. N. Rudmose Brown's new book upon the country is particularly opportune. It is further welcome because it provides the only modern work in English dealing with Spitsbergen in its general aspects; for Sir Martin Conway's "No Man's Land" is an historical volume, narrating the discovery and the early history of whaling and hunting in the archipelago and the adjacent seas. The only other recent general works are those of Holmsen in the Norwegian, and of Cholnoky, curiously enough, in the Magyar language.

Whatever its mining possibilities are (and scepticism has recently arisen), the situation of Spitsbergen as the most easily accessible polar land, along with its wonderful climate, will inevitably lead to its becoming a favourite European playground. In summer, Spitsbergen has a climate, especially in its central and western regions, which is a good deal more tolerable than the average British spring; and, apart from the drawback of polar darkness, its winter climate is said to compare quite well with that of Canada. It has glorious mountain, fiord, and glacier scenery, and the study of its spectacular physical features and natural history will afford exhaustless attractions for scientific travellers.

Dr. Rudmose Brown's book first deals pleasantly with the discovery, physical features, climate, and natural history of the Spitsbergen Archipelago, the geology, however, being deferred to the chapter describing its mineral wealth. The succeeding chapters trace the history, exploration, and economic development of the country. Spitsbergen history may be divided naturally in order of time into the whaling, hunting, exploratory, and economic periods. The whaling industry has been extinct for a century or more. Hunting and trapping have recently revived, after a period of exhaustion, in response to the high prices now obtainable for furs. Dr. Brown records and deplores the unfair and ultimately disastrous poisoning methods practised by some Norwegian hunters. The Norwegian Government, it is hoped, may now be able to deal adequately with this and other crying abuses.

The mining development of Spitsbergen dates from 1904, although coal and other minerals had been found much earlier. The only large-scale mining has been in the excellent Tertiary coal of Advent Bay, which was opened up by an American company, but is now carried on by Norwegians. In 1912 40,000 tons were raised, but in 1919 it is believed that this total will have been more than doubled. While British companies claim areas more than three times as large as those of all other nationalities combined, the war unfortunately stopped their development schemes, and it was only in 1918 and 1919 that they were able to resume their activities and send up prospecting expeditions.

Besides coal, iron ore of good quality is said to occur; gypsum is certainly present in enormous amount; and traces of copper, gold, molybdenum, lead, and asbestos have been found. Oil and oil-shales are possibilities. Nevertheless, Norwegian geologists, who for the last ten years have carried

[1] "Spitsbergen: An Account of Exploration, Hunting, the Minera Riches and Future Potentialities of an Arctic Archipelago." By Dr. R. N. Rudmose Brown. Pp. 319. (London: Seeley, Service, and Co., Ltd., 1920.) Price 25*s*. net.

on extensive prospecting work, especially in the western mountain ranges, are very sceptical as to

FIG. 1.—Temple Mountain from Bjona Haven. The Prince of Monaco's yacht, the *Princess Alice*, at anchor. One of the most important British estates in Spitsbergen is situated here. From "Spitsbergen."

workable mineral resources, except coal, as may be gathered from a perusal of recent correspondence in the *Mining Magazine*. A fierce but feeble answer to these letters by a representative of a British company interested in Spitsbergen fails to meet the facts brought forward by the Norwegian geologists, especially in regard to metalliferous ores. The reviewer believes that mining development in Spitsbergen will rest largely upon coal, with perhaps oil and oil-shale, obtained from the flat-lying rocks of the central tracts.

The later chapters of the book discuss certain German schemes for the exploitation of Spitsbergen, now happily brought to naught, its modern history, and its political status. Spitsbergen is no longer a No Man's Land, and the last chapter of Dr. Brown's book is therefore already outdated by the decision of the Supreme Allied Council to assign the sovereignty of Spitsbergen to Norway.

The twenty-two plates illustrating the book are excellent and doubtless contribute to its high price, but the two maps are comparatively poor. Mistakes and misprints are commendably very few. "Ordovician" is misspelt on p. 216, and

FIG. 2.—Longyear Mine, Advent Bay. Wire ropeway from the mine, coal dump, and jetty with a vessel loading alongside. From "Spitsbergen."

there is a discrepancy in the story of Klaus Thue's wintering on p. 106. A bibliography of the more important works on Spitsbergen would have enhanced the value of the book to interested readers, who will nevertheless find it the best available compendium of Spitsbergen information.

G. W. T.

THE LEAGUE OF UNIVERSITIES.

A REPRESENTATIVE body of British university men and women spent the autumn of 1918 in America as the guests of the United States. By invitation of the Government of the French Republic a similar delegation visited the universities of France last May. From the Belgian Government an invitation was received and accepted in November. The reports of these three university missions may be obtained from the Universities Bureau, 50 Russell Square, W.C.1. In each of the countries visited the representatives of the United Kingdom were received with profuse hospitality and treated with the utmost consideration by the Head of the State and his Ministers, as well as by the heads of the universities and their professors. In innumerable speeches the general objects of this university "entente" received eloquent and enthusiastic expression, stress being laid upon the necessity, in the interests of the world's peace, of bringing the intellectual leaders of the allied and associated countries into closer and permanent touch. There may be rivalry amongst the universities of the civilised world, but there can be no competition, in the sense in which commercial enterprises compete, with the risk of producing discord. All are engaged upon a common task, the making of knowledge, and the training of men and women for professions and occupations in which learning is the only trustworthy equipment.

During the last three or four years the universities of the United Kingdom have discovered that their power and influence may be greatly strengthened by taking counsel together, without any sacrifice of independence. There is the same need for conference and co-operation amongst the universities of the world. Amongst definite problems discussed was the interchange of teachers and students—the migration of those who dispense and of those who seek knowledge, adjusted to modern conditions. The reports of all three missions are in approximately similar terms. It is recognised that professors who are heads of departments have many administrative duties in addition to their duties as teachers. Their universities cannot spare them for any considerable time, nor can their duties be taken over by strangers. Heads of departments might with great advantage give short courses of lectures in foreign countries, provided the language difficulty can be overcome. Professors of highly specialised or recondite subjects, for which the demand is limited or occasional, might well distribute their services amongst several universities, spending an occasional year abroad.

With regard to migration of students, it is clearly desirable that students of languages should spend a part of their undergraduate career in foreign countries; but with this exception it is almost universally agreed that only in rare instances would it be to the advantage of a student to leave the university in which he is matriculated until after graduation. The first year's work at any one university is not easily articulated to the second year's work at any other. Nor would any university be content to part with its third-year students. For a graduate, every possible facility for migration should be afforded. Even though his new university be not so well equipped for work in the subject to which he is devoted, it is to his advantage that his experience should be enlarged. So far as British universities are concerned, post-graduate study will be encouraged by the new Ph.D. degree which all have now established. The same degree is obtainable in the U.S.A., and its equivalent, the doctorat de l'Université, in France and Belgium.

NOTES.

THE new session of Parliament was opened in state on Tuesday by the King, who was accompanied by the Queen and the Prince of Wales. Among the matters referred to in the King's Speech were a Bill to make further provision for education in Ireland, measures to stimulate and develop the production of essential foodstuffs within the United Kingdom, and to encourage and develop the fishing industry, and Bills providing against the injury to national industries from dumping and for the creation of an adequate supply of cheap electric and water power.

As successor to the late Mr. Henry Watts in the editorship of the Journal of the Chemical Society, and as the first secretary and registrar of the Institute of Chemistry, Mr. Charles Edward Groves, F.R.S., was for many years a very prominent figure in the chemical world. His scientific education was received under Hofmann at the Royal College of Chemistry, where he was contemporary with a group of young men of whom many became distinguished men of science. In October, 1862, Mr. Groves became senior assistant to Dr. John Stenhouse, F.R.S., who had established a private laboratory for research in Rodney Street, Pentonville, and there he remained as factotum until Dr. Stenhouse's death in 1880. He then became lecturer in chemistry at Guy's Hospital. The greater part of Mr. Groves's scientific work was done in the Pentonville laboratory, and was published under the joint names of Stenhouse and Groves, though, in consequence of Dr. Stenhouse's infirmity, the work was mostly done by his assistant. Mr. Groves was a good manipulator and a skilful analyst, and not only assisted in the research laboratory, but for five years also took part in the work of external assayer to the Royal Mint—an office held by Dr. Stenhouse until 1870, when it was abolished. Mr. Groves in his early days was a very active walker and climber in the Alps. For many years he spent his summer holidays in Switzerland, and will be remembered by many of the senior members of the Alpine Club. His death on February 1, at an age approaching eighty years, leaves but few survivors of the original group of students of the Royal College of Chemistry.

THE Carnegie Corporation of New York has announced its intention to give five million dollars for the use of the U.S. National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organisations. The remainder will be placed in the hands of the academy, which enjoys a Federal charter, to be used as a permanent endowment for the National Research Council. This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry. The Council is a democratic organisation based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent divisions. It is not supported or controlled by the Government, differing in this respect from other similar organisations established since the beginning of the war in England, Italy, Japan, Canada, and Australia. The Council was organised in 1916 as a measure of national preparedness, and its efforts during the war were mostly confined to assisting the Government in the solution of pressing war-time problems involving scientific investigation. Reorganised since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science.

SIR HENRY FOWLER has been elected president of the Institution of Automobile Engineers for the session 1920–21, and Dr. Blackwood Murray, Lt.-Col. D. J. Smith, and Mr. Geo. Watson vice-presidents.

THE National Sea Fisheries Protection Association has decided to form an organisation, to be known as the British Fisheries Guild, with the following objects:—(1) To gather and diffuse information upon all matters relating to fish and fisheries, and to collect and circulate statistics relative thereto; (2) to unite, encourage, and maintain all interests relating to fish and fisheries, and to affiliate local or other organisations with similar objects; and (3) to deal with all questions relative to fish and fisheries, whether scientific or economic in character.

AT the meeting of the Royal Anthropological Institute to be held on February 17 Mr. J. Reid Moir will exhibit and describe certain flint implements and flakes found in the Boulder Clay in pits north of Ipswich and at Claydon. Prof. J. E. Marr is of the opinion that this deposit represents part of the large sheet of Boulder Clay of the Ipswich sheet. Mr. Moir's examination of the form and technique of these implements has led him to the conclusion that they may with probability be referred to the Mousterian phase of culture.

MR. F. H. CARR has just been elected to a seat on the board of directors of the British Drug Houses, Ltd. After holding for several years the Salters' research fellowship, first at the Pharmaceutical Society's research laboratory and afterwards at the Imperial Institute, where he specialised on the active principles of drugs and became a leading authority on alkaloids, Mr. Carr was appointed chief of Messrs. Burroughs Wellcome and Co.'s Chemical Department. In 1914 he was appointed a director of Boots Pure Drug Co., from which position he resigned at the end of the war.

A RADIO Research Board has been established by the Department of Scientific and Industrial Research to co-ordinate and develop researches into wireless telegraphy and telephony at present being undertaken by Government Departments. The members of the Board are:—Admiral of the Fleet Sir Henry B. Jackson, G.C.B., F.R.S., chairman; Comdr. J. S. Salmond, R.N., Lt.-Col. A. G. T. Cusins, C.M.G., Wing-Comdr. A. D. Warrington Morris, C.M.G., Mr. E. H. Shaughnessy, and Prof. J. E. Petavel, F.R.S.—representing the Admiralty, War Office, Air Ministry, Post Office, and Department of Scientific and Industrial Research respectively—and Sir Ernest Rutherford, F.R.S.

ELEANOR ANNE ORMEROD, the distinguished student of economic entomology, lived at Torrington House, St. Albans, from 1887 until her death in 1901, and it was during her residence there that she achieved the final success of her great project to convince the general agricultural public that an accurate knowledge of the life-history of injurious insects was worth having, because it provided the only sure foundation for preventive and curative measures. To commemorate her residence in the county, the Hertfordshire Natural History Society has lately put up a tablet at the gate of Torrington House on Holywell Hill, which will help to keep alive the memory of Miss Ormerod's splendid record of unselfish work.

INFLUENZA is still far from assuming anything approaching an alarming epidemic, although the Registrar-General's return for the week ended January 24 showed a slight increase. In London the deaths were 24, which is rather more than in any week since the commencement of last autumn, but the deaths in the week ended January 31 are nine fewer than in the preceding week. The deaths for the ninety-six great towns of England and Wales, including London, in the week ended January 24 were 85, also the highest in any week since last autumn, but the following week shows a decrease of 19. Both December and January were remarkably mild, which, guided by the weather associated with previous epidemics, is scarcely in favour of lessening an outbreak. So far as can be judged at present, the general health over England and Wales seems highly satisfactory.

JANUARY was very mild over the British Isles with the exception of the first week, when the mean for the United Kingdom generally was nearly 2° F. below the normal. The weekly weather reports issued by the Meteorological Office show that the mean temperature for the second week was, taking the British Isles as a whole, 4° above the normal, and in the third week the excess was 2·3°, whilst for the closing week the excess for the whole kingdom was 1·6°, a deficiency of temperature occurring in Ireland. In each week the rainfall was in excess of the normal over England. The Greenwich records show that the mean temperature was continuously above the average after the first week. The mean for the month was 42·1°, which is 3·6° above the normal for the last thirty-five years; the mean maximum was 4·9° in excess, and the mean minimum 2·1° in excess. There were fourteen days with the thermometer at 50° or above, and on four days the temperature was 55° or above. So far as London is concerned, January was warmer in 1916, when at Greenwich the mean temperature for the month was 3° warmer than January this year; the January mean for 1916 was 45·3°, whilst for 1917 it was 35·3°. In Canada January was abnormally cold, the contrast with the British Isles resembling greatly the winter of 1898–99. For the nine weeks of winter from November 30 to the end of January there was an excess of temperature, and also of rainfall, over the British Isles. The controlling factor was the frequent passage of disturbances from the Atlantic, the centres of which, for the most part, travelled in proximity to Scotland.

THE twelfth annual report of the National Museum of Wales for 1918–19 is a record of steady progress. Considerable advance has been made in the formation of the Welsh portrait and topographical collections, which will in the near future be extensively used for educational purposes and for circulation. The most important accession to the zoological department was the collection of British Lepidoptera and birds' eggs presented by Mr. A. F. Griffith, of Brighton. Specimens, models, and drawings are being collected with the view of forming a Welsh Naval and Military Historical Record, including aviation, which will not be confined to recent years, but will embrace naval and military incidents connected with Wales or in which Welshmen have taken a conspicuous part. The importance of the museum for education in Wales is shown by the use of the collections for special studies in different branches of natural science, and by visits paid by parties of mining students to Cardiff for the purpose. The museum officials do good service in answering inquiries on scientific questions and by identifying specimens submitted for examination.

THE Syndics of the Cambridge University Press have issued a new Catalogue, to which is prefixed an interesting note on the progress of printing in Cambridge. The first printer, John Siberch, settled there in 1521, and eight books have been found bearing his imprint. The modern history of the Press may be said to have begun in 1698, when, thanks to the labours of Richard Bentley, a great revival of typography took place. Additions were made to the buildings, new presses set up, beautiful types imported from Holland, and a body of Curatores Præli Typographici, of whom the Press Syndics of the present day are the successors, was appointed. One of the most famous English printers, John Baskerville, entered into an agreement with the University in 1761. Early in the nineteenth century stereotype plates, the invention of the third Earl Stanhope, were successfully used. In 1824 part of the surplus of the fund for erecting a statue of William Pitt was devoted to the new Press buildings; J. W. Parker (1836–54) was the first to introduce steam-power; and since then under the control of the Clay family—John Clay, the late printer, died in 1916—and of the present printer, Mr. J. B. Peace, the work of the Press has rapidly extended its operations, the result of which is fully illustrated in the new Book Catalogue.

IN the "Historical Collections of the Essex Institute" (vol. lvi., part i., January, 1920) Mr. F. B. C. Bradlee gives an interesting account of the maritime history of Newburyport, Massachusetts. Many famous vessels sailed from this old Essex County city, among the best known of which was the *Dreadnought*, built in 1853, and afterwards celebrated for making the shortest passage across the Atlantic ever accomplished by a sailing vessel—nine days and seventeen hours from Sandy Hook to Queenstown. She was named by sailors the "Wild Boat of the Atlantic," and was a semi-clipper, possessing the merit of being able to bear driving as long as her sails and spars would stand. Mr. Bradlee, in opposition to what he calls "a small coterie in New York," claims to have proved the correctness of the records of this famous voyage of the *Dreadnought* in 1859, and gives a full account of later ships sailing from Newburyport.

IN the issue of the Annals of the Natal Museum for May, 1919 (vol. iv., part 1), a valuable paper is contributed by Mr. Claude Fuller entitled "The Wing Venation and Respiratory System of Certain South African Termites," illustrated by eight folding plates. The author's observations on the development of the wing-veins have been directed towards an investigation of the conclusions of Comstock and Needham. One of the main points wherein he differs from the American authors is in the origin of the wing tracheæ. It is remarked that the tracheæ of the wing-sac develop from two or three buds, arising from the spiracular trunk tracheæ of the meso- and metathorax, and not upon the dorsal and ventral longitudinal trunks, as enunciated in the general scheme of Comstock and Needham. In a recent book by Comstock, "The Wings of Insects" (1918), which apparently was issued while Mr. Fuller's paper was in the press, an article is contributed by Chapman on the basal connections of the wing tracheæ, and it appears that these recent observations are more in accord with those of Mr. Fuller than the earlier American work. It is evident, however, that the origin of the wing tracheæ in termites is less primitive than in some other insects. The remainder of the paper deals with the spiracles and the tracheal system as a whole, together with a study of the venation in the completed wings of various species and of the wide range of variation exhibited therein.

IT is well known that when America was discovered maize was widely cultivated by the aborigines, but the wild source of the plant has remained obscure. Various views concerning its origin have been entertained, one being the theory of Mr. Collins, based on breeding experiments and morphological comparisons, that maize arose as a hybrid between the Mexican teosinte (Euchlæna) and some unknown grass belonging to the Andropogoneæ. Mr. Y. Kuwada in an interesting paper (Journ. Coll. Sci. Imp. Univ. Tokyo, vol. xxxix., art. 10) has studied the chromosomes of maize and its relatives, and brings cytological evidence in support of Mr. Collins's hypothesis. Maize, as well as Euchlæna and Andropogon, is found to have ten pairs of chromosomes, but those of Euchlæna are longer than those of Andropogon, while in maize they are found to be of different lengths, a pair frequently being composed of a longer and a shorter chromosome. From this it is concluded that maize is hybrid in origin, the two types of chromosomes being traceable as in certain experimentally produced animal hybrids. Some races and individuals of sugar-maize are found to have eleven or twelve pairs of chromosomes, which is attributed to cross-segmentation of one or two pairs. It would appear that in the origin of the many known varieties of maize, a considerable number of which were grown by the natives in different parts of the American continent, hybridisation and mutation may have gone hand in hand.

The United States Department of Agriculture is publishing a folio atlas of American agriculture. Part ix., section i., deals with rural population, and contains thirty black-and-white maps and diagrams based on the census returns of 1910. Among the most interesting maps are two showing respectively the increase and decrease in rural population between 1900 and 1910. Increase was mainly in the Pennsylvania mining district, in the cotton belt, in the newly developing agricultural regions of the west, and around cities. Decrease was most marked in the maize and winter wheat region. It is explained by the consolidation of many small farms into a few large ones in order to secure the full benefit of the use of machinery and large-scale production. The decrease in population in these districts is mainly a measure of their productiveness. Of much interest, too, are the maps showing the distribution of native white, foreign, and negro stocks. For this purpose all people are classed as foreign who either were born abroad or one or both of whose parents were born abroad. A series of maps shows the distribution of foreign population by countries of origin. In both urban and rural populations the Germans are the principal nationality of foreign stock, and the Irish the second. Except in the case of Norwegians, Danes, and Swedes, the foreign element is more noticeable in the urban than in the rural population. A map illustrating the percentage of the rural population unable to speak English shows a high proportion in the west and north, particularly in Wyoming, North Dakota, and Minneapolis, where the Russian and Scandinavian elements are marked, and in Pennsylvania, with its comparatively recent influx of Slavs, Hungarians, Germans, and Italians.

A good geographic account of the Mackenzie River basin has been drawn up by Messrs. C. Camsell and Wyatt Malcolm for the Geological Survey of Canada (Memoir 108, 1919). It has an eminently practical bearing, and should guide those seeking new agricultural lands or new fields for industry in the North-West.

M. L. de Launay furnishes an important review of the mineral resources of Alsace-Lorraine in the *Revue Scientifique* (November 15, 1919, p. 673). It is interesting to note that this article arose from a lecture given in the recovered town of Metz, which lies at the south end of the great field of oolitic iron-ore. Sketch-maps are given of this field and of the potassium and petroleum areas in the Rhine-vale.

The importance of algæ in the formation of limestone is further emphasised by the publication of Mr. W. H. Twenhofel's paper on "Pre-Cambrian and Carboniferous Algal Deposits" (*Amer. Journ. Sci.*, vol. xlviii., p. 339, November, 1919). In the massive cases here described it is held that the calcium carbonate does not enter into the tissues of the plant, but is deposited, as in so many recent travertines, by the lessening, through the activity of organisms, of the capacity of the water to retain the salt in solution. The deposits are thus of the nature of laminated encrustations.

The Monthly Bulletin of the Hawaiian Volcano Observatory, which is always noteworthy for its unique illustrations, gives (in vol. vii., No. 8, August, 1919) a fine picture of a lava-rush in a cave, photographed in June, 1919. The work of observation has been rendered far more interesting for readers of Nature since the publication of the views of the great topographic model, in which the situation of the scientific station is clearly shown (Nature of August 7, 1919, vol. ciii., p. 456). Mr. E. S. Shepherd gives a number of analyses of the gases collected from Kilauea in Bulletin No. 7, 1919, showing a "surprisingly high" amount of water.

The appearance of a memoir of 300 pages on "The Geology of the Country around Lichfield" (Mem. Geol. Survey, England and Wales, 1919, price 9s.) makes us once more wish that some relic of the Colby-Portlock plan, hazarded in Ireland in 1840, had been allowed to remain in our Geological Survey organisations. The scheme of the Irish Ordnance Survey was undoubtedly too ambitious for the limitations of public finance, and we now possess adequate unofficial descriptions, from the Victorian county histories down to the compact and clever Cambridge geographies, of the greater part of England. The Lichfield country is fully treated in this memoir from a geological point of view, in continuation of the important modern descriptions of the details of our British coalfields; but we should hail some expansion of Mr. G. Barrow's twelve lines on the "distribution of the population." The broad agricultural landscape, controlled by Triassic strata, that is so well seen from the tower of Tamworth, is bounded on the east and west by busy coalfields. The Roman highway leading to the west undulates upwards to the bleak moor of Cannock, a "chase" long after the days when a king's daughter held Tamworth Hill against the Danes. English history is epitomised in the buildings on this hill, now so well preserved as the municipal museum; and the changes in the density of population, from the making of the Watling Street down to the development of the coal-mines, are largely concerned with geology, and deserve a chapter to themselves.

Both botanists and geologists will welcome the second part of the memoir on the remarkable petrified plants from the silicified peat-bed in the Old Red Sandstone of Rhynie, Aberdeenshire, by Dr. R. Kidston and Prof. W. H. Lang, just published in the Transactions of the Royal Society of Edinburgh (vol. lii., No. 24, with 10 plates). The genus Rhynia and a new allied genus Hornea are described in detail and referred to a new family, Rhyniaceæ, of the class Psilophytales. These, and the other vascular Cryptogams preserved with them, are the most ancient plants of which the internal structure and external appearance are adequately known. Rhynia and Hornea have neither leaves nor roots, each consisting merely of an underground rhizome, with long, unicellular rhizoids, and a round aerial stem, dichotomously branched, with sporangia at the ends. They are the simplest known undoubted Pteridophyta, and fundamentally more primitive, not only than all existing land-plants, but also than most of the plants of the Upper Devonian and Carboniferous floras. Their geological age is not later than that of the Middle Old Red Sandstone of Scotland, and an apparently related genus, Sporogonites, occurs in the Lower Devonian of Norway. Several interesting comparisons are made with existing Cryptogams, but the authors wisely defer general conclusions until they have studied more of the associated plants.

The Report of the Department of Mines of the State of Mysore for the year 1917–18 gives a detailed account of the results of the year's mining operations. Naturally, gold-mining in the Kolar goldfield still forms the preponderating part of the industry; it is satisfactory to find that, in spite of the shortage of skilled labour and the difficulty of obtaining supplies owing to war conditions, there was but little falling-off in the output, the production, amounting to 536,558·72 oz. of fine gold, being only 17,680·71 oz. below that of the previous year. The number of accidents shows an appreciable diminution, and it is interesting to note that the dangerous effects of the rock-bursts, to which this field is liable, have been somewhat prevented by the new methods of supporting the hanging wall by means of packs of waste rock. Of the other minerals produced manganese-ore is the most important; the output of this was 31,331 tons as against 20,674 tons in the previous year. Chrome-ore, magnesite, and asbestos are also produced in small quantities, whilst workings for mica, antimony-ore, corundum, galena, and kaolin are proceeding on what can, for the present, be described as a purely experimental scale.

Amongst the reports on the mineral resources of the United States recently issued by the Geological Survey of that country one of the most interesting deals with the cement production in 1917. It is there pointed out that the United States produced 93,000,000 barrels in that year, as against a production in Europe of 72,000,000 barrels. An interesting account is also given of the development of concrete shipbuilding. The pioneer concrete ship was a small boat built in France in 1849, followed in 1887 by a small vessel built in Holland. In America the first serious attempt was commenced about 1912, when a number of concrete barges were constructed, until in 1918 the *Faith*, a sea-going vessel of 5000 tons, was launched at San Francisco. It is stated that the percentage of dead-weight to full-load displacement for vessels of 3500-tons dead-weight capacity works out at 52 for concrete, 53 for wood, and 68·6 for steel, so that the capacity of the concrete ship is considerably less than that of the steel ship, although this drawback is to some extent offset by the lower first cost of the concrete ship. Much attention is being paid to this problem in the United States, the design of the steel reinforcement and the production of cement of low specific gravity being in particular closely studied. The report, though brief, contains much information of value to those interested in this modern application of reinforced concrete.

The annual volume of the Journal of the Scottish Meteorological Society recently published contains papers of considerable interest which should be read by meteorologists on both sides of the Tweed. In the first article Lt.-Col. Gold discusses the relation of meteorology to aviation, and directs attention to the new calls which flying has made on the meteorologist. Thus, for example, visibility and cloud-height, to which little attention was directed in the daily weather service a few years ago, are now of great importance, and provision must be made for such observations in any modern system of reporting to a central office. In another paper Dr. E. M. Wedderburn, who did much to advance the usefulness of meteorology to gunners during the war, states the nature of some of the problems met with in this branch of the subject and of the solutions adopted. In the old days gunners were content to use surface meteorological conditions only in working out their corrections. The introduction of the "ballistic wind" and "ballistic temperature," which take account of the changes of the meteorological elements at all heights traversed by the shell, marks a great step forward. A note by Capt. C. K. M. Douglas shows what valuable information concerning the formation of haloes and similar manifestations may be obtained by flying among the clouds which give rise to the phenomena; while an article by Capt. T. B. Franklin on meteorology and agriculture will appeal to a different class of reader.

The February issue of *Conquest*, the new popular science monthly, gives, amongst other articles of interest, a *résumé* of the first two of Prof. W. H. Bragg's Royal Institution lectures to children on sound and an article by Dr. Rosenhain on glass. In the latter, which is well illustrated, it is pointed out how serious the consequences of our former neglect of the scientific side of glass-making might have been if we had not set about repairing this fault in the early years of the war. The author describes some of the difficulties which have to be overcome before glass suitable for scientific instruments can be produced. Impurities from the melting-pots and enclosed air-bubbles account chiefly for the large percentage of rejected glass, which may reach 80 per cent. Before the war glass for chemical laboratory use was entirely imported. Our own glass manufacturers have risen to the occasion, and it is to be desired that they should in the future be able to retain a position in the industry.

It has been known for many years that by treating a photographic plate with a weak solution of a soluble iodide development may be accelerated. In the January issue of the Journal of the Royal Photographic Society S. E. Sheppard and G. Meyer (of the Eastman Kodak Co.) describe some results of their investigations of this action. It seems that the iodide has little or no effect on the action of developers that produce a visible result very soon after their application, but that developers like glycin and hydroquinone, which are slow to produce a visible effect, are much accelerated by it in the early stages of development. With hydroquinone the whole course of development is changed. Ferrous oxalate is not affected by it. The authors suggest that the process of development takes place by the formation of a complex of silver haloid and developer (which then breaks up into metallic silver and oxidation products of the developer), and that the small proportion of silver iodide produced facilitates the formation of this complex. It is well established that silver iodide has a far stronger mordanting action on dyes than silver bromide. Unfortunately for the practical application of the process, the iodide treatment seems always to produce fog.

The Journal of the British Science Guild for January contains an appeal to members to co-operate more fully in the work of the journal, which is extending its scope. A feature of interest in the present issue of the journal is the series of short editorial notes on topical events, forming a useful supplement to the more detailed accounts of reports, etc., following. A short account is given of the last British Scientific Products Exhibition, and Sir Richard Gregory's address on "Science in Industry," delivered before the Circle of Scientific, Technical, and Trade Journalists at its meeting on the opening day of the exhibition, is reproduced. The report of the Microscope Committee, originally published in the Journal in 1916, is now presented in its revised form. The newly formed Parliamentary Committee, in conjunction with the Agricultural Committee, was instrumental in presenting a memorandum on the Forestry Act, stress being laid on the inclusion, amongst the seven suggested Commissioners, of at least one member having adequate technical and scientific knowledge of the subject. In view of the contemplated legislative measures in regard to deep-sea fisheries, the need for a comprehensive scientific survey of the industry, in order that knowledge may precede legislation, is again pointed out.

The President of the Board of Education, we note in the Journal of the British Science Guild for January, does not see his way to adopt at once the suggestion of the guild for a consultative committee to advise the Board on matters affecting the relationship of universities and higher technical education to industry, but offers hope that the request may be complied with later. The suggestion conveyed to the Foreign Office that scientific *attachés* should be added to British Embassies and Legations was met by the counter-proposal that technical associations should make their own arrangements to obtain information on foreign developments. The Department of Overseas Trade has issued a circular requesting early intimation of visits to foreign countries by representatives of British firms, in order that consular officers and other officers abroad may be notified. In view of the extensive and valuable work recorded, the appeal being made by the guild for new members and additional funds should meet with generous response. The address of the guild is now 6 John Street, Adelphi, W.C.2.

The Cammellaird-Fullagar marine oil-engine, constructed by Messrs. Cammell Laird and Co., of Birkenhead, forms the subject of an illustrated article in *Engineering* for January 30. This engine is of the two-cycle type, with two opposed pistons working in the same cylinder, which is open at both ends, and the cycle takes place between the pistons. There are two vertical cylinders in each unit, arranged side by side, and two cranks at 180°. The top piston in each cylinder is connected by inclined rods to the bottom piston of the other cylinder. There are great advantages in this arrangement, among which may be mentioned the saving in space, which is reduced greatly as compared with an ordinary marine four-cycle engine. The opposed piston type has been tried for steam, gas, and petrol engines, and has so far been found wanting. For oil-engines it has several attractive features. There is no cylinder head, and the liner is a single tube free to expand at both ends. Scavenging is simple and effective, since the sweeping-out air enters at the end opposite to that through which the exhaust leaves, and no valves are required to control the scavenging. The piston speed can, in effect, be doubled, due to the compression taking place between the approaching pistons, and thus reducing the most important heat losses during this stroke of the cycle. The turning moment is improved, and stresses are not taken up by the engine framing, but confined to the moving parts of the engine. The test-bed results for the engine under notice are good, and the performances under seagoing conditions will be watched with the greatest interest.

The latest catalogue (No. 185) of Messrs. W. Heffer and Sons, Ltd., Cambridge, contains the titles of nearly two thousand works, ranging over the subjects of agriculture and husbandry, anthropology and ethnology, botany, chemistry, geology, mineralogy and palæontology, biology, physiology, anatomy and medicine, mathematics and physics, astronomy, and engineering. Some of the volumes were formerly the property of Sir William Crookes and Sir Frank Crisp. In addition to the books referred to, there are for disposal a number of portraits of scientific men.

OUR ASTRONOMICAL COLUMN.

Large Fireball on February 4.—In the early evening at 6h. 14m. a splendid meteor was seen from various parts of the country. Among the observers were several persons who have gained experience in recording meteors, so that the real path derived from their data may be regarded as fairly accurate. The fireball was seen at a low altitude in the southern or south-eastern sky, and it moved very slowly in a very long horizontal flight, distributing sparks as it sailed along, and finally breaking up into fragments.

The radiant was at 145°+8°, and the height of the object from 55 to 44 miles, length of luminous course 275 miles, and velocity 18 miles per second.

The recent fireball was a brilliantly conspicuous object, though the full moon had just risen, and many people mistook it at first for a rocket-like firework on account of its vividness, slow motion, and final burst into spark fragments.

RELATIVE MASSES OF BINARY STARS.—Any increase in our knowledge of the masses of the stars is of great value from a physical point of view, since it throws light on the correlation of mass with spectral type. Mr. G. van Biesbroeck, in *Popular Astronomy* for January, states that photographs of binary stars are now being taken with the Yerkes refractor to determine the motion of each star of the pair, as referred to the background of faint stars, and so obtain the relative masses. Photographs of Castor were taken in the years 1916 to 1919, and give the annual motion of the bright component in R.A. −0·0167s., and for the faint component −0·0118s. Assuming Boss's value for the motion of the centre of gravity, viz. −0·0135s., it results that the faint star is 1·9 times as massive as the bright one. The weakest point is the assumption of the motion of the centre of gravity. Boss assumed equal masses; but since a value identical with his was published in Monthly Notices R.A.S. for 1907 on the assumption that the faint star is six times as massive as the bright one, it would seem that the value −0·0135s. is close to the truth.

The systems of Procyon and ζ Cancri are also being investigated. It is hoped in the former case to fill up the gap in the orbit in the region where the faint star is too near to the primary to observe.

LONG-PERIOD VARIABLES.—Several years ago the Rev. T. E. R. Phillips proposed a division of these variables into Groups I. and II., which differ in the relation to each other of the first and second harmonics, when the magnitude variation is developed in a Fourier's series. Prof. Turner and Miss Blagg contributed a paper to the Monthly Notices R.A.S. for November on the star W Cygni, analysis of the light-curve of which suggested that this star is in the act of passing from Group II. to Group I. A further paper by Prof. Turner was read at the January meeting of the Royal Astronomical Society, in which he examined the observations of several stars of Group II., for which Prof. Chandler gave a secular change of period. The analysis indicates in every case a diminution of period, but seems to show that this takes place by sudden jumps, not by a steady, continuous process, such as Chandler's formula implies. It is suggested that the period decreases to a minimum value, after which the star passes into Group I., and its period then increases again.

It was formerly the idea that these red variables were near the end of their career as suns, but from a study of their proper motions, which seem to be very small, it is inferred that they are giants, near the commencement of their career. From the case of our sun, which is an incipient dwarf star, with a sun-spot variation period much longer than that of any known variable, we may conjecture that after passing into Group I. the period continually lengthens, while the amplitude diminishes and becomes practically inappreciable, except in the case of the sun, the surface of which can be studied in detail.

AUSTRALIAN SIGNPOSTS.

IN the Records of the South Australian Museum for August, 1919,[1] Mr. E. R. Waite completes a description of the Toas or direction signs of the Australian aborigines which was partly translated and arranged from the manuscript of the late Rev. J. G. Reuther, of the Lutheran Mission, by the late Sir Edward Stirling.

The description is prefaced by a summary account of the religious beliefs of the Diari and associated tribes in the district east of Lake Eyre, in South Australia. According to Mr. Reuther, these believed in a single Supreme Being called *Mura*, who was great, powerful, beautiful, omnipresent, righteous, and omniscient. *Mura* created a number of demi-gods—*Muramura*—some perfect and others imperfect, with their wives or subjects—*Mili*. The *Muramura* were the ancestors of mankind. They wandered about the country, and the legends of the natives are the records of their journeys and adventures. Native songs and invocations were addressed to them. The *Muramura* named all things, and many of the natural features of the country are ascribed to them. They named each of their camps from something noticed there, and these are the native place-names of the district.

On the death of a *Muramura* his body usually changed to a stone, which was venerated by his descendants. Sun, moon, and the constellations were also regarded as abodes of departed *Muramura*.

The Toas are thus described. They consist mostly of a piece of flattened wood (usually from 6 in. to 18 in. in length), "pointed at one end, and either coloured or plastered over with white clay, which itself may be coloured uniformly or marked with simple designs. At the upper end the clay is frequently moulded into a spherical or oval knob, and this also may be plain or variously coloured or have inserted some object typical of the locality or symbolical of a Muramura's adventure, such as a tuft of grass, twigs, feathers, hair, etc., pieces of bone, charcoal, or a model of some weapon or utensil. In a considerable number of Toas the upper end is modelled into a representation of some part of the human body, such as the hand, head, or foot, or into that of the whole or some part of a bird, fish, or other animal."

More than three hundred coloured illustrations of Toas contained in the museum collection are given. They show a surprising variety of form and ornamentation. Each Toa has a name which is a native place-name with the suffix *-ni* or *-ri*, meaning "direction towards." Four of the figures, with their explanations, are here given as examples. They are Nos. 1, 14, 66, and 187.

"1. *Dakarawitjarini* (Diari Tribe).—The word means a hard flat or plain, where Emus run to and fro, and it originates from the legend of the Muramura, Ngurakarlina, who, coming to the place, saw many of these birds running about.

"The longitudinal, vertical, and partly sinuous black stripe on the Toa represents a salt creek, the oval patch being a deep waterhole, and the lateral branches tributary creeks. Surrounding these is the plain where the Emus used to run, the white spots indicating bushes and scrub. This is the largest Toa in the collection, being over five feet in length."

"14. *Mararuni* (Wonkanguru Tribe).—To the hand

[1] "Description of Toas, or Australian Aboriginal Direction Signs." Being an Abstract from the J. G. Reuther Manuscript by the late Sir Edward Stirling, F.R.S., Hon. Curator in Ethnology, and Edgar R. Waite, Director, South Australian Museum. Pp. 105-55+plates xi-xx Public Library, Museum, and Art Gallery of South Australia. Records of the South Australian Museum. Edited by the Museum Director. Vol. i., No. 2. (Adelaide: Published by the Board of Governors, August 30, 1919.)

with four fingers, the Toa representing a four-fingered hand. The Muramura, Wutjukana, had a servant whose index and middle fingers had partly grown together, as indicated by the Toa. The Toa also has a geographical significance, for when Wutjukana came to a gorge which divided into four branches, one being deeper than the others, he said to himself, 'This place looks like the hand of the servant,' and so he gave it this name."

"66. *Witjikurawinpani* (Tirari Tribe).—To the tracks of the whirlwind in the sand. When the Muramura, Patjalina, once came, hunting, to this place, he noticed that a whirlwind had passed over it, which had effaced the tracks of animals and had swept together a litter of leaves and grass; hence he named

1

FIG. 1.

14

FIG. 2.

66

FIG. 3.

187

[F]IG. 4.

it thus. The white knob represents a sandhill overgrown with bushes (red dots) which adjoins Cooper's Creek. The crescent-shaped, black figure below indicates the creek itself, and the black vertical band a deep waterhole at the foot of the hill, which has been washed out by a flood. The surrounding borders of white and yellow signify soil of these colours, and the white spots trees."

"187. *Muramurawintini* (Tirari Tribe).—To the Muramura's hair. So named because on this plain the Muramura, Patjalina, tore out his hair and threw it away. The white colour represents the plain, with watercourses (red and yellow stripes), and, in accordance with the name, the Toa bears a tuft of hair."

When a native is about to remove to another camp he makes a Toa representing the locality to which he is removing and sticks its pointed end into the earth of the camp which he is leaving. Signs are made on the ground directing attention to its presence. His friends who arrive later recognise the significance of the Toa, and are thus made aware of the place to which he has gone.

The whole collection and its elucidation form a most interesting contribution to the study of Australian symbolism.

SIDNEY H. RAY.

HUMAN METABOLISM.[1]

THE first of the monographs before us deals with the prediction of basal metabolism from a knowledge of individual physical and biological constants. The usual process has been to multiply the subject's surface area, as deduced from the height and weight by du Bois's method, by the average Calorie output per square metre determined from a "standard" series, it being assumed that the metabolism per unit area in adults is approximately constant. The order of the error involved and the improvement effected by Drs. Harris and Benedict's process can be gauged by the following example. In these authors' series of 136 adult males, the mean twenty-four hours' basal output was 1631·7 Calories with a standard deviation of 204·7 Calories; the latter is 12·5 per cent. of the mean. The corresponding mean per square metre of surface was 925·5 Calories with a standard error of 74·5 Calories, about 8 per cent. of the mean.

It follows that if the distribution around the mean be assumed to be normal (actually, using a coarse unit of grouping, we find that the authors' series for women is in good agreement with a normal distribution; the series for men is somewhat less regular, but not a very improbable sample from a normal population), the assignment of 925·5 Calories per square metre as the basal metabolism of an unknown individual is subject to a standard error of ±8 per cent. But if a prediction is based upon a multiple regression equation of the first degree, the other variables used being height, weight, and age, the standard error of the prediction falls from 204·7 Calories to 101·7 Calories, or the *average* percentage is 6·2.

These remarks assume that the correlation is normal correlation. As this may not be the case, and as a complete study of the form of the regression cannot profitably be made without a larger collection of data, the authors have empirically tested the accuracies of the several methods, comparing the predictions based on their equations for samples not utilised in the calculation of the constants with those afforded by the surface rule. In nearly every case the regression equations give results closer to the truth than does the surface rule.

We may illustrate with a couple of examples taken at random from the data. A man aged twenty-nine, weighing 66 kg. and 177 cm. tall, had a basal metabolism of 1695 Calories. The surface rule would assign 1675 Calories, with a standard error of 135; the multiple regression formula gives 1664 Calories, with a standard error of 102. Here both results are good. In another case a man aged forty-three, weighing 58·5 kg. and 181 cm. tall, had a basal meta-

[1] (1) "A Biometric Study of Basal Metabolism in Man." By J. Arthur Harris and Francis G. Benedict. Publication No. 279. Pp. vi+266. (Washington: The Carnegie Institution of Washington, 1919.)
(2) "Human Vitality and Efficiency under Prolonged Restricted Diet." By Francis G. Benedict, Walter R. Miles, Paul Roth, and H. Monmouth Smith. Publication No. 280. Pp. xi+701. (Washington: The Carnegie Institution of Washington, 1919.)

bolism of 1331 Calories. The regression formula gives 1486 Calories ± 102; the surface rule 1620 Calories ± 130.

Neither prediction is close to the truth, but that of the regression equation is decidedly superior. On the whole, there is no doubt that the regression method is preferable, and that the tables provided by the authors are of value. In general, however, the difference is not such as to give rise to any apprehensions that the use heretofore made of the surface rule has led to practical inconvenience. Prof. Lusk recently wrote:—"For the study of metabolism processes it is certainly most fortunate that the unit of surface area eliminates the same amount of heat in the normal adult within 10 per cent. of a determined average. The reason is not clear."

This remark is not invalidated by Drs. Benedict and Harris's results, although they have provided a somewhat superior criterion. It is proper to notice this point, as our authors are a little too prone to lecture their physiological colleagues upon the real meaning of scientific "laws," and, as we think, exaggerate the importance which the surface "law" assumes in the minds of those who have employed it as a convenient working rule.

Space would have been saved and the statistical results and methods might have been brought to a sharper focus had a number of sententious generalities been omitted. An instance occurs on p. 148. The authors properly remark that surface must be less variable than mass (when Meeh's formula is used), and imply that it is a direct arithmetical consequence that heat per surface unit is less variable than heat per mass unit. This really needed further investigation. The coefficient of variation of an index is a function not only of the coefficients of variation of its constituents, but also of their correlation; the substitution for one constituent of another less variable constituent might not reduce the variability of the index were the correlation also greatly reduced. In the present case the two correlations are nearly equal, and the authors could have actually made their point more securely had they explained the theory of the matter more fully.

Were physiologists really so ill-acquainted with statistical methods as the authors hint, the remarks on p. 16 with respect to the "probable error" of the mean of a sample of four might be dangerous. But we think that British physiologists are quite alive to the importance of biometric methods, sufficiently so to congratulate Drs. Benedict and Harris upon the conclusion of a laborious task which has yielded results of appreciable value to other students of metabolism.

The second volume describes two series of experiments upon squads of college students, originally twelve in each squad. In squad A, diet providing approximately 2500 Calories and 13 grams of nitrogen was maintained for four months; in squad B, a still lower diet, yielding about 9 grams of nitrogen and 1500 Calories, was used for three weeks. The former squad lost on the average 12 per cent. of the initial body-weight, and the basal metabolism per square metre per twenty-four hours fell from 940 to 817 Calories. Squad B lost 6·5 per cent. of the average body-weight, and the basal metabolism also declined considerably. The urinary excretion of nitrogen in both series was not so variable as might have been expected, and did not decline, *pari passu*, with the diminished intake. By the end of the experiment on squad A, an average loss of 175 grams of nitrogen (based on nine men continuously observed) was inferred.

In the course of the experiments intervals of uncontrolled feeding occurred, viz. during the Thanksgiving celebrations, November 29 to December 2, 1917, and during the Christmas holidays, December 20, 1917, to January 6, 1918. On alternate Sundays the diet was usually uncontrolled. A very large number of anthropometric, physiological, and psychological measurements were made upon these men. In addition to the decline of basal metabolism above noted, both pulse-rate and blood-pressure diminished. Little objective evidence of a decrease of physical efficiency was obtained. The majority of the psychological tests pointed to a diminution of efficiency, or at least to a lack of improvement with practice. The students' college work, on the other hand, did not appear to suffer.

The value of this research, which verifies upon a relatively large scale the practicability of diminishing both the rate of metabolism and the quota of body nitrogen by a simple reduction of intake, should be appreciated by scientific clinicians, while many issues of physiological interest are raised and lines of advance suggested to the pure physiologist, especially in connection with the study of levels of nitrogenous metabolism.

As a contribution to the science and art of national dietetics, this elaborate—one might almost say over-elaborate—study is not of so much importance. It is shown that a great reduction, both of available energy and protein, may be borne for some months by healthy adults without either immediate breakdown or sign of enduring deterioration; these are facts which involuntary experiment on a vast scale had already demonstrated. The correlation between variations of nutrition and of resistance to infection, which "common sense" has postulated and which the vital statistics of Europe seem to substantiate, must engage the attention of future investigators; at present an adequate experimental technique is lacking. We do not think that Dr. Benedict and his associates have obtained any results either invalidating the general conclusions expressed by the Food (War) Committee of the Royal Society or filling up lacunæ in our knowledge of the general subject shown by that committee to exist. The experimental and statistical study of national dietetics is still in its infancy. M. G.

ISOSTATIC COMPENSATION IN THE EARTH'S CRUST.

TWO articles on isostasy by the late Prof. Joseph Barrell, which appeared in the *American Journal of Science* for October, 1919, contain what may be regarded as his mature views on the subject. The first, entitled "The Nature and Bearings of Isostasy," was a summary of six lectures delivered by Prof. Barrell at Columbia University in 1916; it gives a general account of the theory of isostatic compensation, and of the methods of investigation which have led to the recognition of the phenomenon. The second article, "The Status of the Theory of Isostasy," was written just before the author's death; it vindicates the theory as to attacks which have been made on it by MacMillan and others, and describes the various views which are held as to the degree of perfection of isostatic balance existing in Nature. Hayford's general conclusion is maintained: that surface inequalities of contour and mass are accompanied by inverse inequalities of density beneath the surface, so that at a depth of about 120 km. equal areas have equal masses superposed; but a view different from Hayford's is taken as to the exactness of this compensation.

Hayford estimated the greatest departure from compensation as being 250 ft. above or below the level for perfect balance over an area of one square degree on the earth. Other geodesists consider that the deviation is much less than this, even when the areal extent is smaller; Sir S. G. Burrard, for instance, at the recent discussion on isostasy before the Royal Astronomical Society (*Observatory*, December, 1919), suggested that so small a body as the Great Pyramid might be compensated. Prof. Barrell, on the other hand, while admitting that the larger relief of the earth is compensated for with considerable exactness, contends that over limited areas there are large deviations—amounting to 1000 ft. over an area 200 miles in diameter (about 3°), or even more. He regards the upper part of the earth's crust as sufficiently strong to sustain uncompensated loads of this amount, the vertical magnitude of the departure being, of course, inversely proportional to its areal extent; it can thus support individual mountains or limited ranges, as well as erosion features of considerable magnitude, such as the Nile and Niger deltas. Under greater and more widely extended loads, however, the crust is supposed to bend in gentle curves involving but little crustal stress; this bending is accompanied by yielding in a lower, weaker layer, which brings about isostatic compensation.

The question at issue is largely one of fact, which can be settled by observation; *e.g.* if pendulum observations show that the Nile deposits are compensated in the crust, the result will confirm the views of the extreme isostasists, that continuous adjustment goes on when the surface load changes over a comparatively small area. The manner of this adjustment, however, has not yet been made clear, and Prof. Barrell's picture of the process is more easy to conceive. On the other hand, Sir S. G. Burrard has shown recently that the alluvium in the Gangetic trough at the foot of the Himalayas is compensated for. It is much to be regretted that Prof. Barrell's death deprives us of his interpretation of this result.

DEFENSIVE SCIENCE IN GAS WARFARE.

THE prizes and certificates gained by students at the Sir John Cass Technical Institute, Aldgate, were distributed by Lt.-Col. P. S. Lelean, professor of hygiene, Royal Army Medical College, on the evening of Tuesday, February 3, when the chair was taken by the Rev. J. F. Marr, who has succeeded Sir Thomas Elliott, K.C.B., as chairman of the governing body.

Following the distribution, Col. Lelean gave an address on "Defensive Science in Gas Warfare," in which he described the preventive measures that had been adopted to meet its onset and evolution. After referring to the initial attack on April 23, 1915, when the civilised world was aroused to just anger by the news that the Germans had broken their pledged word in respect to the use of poisons as a means of injuring the enemy, Col. Lelean dealt with the means of protection first adopted in the form of pads soaked in sodium thiosulphate, of which no fewer than 98,000 were distributed to the Front within sixty hours of the attack, 300,000 within a week, and 2,000,000 within a month—a truly notable achievement, which was rendered possible only by the combined efforts of men of science, manufacturers, and voluntary helpers.

With the recognition of gas attacks as an established adjunct of modern warfare, this temporary device was succeeded by the more efficient protective appliances which were called for by the advent of toxic, paralysing, and lachrymatory gases such as carbonyl chloride, hydrocyanic acid, and chloropicrin, which culminated first in the adoption of the "P" helmet, of which nearly 27,000,000 were issued between July, 1915, and the final withdrawal in February, 1918, in favour of the now well-known "box-respirator."

A full description was given of the great difficulties that were met with stage by stage during the development of these protective appliances, especially in respect to the need for the complete absorption of the small percentages of the poison gases concerned, together with the fundamental requirements of comparative ease of breathing and exhalation.

Col. Lelean paid a special tribute to the outstanding services of Sir William Horrocks and to the late Col. E. F. Harrison in this connection; also to the many scientific helpers with whom they were associated, and particularly to the gallantry and devotion to duty of the small band of scientific workers who had served under him and upon whom had devolved the practical testing of the efficiency of the many devices which were experimented with in a "lethal chamber" before their issue to the fighting forces could be justified.

In speaking of the helpful war-work contributed by the staff of the Sir John Cass Technical Institute, Col. Lelean expressed the view that it was to such institutes that the nation looked in its hour of scientific need, and had not looked in vain; and that it is to such institutes also that, with an ever-increasing appeal, we shall have to look for victory in the future strife of industrial competition, which can be won only by superior technical skill.

VISUAL TESTS FOR MOTOR-DRIVERS.

THE Council of British Ophthalmologists, realising the importance of submitting chauffeurs and other drivers of motor vehicles to some visual tests, appointed a committee to consider the question. Its report is divided into five parts:—(1) The existing conditions under which licences are at present granted; (2) the number of accidents occasioned annually in London by mechanically propelled vehicles; (3) the various kinds of visual defects in motor-drivers from which accidents may arise; (4) proposed scheme of visual testing for licences; and (5) summary of recommendations. The subject is complicated by the following facts. There are two licensing authorities, the county or borough councils and the police authorities. The requirements vary according to the type of vehicle, *e.g.* private cars, commercial cars, omnibuses, taxi-cabs, and tramcars. The total number of applicants for licences makes it impracticable to submit every one to a satisfactory sight test. The council's chief recommendations are:—

"That special sight-test certificates for drivers of motor vehicles be instituted, and granted to applicants whose sight has been tested by ophthalmic surgeons appointed for the purpose, these certificates to be of three grades: Grade A, certifying the holder's visual capacity to drive any kind of motor vehicle; Grade B, certifying the holder's visual capacity to drive any kind of motor vehicle other than a motor-omnibus or tramcar; and Grade C, certifying the holder's visual capacity to drive a motor-tramcar.

"*For Grade A Certificate.*—(1) Every applicant, in addition to manifesting his ability to steer a motor-car satisfactorily in daylight, should be required, in a trial trip at night, to show himself capable of driving in dim light and under varying degrees of illumination. (2) In an examination by an ophthalmic surgeon he should show: (*a*) Visual acuity of 6/9 in one eye and 6/24 in the other eye without the aid of glasses; (*b*) a full field of vision in each eye; (*c*) no manifest squint; and (*d*) no double vision.

"*For Grade B Certificate.*—(1) Every applicant, in addition to manifesting his ability to steer a motor-car satisfactorily in daylight, should be required, in a trial trip at night, to show himself capable of driving in dim light and under varying degrees of illumination. (2) In an examination by an ophthalmic surgeon he should show: (*a*) Visual acuity of 6/9 in one eye and 6/24 in the other eye, with glasses if necessary; (*b*) a full field of vision in each eye; and (*c*) no double vision.

"*For Grade C Certificate.*—(1) Every applicant should be required in a trial trip to show himself capable of driving a motor-tramcar by day and by night under varying degrees of illumination. (2) In an examination by an ophthalmic surgeon he should reach the same visual standards as for a Grade A certificate."

The council has clearly taken great pains to consider the subject in all its manifold bearings. The recommendations appear to be adequate and reasonable, and there is evidence that the authorities are favourably disposed to them.

INERTNESS OF INDUSTRIAL EXPLOSIVES.

FROM Western Australia we have received an interesting report on investigations into the development of inertness in industrial explosives of the nitro-compound class by Mr. E. A. Mann, Chief Inspector of Explosives, and his colleague, Mr. T. N. Kirton (Perth, W.A.: Government Printers). These investigations were started in 1912 in consequence of repeated complaints from the mines that the explosives supplied failed to do the work expected of them. That these complaints were not without foundation was soon ascertained by obtaining samples of the explosive under suspicion and testing their velocities of detonation. The method employed was the well-known D'Autriche system, by which the velocity is calculated in relation to the meeting point of detonations of "cordeau détonant" or T.N.T. fuse initiated at either end by detonators embedded at a fixed distance from one another in the sample under test. The results were startling, and in some instances almost incredible had they not been confirmed by excellent photographs. One of the most striking cases is perhaps that of a gelignite cartridge both ends of which were shattered by the detonators attached to the T.N.T. fuse, while the main body of the cartridge remained intact. This is, of course, an extreme case, but in several instances the velocity of detonation was found to be as low as a few hundred m.p.s. as compared with about 2300 m.p.s. on arrival in the country. Another significant feature is that these inert samples have invariably increased in density from about 1·60 on arrival to about 1·69.

Although a certain degree of after-gelatinisation, with consequent reduction of sensitiveness to detonation, is a recognised phenomenon even in this country, it has not been sufficient to have any practical effect in our temperate climate; but as a result of this report it cannot be denied that, so far as our Oversea Possessions are concerned, the matter is of considerable importance, and deserves the consideration which we understand our leading manufacturers are giving to it. From concurrent observations which the writers of the report have made in regard to the alteration in the viscosity of the nitro-cotton when extracted with amyl acetate, they are disposed to attribute the phenomenon to a change in the molecular structure of this ingredient, and the further investigations they promise will be interesting.

FLOW OF WATER THROUGH A PIPE.

A PAPER entitled "The Orifice as a Means of Measuring the Flow of Water through a Pipe" describes experiments made by Messrs. Davis and Jordan, of the Engineering Experiment Station of the University of Illinois (Bulletin 109), to determine the practicability of measuring the flow of water in a pipe line by means of the pressure drop across a circular orifice in a thin plate diaphragm inserted at a pipe joint. The experiments, which covered a range of pipe diameters ranging from 4 in. to 12 in., show that as a temporary measuring device, or where the loss of head produced by the diaphragm is not serious, the method is capable of useful application. Measuring the upstream head at a point 0·8 of the pipe diameter from the diaphragm, and the downstream head at a point 0·4 pipe diameter from the diaphragm, the discharge is proportional to the square root of the difference of these heads. For a given pipe, the discharge coefficient varies slightly with the diameter of the orifice and with the velocity of flow. So long as the ratio of the diameters is between 2 and 8, the variation is, however, small. For measurements in which an error of 2 per cent. is not serious, the discharge may be taken as given by:—

$$Q = AK\sqrt{h} \text{ cub. ft. per sec.}$$

where A is the area of the pipe in sq. ft.

,, h is the difference of head on the two sides of the orifice.

$$,, \quad K = \sqrt{\frac{2g}{2.64\left(\frac{D}{d}\right)^4 - 1}}.$$

Tables showing the accurate values of K for different diameters of pipe and of orifice are given in the original paper. The device would appear to be of value for field service, as being capable of easy and inexpensive application, since in a flanged pipe system the diaphragm may be inserted at a joint with little or no disturbance of the existing piping.

APPLICATIONS OF AMPLIFYING ELECTRIC VALVES.

M. L. BLOCH communicates an interesting paper on the industrial applications of the amplifying valves used in radio communication to the *Revue Scientifique* of January 10. When the vacuum is almost perfect these valves can be used to increase the amplitudes of high-frequency oscillations at least a thousandfold. Their great advantage is that they act as if devoid of inertia, and so completely solve the problem of a telephonic relay. They are already in use in long-distance telephony. For alternating currents of low frequency the vacuum in the valves does not need to be nearly so high. If argon is used a vacuum of 3 cm. suffices, and currents as large as five amperes can pass through the valve. The valves can be usefully employed for charging accumulators from alternating-current circuits. Another important application is for measuring very small currents and pressures. The currents are magnified a thousand times, and then they actuate direct-reading instruments. By their use the messages sent from the powerful American radio stations at Annapolis and New Brunswick can be recorded on a Morse ribbon in Paris. They were much used in "earth-telegraphy" during the war. Two conductors were fixed in the ground about 50 metres apart, and a source of high-frequency current and a microphone were connected between the conductors. The receiving circuit was similar, but contained an amplifying valve and a telephone. Messages could easily be sent in this way. This method proved of great value when the ordinary lines were cut by the enemy. The valves also made "direction finding" and communication between aeroplanes easy. When used as generators they give currents the frequencies of which can be varied from a tenth to millions per second. They are of great value, therefore, for calibrating wave-meters. It is also possible by their use to maintain the oscillations of mechanical vibrators by suitable arrangements. They introduce the equivalent of negative friction or negative damping into the circuits.

THE FUTURE OF TROPICAL AUSTRALIA.

THE possibilities of settlement in tropical Australia are discussed in great detail by Mr. Griffith Taylor in the *Geographical Review for* August (vol. viii., No. 2). Taking tropical Australia to be bounded by the southern tropic, Mr. Taylor gives it an area equal to barely 40 per cent. of the total area of Australia and about one-thirtieth of the total population. Analysing carefully the climatic and vegetational factors, he concludes that it is mainly a pastoral land except in eastern Queensland, where tropical crops and wheat do well. The coastal lands of the Gulf of Carpentaria are also fit for agriculture. Mr. Taylor sees little hope of tropical Australia becoming a prosperous and productive land if the White Australia policy is maintained. Chinese are chiefly restricted to tropical lands with an abundant rainfall. The hot, dry climate of the greater part of tropical Australia is best suited to the natives of India. Even if white settlement proved to be possible by a slow process of acclimatisation, it would only be at the cost of many lives, and at best would take a very long time. But, assuming that political difficulties will eventually be overcome, Mr. Taylor tries to estimate the future population that tropical Australia could support provided transport facilities are introduced. One district in the interior of Western Australia and the Northern Territory, with an area of about 150,000 square miles, is suited for any population. The remainder of the area under consideration, according to his estimate, could support a total population of about 1,400,000, with a density varying from 8 per square mile in the east of Queensland to 1 per square mile or less in the more arid parts of Western Australia and the inland regions of the Northern Territory. Mr. Taylor's paper is a valuable contribution to the study of Australian problems.

PLANT-LICE IN THE TROPICS.

A RECENT publication of the Scientific Institute of Buitenzorg contains a well-worked-out monograph by P. Van der Goot of the aphides of Java. The author attributes the comparative scarcity of plant-lice in the tropics, as compared with temperate regions, to the attacks of insect enemies such as Syrphidæ, Coccinellidæ, and mining wasps, and also to the occurrence of violent rainstorms, drought, and other unfavourable climatic conditions. The tobacco plant and sugar-cane are the only cultivated plants seriously injured by aphides in Java. In Europe there is always a longer or shorter period of lowered temperature during which the functions of plants are more or less in abeyance. This unfavourable period is generally passed through by aphides in the form of eggs laid in autumn by sexually developed females. If, however, the temperature is artificially kept up, the sexually developed females persist, together with the eggs, and propagation takes place in the regular manner, *i.e.* by means of parthenogenetic, viviparous females. In the tropics there is no considerable lowering of temperature; there is, however, generally a rainy and a dry season. In the latter, though there is often a failure of nutriment, there is never found a rest-form in the condition of sexually produced eggs. Even in mountain regions, where in the dry season the temperature may fall to freezing point, the author has never found sexually developed aphides. Propagation of these insects in the tropics, says Van der Goot, takes place invariably by means of parthenogenesis. He has never observed in Java a regular migration of aphides; whether such a phenomenon ever occurs he is unable to conjecture. The production of winged forms does not always depend on the drying-up of plant-food, for some species acquire wings in the middle, and others at the end, of the dry season.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The board of management of the Brewing School has given the sum of 20,000*l*. for the endowment of a chair of brewing, to be known as the Adrian Brown chair, in memory of the late Prof. Adrian Brown, F.R.S., the first professor of brewing in the University.

A sum of more than 2000*l*. has been subscribed for the endowment of a lectureship in social philosophy as a permanent memorial in honour of Prof. J. H. Muirhead.

LIVERPOOL.—The council of the University has appointed Mr. G. E. Scholes to the recently established chair of engineering-thermodynamics of heat engines. Mr. Scholes studied in the engineering department of Owens College, Manchester, and has held important teaching posts in engineering subjects at Manchester and Liverpool Universities and in the Army engineering schools. During his career in the Army, which he joined in 1915, Mr. Scholes did valuable work as a captain-instructor in petrol and other engines at one of the R.E. schools. Also as experimental officer he successfully devised important technical improvements relating to aircraft defence. The chief of these was a device in connection with sound-locators, which Mr. Scholes designed and constructed. This invention was adopted and standardised, the inventor being awarded a grant from the Inventions Award Committee.

MANCHESTER.—Mr. Frank Watts, who has been appointed assistant to the director of the Department of Industrial Administration at the College of Technology, will devote especial attention to a study of vocational selection and training, and assist in working out a set of tests of industrial fatigue.

THE Regional Association, the president of which is Prof. Patrick Geddes, will hold a conference on regional survey during the Easter vacation (April 6–13) at the Outlook Tower, Edinburgh. Residence is being arranged in University Hall, so that the advantages of communal life may be enjoyed during the week.

THE Seale-Hayne Agricultural College at Newton Abbot, in Devon, commenced last month its first series of regular courses in agriculture with a very satisfactory complement of students. The courses given comprise a three-year diploma in agriculture, a two-year certificate in agriculture and horticulture, and short courses upon various subjects of agricultural importance, such as poultry-keeping, dairying, etc.

THE election to the Sorby research fellowship of the Royal Society and the University of Sheffield will take place after Easter. The appointment will be for five years, and the value of the fellowship is approximately 500*l.* per annum. The person elected will be expected to pursue his investigations at the University of Sheffield, if possible. A copy of the regulations governing the fellowship is obtainable from the Royal Society, the secretaries of which will receive applications for the fellowship itself up to April 20.

A COURSE of five public lectures is to be given at 5 o'clock on successive Wednesdays, beginning on February 25, at the Imperial College of Science and Technology, South Kensington, by Sir Richard Glazebrook, the University of London Zaharoff professor of aviation. The subjects will be:—"Aeronautical Research," "Stability and its Investigation," "Instruments and Methods of Full Scale Research," "Strength of Construction," and "The Airscrew: Its Design and Efficiency." Application for tickets of admission should be made to the Registrar of the college.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 29.—Sir J. J. Thomson, president, in the chair.—Prof. W. **Bateson** and Caroline **Pellew**: The genetics of "rogues" among culinary peas (*Pisum sativum*). In a previous communication (Proc. R.S., lxxxix., 1915) the authors showed that certain intermediates between types and rogues in peas had a peculiar genetic behaviour. Families raised by self-fertilisation from them consist of a small minority of type-like plants and a majority of rogues. Preliminary experiment showed that the type-like plants come from seeds contained in the *lower* pods. Investigations of the past four years, consisting chiefly of reciprocal crosses made from successive flowers, have confirmed this conclusion, and proved further that the ratio of type-like to rogue-like gametes is different on the female and male sides. On the female side the ratio is about equal for the first ten flowers, after which the proportion of rogues increases. On the male side, taking the type-like gametes as unity, the proportion of rogue-like for the first six flowers in succession is as follows:—4·6, 4·9, 7, 10, 12·3, and 29·5. From self-fertilisations the proportion found for the first six flowers is 15, 11, 13, 15, 54, and more than 100. There is thus a gradational change in successive flowers. This gradual elision of the type-characters must be brought about by a process similar to that which operates more rapidly in the case of F_1 plants bred between type and rogue. These, though containing the type, breed rogues only, the type being excluded in the base of the plant.—L. T. **Hogben**: Studies of synapsis. I.: Oogenesis in the Hymenoptera. The more salient conclusions arrived at are as follows:—(1) Sex determination in ♀ agamically produced: In Cynips and Rhodites (agamic forms) there is reduction of the chromosomes in the young oocyte. The somatic number of chromosomes in Rhodites is 18, as believed by Henking. The chromosomes of the young oocyte counted by Schleip are double (bivalent). Henking's belief in the doubling of chromosomes in segmentation is confirmed. Both polar bodies are probably formed as the result of homotypic division. (2) The maturation prophases: A diploteric and pachyteric stage with the biciploid number of filaments follows synapsis in all cases in the young oocyte. At this stage nurse-cells are differentiated. In Cynips, Rhodites, and Orthopelma the *diploid* number reappears after a "diffuse" stage. These univalents pair end to end, as described by Heynes in Copidcsoma. There are thus two chromosome conjugations in the parasitic Hymenoptera, as described in Lepidosiren by Agar, but not hitherto confirmed in other animals by other work. An abortive spindle followed by an atypical formation of polar bodies appears to be general in the Hymenoptera. (3) Secondary nuclei and the oosoma: Secondary nuclei were observed in the oogenesis of Synergus, Formica, and Lasius. They appear to arise from chromidia ejected from the germinal vesicle at the time when the latter undergoes diminished staining capacity. The "oosoma" arises in Synergus as a cloud of cytoplasmic granules. It is not nuclear in origin.—H. **Onslow**: A periodic structure in many insect scales, and the cause of their iridescent colours. The cause of iridescence in insects, etc., still remains unexplained. The minute structure of many iridescent bodies was investigated, because the most eminent physical authorities differed fundamentally as to the cause of their colour. The great variety of structures described and illustrated shows that each object must be judged on its own merits, because no general theory will explain all cases. The principal type of colour-producing structure found in butterflies has not hitherto been described. It consists of transparent plates of chitin separated by films of air. These plates are at right angles to the scale-surface, and only a few half-wave-lengths in thickness. Their height, shape, and colour together control the colour-tone and saturation. Some butterflies have plates of chitin apparently parallel to the plane of the wing; others, again, show structures the colour of which cannot be explained. Reasons are given showing that the monochromatic transmission and reflection colours in beetles' scales are probably not entirely due to "gratings," as was proposed by Michelson. The chief objections to metallic reflection in the case of scales are not met with in the wings of scaleless beetles. Here the colour-producing layer is so near the surface that it would be difficult for any other adequate structure to exist. In certain beetles the colour is produced by a thick layer of doubly refractive rods, such that sections tangential to the surface still retain their colour. The wing chitin of golden "tortoise beetles" appears metallic at all depths when moistened, but loses colour when dry. In other insects and some ticks the colour returns on wetting, apparently because there is a thin film, which by adsorbing water becomes transparent, and can cause interference. Iridescence in dragon-flies, the eyes of flies, plants, and certain hairs, such as the golden mole, is also discussed.

Mineralogical Society, January 20.—Dr. A. E. H. Tutton, past president, in the chair.—Dr. E. S. **Simpson**: Gearksutite at Gingin, Western Australia. This mineral, which occurs in Cretaceous greensand, is considered to have a composition corresponding to the formula $CaF_2.AlF(OH)_2.H_2O$, and to have originated from the interaction *in situ* of fluorapatite, gibbsite, and carbonated water.—C. E. **Barrs**: Fibroferrite from Cyprus. Analysis of material from Skouriotissa, Cyprus, gave the following result. Fe_2O_3, 31·36; SO_3, 30·95; H_2O (by difference), 37·01; insoluble, 0·68.—Dr. G. T. **Prior**: The classification of meteorites. For purposes of the classification of meteorites, the significance is pointed out of the chemical composition of the nickel-iron and the magnesium silicates. In the case of meteoric irons, the structural features, as revealed by etching, are shown to be closely related to the content of nickel. In meteoric stones the proportion of magnesia to ferrous oxide in the magnesium silicates varies directly with the proportion of iron to nickel in the nickel-iron. On these principles the four classes of meteorites, viz. irons, stony-irons, chondrites, and achondrites, can be divided into interrelated groups.

The three groups of chondrites are distinguished as enstatite-chondrites, bronzite-chondrites, and hypersthene-chondrites, according to the chemical composition of the pyroxene. The achondrites are divided into corresponding groups of enstatite-achondrites, bronzite (-augite)-achondrites, and hypersthene-achondrites, while a fourth group is added richer in lime (and mostly also in alumina) than the chondrites. To avoid confusion owing to Brezina's misuse of the term chladnite, the enstatite-achondrites, comprising Aubres, Bustee, and Bishopville, are called aubrites; while for the hypersthene-achondrites (Shalka, etc.) a reversion is made to Tschermak's original name of diogenite.—A. F. **Hallimond**: Torbernite. In continuation of the author's previous work, a series of weighings was made on Gunnislake material held over various concentrations of sulphuric acid. Dehydration did not occur at the pressure required, and only took place slowly over strong acid in a period of many months. It is clear that this mineral cannot be identical with ordinary torbernite. The refractive index agrees with that found for an abnormal torbernite by N. L. Bowen. Normal torbernite has the density 3·22 and mean index 1·585, while for artificial meta-torbernite and for the Gunnislake mineral the density is 3·68 and the index 1·624. An approximate reading yielded for Gunnislake crystals $c:a=2{\cdot}28:1$. The basal planes of the two forms are of the same dimension, and the volume-change due to the addition of $4H_2O$ is borne by an increase in the vertical axis. The density of the water of crystallisation is 1·2, a value common in hydrated salts, while the refractive power is equal to that for liquid water.

CAMBRIDGE.

Philosophical Society, January 26.—Sir Joseph **Larmor**: Gravitation and light.—E. **Landau**: Note on Mr. Hardy's extension of a theorem of Mr. Polya.—L. J. **Rogers**: A Gaussian series of six elements.

MANCHESTER.

Literary and Philosophical Society, January 20.—Sir Henry A. Miers, president, in the chair.—Prof. W. M. **Calder**: Geography and history in the Mediterranean. The author described the relation of the Mediterranean to the series of great plains lying to its north and south, and to the mountain systems known as "the roof of the world." The influence of the sea and land routes on the trade and growth of neighbouring countries was discussed. The great importance of Aleppo as the railway junction of the future for London, Berlin, Calcutta, Cairo, and Cape Town was pointed out. "Rail power" may one day restore the Levant to its ancient position as the centre of communications of the Old World.

Literary and Philosophical Society (Chemical Section), January 30.—Mr. R. H. Clayton in the chair.—Dr. R. S. **Willows**: Recent work on colloids. A definite amount of energy is associated with definite colloidal areas. Adsorption was defined and sols described. Surface tension and some technical applications were discussed by the author.

PARIS.

Academy of Sciences, January 5.—M. Henri Deslandres in the chair.—A. **Lacroix**: The systematic classification of grained rocks containing plagioclase and felspars.—C. **Moureu**, C. **Dufraisse**, P. **Robin**, and J. **Pougnet**: The stabilisation of acrolein. Preservative action of phenolic bodies. Phenols all possess the property of stabilising pure acrolein, and certain polyphenols (pyrocatechol, hydroquinone, and pyrogallol) are especially active.—A. **de Gramont**: The direct arc-spectra of metals of low melting point. The metals examined were lead, zinc, cadmium, tin, antimony, bismuth, aluminium, and magnesium. In some cases spectrographs were obtained showing three spectra of the same metal (spark, direct arc, and carbon arc) on the same plate, and reproductions of these for lead and tin are given.—P. **Humbert**: The calculations of G. H. Darwin on the stability of the pyriform figure. G. H. Darwin and Liapounov came to opposite conclusions on the stability of the pyriform figure of equilibrium of a fluid in rotation. The method used by Darwin, due to Poincaré, is exact, but the development of the series was not carried to a sufficient number of terms, and the results are inexact, or at least doubtful.—A. **Véronnet**: The formation of an isolated star in an indefinite homogeneous nebula.—J. **Andrade**: The experimental control of doubly damped pendular vibrations.—G. A. **Hemsalech**: The emission of positive luminous particles by the alkali metals at high temperatures.—A. **de Gramont**: Observation on the preceding communication.—J. B. **Senderens**: The catalytic hydrogenation of lactose. A repetition of the experiments of Ipatiew on the reduction of lactose in water-alcohol solution by hydrogen at high pressures (74 atmospheres) at 130° C. in presence of nickel and nickel oxide. The main product of the reaction is dulcite, but there is a secondary reaction depending on the activity of the nickel catalyst. A new sugar, lactosite, $C_{12}H_{24}O_{11}+H_2O$, is formed, and corresponds to the melibiotite obtained as a syrup by Scheibler and Mittelmeier. On inversion, lactosite gives sorbite and galactose.—E. **de Loisy**: A commercial method for the synthetic production of alcohol or ether, starting with coal-gas. The velocity of absorption of ethylene from coal-gas by sulphuric acid is increased by the addition of a catalyst, and the same acid can be used in succession for the removal of ethylene, other unsaturated hydrocarbons, moisture, and, finally, for the preparation of ammonium sulphate.—N. J. **Lebedeff**: The Carboniferous in the Caucasus chain.—Ch. **Picquenard**: The fossil flora of the coal basins of Quimper and Kergogne.—Ch. **Gorceix**: Some considerations on the surfaces of equal density at the interior of the earth.—E. **Licent**: The ascophore form of *Clasterosporium fungorum*.—G. **Mangenot**: The evolution of the chondriome and plasts in the Fucaceæ.—P. **Noguès**: Hovering flight produced by a horizontal wind of invariable direction and velocity.—MM. **Constantin** and **Soula**: A new method of graphical recording in physiology, using a microphone and electromagnetic style. A directly recording sphygmograph.—Mlle. M. **Gauthier**: The "trypanosome" of the trout. The first trypanosome was discovered by Valentin in 1841 in the blood of a trout, but no further work on this particular parasite appears to have been done since that date. Additional observations on this organism show that it should not be included in the genus Trypanosoma properly so-called, but in the genus Trypanoplasma, created by Laveran and Mesnil in 1901.—T. **Kabéshima**: Experimental therapy on germ-carriers.—F. **d'Herelle**: The process of defence against the intestinal bacilli and the ætiology of diseases of intestinal origin.—P. **Courmont** and A. **Rochaix**: The bacterial flora of sewage effluents purified by the method known as *boues activées*. The reduction in bacteria by this process is considerable, and the species remaining in the effluent are all aerobic, and include no known pathogenic form.—F. **Bordas**: The preparation and conservation of vaccinal pulp. Reply to some criticisms by P. Achalme and Mme. Phisalix.

January 12.—M. Henri Deslandres in the chair.—G. **Bigourdan**: The observatories of Lalande at the

Palais-Royal and at the Collége de France.—L. **Maquenne** and E. **Demoussy**: The distribution and migration of copper in the tissues of green plants. Twenty-seven species of plants were examined, and copper was found in all parts of the plants, this metal tending to accumulate at points where the percentage of water is at a maximum. The increase of copper is not the consequence of a physico-chemical phenomenon, as is the case with silica and calcium carbonate, but follows a process analogous with that governing the nutrition of the plant.—A. **Blondel**: A method for the measurement of atmospheric transparency.—L. **Pomey**: Fermat's numbers.—M. **Pauthenier**: The absolute retardations in Kerr's phenomenon.—P. **Braesco**: The expansion of copper-antimony alloys. There is a sharp maximum in the increase of length for the alloy containing 38·6 per cent. of antimony, a composition corresponding with the compound Cu_3Sb; no indication of the existence of any other definite compound is given by the expansion curves.—N. H. **Dhar** and G. **Urbain**: The polarisation e.m.f. and the constitution of complex cobaltic compounds.—E. **Wourtzel**: The existence of nitrous anhydride in the gaseous state. The contraction produced on mixing known quantities of NO and O_2 was measured, keeping the NO in excess. Two experiments gave a contraction corresponding with the presence of about 2·5 per cent. of N_2O_3 in the gas mixture. This is sufficient to explain the known production of nitrite when the gas is absorbed by alkaline solutions.—A. **Kling**, D. **Florentin**, and E. **Jacob**: The preparation of chlorinated methyl carbonates.—F. **Canac**: Determination of the orientation of the rows and reticular planes of a crystal.—P. **de Souza**: The Lower and Middle Carboniferous in Portugal.—J. **Savornin**: The geology of Djurdjura and Biban (Algeria).—P. **Russo**: The phosphatic Eocene and Turritelles layers of Tadla (Western Morocco).—L. **Besson**: Diminution of the transparency of the air at Paris. Systematic observations from the summit of the Tour Saint-Jacques in the centre of the city, initiated in 1895 by J. Joubert and carried on continuously under identical conditions for twenty-five years, lead to the conclusion that for the first twenty years the clearness of the atmosphere was slowing decreasing; during the period of the war this diminution became much more marked.—G. **André**: The inversion of cane-sugar during the preservation of oranges.—E. **Saillard**: The nitrogen balance in sugar manufacture. Precipitation of the albuminoid materials of the beetroot by sulphurous acid, bisulphites, and hydrosulphites. Sulphurous acid and its compounds precipitate the same polarising materials as basic lead acetate, working with normal beets; they also precipitate the same albuminoid materials from the beet-juice as copper hydrate.—M. **Lemoigne**: A specific reaction of 2 : 3-butyleneglycol and of acetylmethylcarbinol, products of the butyleneglycollic fermentation. As the production of acetylmethylcarbinol serves to differentiate certain closely related groups of micro-organisms, a delicate and specific test is desirable. The culture is oxidised with a little ferric chloride and distilled; diacetyl passes into the distillate. This is treated with ammonia, hydroxylamine chloride, and a nickel salt, when the scarlet nickel dimethylglyoxim is produced. Acetylmethylcarbinol at a dilution of 1 in 1,000,000 can be readily recognised by this test.—W. **Kopaczewski** and Mme. Z. **Gruzewska**: Seric toxicity and the physical properties of colloidal gels. A relation has been established between the toxic power of gels and the sign of their electric charge. Gels with a positive electrical charge (alumina, barium carbonate, ferric arsenate, calcium phosphate, ferric oxide) have no toxic power, but an electro-negative silica gel is toxic.—A. **Krempf**: The development and relations of the orthosept and sterigmatosept in the Anthozoa.—E. **Grynfeltt** and L. **Carrère**: The muscles of the iris of the crocodile.—L. **Chopard**: Observations on the praying mantis and its parasites.—M. **Lagrange**: The compressive and decompressive operation of the eyeball.—M. **Fouassier**: The decomposition of hydrogen peroxide by micro-organisms extracted from pasteurised milk.

BOOKS RECEIVED.

Practical Science for Girls: As Applied to Domestic Subjects. By E. E. Jardine. Pp. xiii+112. (London: Methuen and Co., Ltd.) 3*s*.

A Class-Book of Organic Chemistry. By Prof. J. B. Cohen. Vol. ii. Pp. vii+156. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

A Manual of Practical Anatomy. By Prof. T. Walmsley. In 3 parts. Part i.: The Upper and Lower Limbs. Pp. viii+176. (London: Longmans and Co.) 9*s*. net.

Employment Psychology. By Dr. H. C. Link. Pp. xii+440. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

The Birds of the British Isles and their Eggs. By T. A. Coward. First series. Pp. vii+376+159 plates. (London: F. Warne and Co., Ltd.) 12*s*. 6*d*. net.

Mathematics for Engineers. By W. N. Rose. Part ii. Pp. xiv+419. (London: Chapman and Hall, Ltd.) 13*s*. 6*d*. net.

Physiology and National Needs. Edited by Prof. W. D. Halliburton. Pp. vii+162. (London: Constable and Co., Ltd.) 8*s*. 6*d*. net.

Scientific Method: Its Philosophy and its Practice. By F. W. Westaway. New edition. Pp. xxi+426. (London: Blackie and Son, Ltd.) 10*s*. 6*d*. net.

Physiology of Farm Animals. By T. B. Wood and Dr. F. H. A. Marshall. Part i.: General. By Dr. F. H. A. Marshall. Pp. xii+204. (Cambridge: At the University Press.) 16*s*. net.

The Universities and the Training of Teachers. By F. J. R. Hendy. Pp. 28. (Oxford: At the Clarendon Press.) 1*s*. 6*d*. net.

Food Supplies in Peace and War. By Sir R. H. Rew. Pp. vii+183. (London: Longmans and Co.) 6*s*. 6*d*. net.

Telephonic Transmission: Theoretical and Applied. By J. G. Hill. Pp. xvi+398. (London: Longmans and Co.) 21*s*. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. E. Conrady: Recent Progress in Applied Optics.

ROYAL SOCIETY, at 4.30.—J. W. McBain and C. S. Salmon: Colloidal Electrolytes. Soap Solutions and their Constitution.—C. C. Farr and D. B. Macleod: The Viscosity of Sulphur.—C. V. Raman and B. Banerji: Kaufmann's Theory of the Impact of the Pianoforte Hammer.—Commander T. Y. Baker, R.N., and Prof. L. N. G. Filon: A Theory of the Second Order Longitudinal Spherical Aberration for a Symmetrical Optical System.—Prof J. W. Nicholson: The Lateral Vibrations of Sharply Pointed Bars.—R. E. Slade: A New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide.—Dr. S. Chapman: A Note on Dr. Chree's Discussion of Two Magnetic Storms (Title only).—Dr. C. Chree: An Explanation of the Criticisms on Dr. Chapman's Recent Paper: "An Outline of a Theory of Magnetic Storms" (Title only).

LONDON MATHEMATICAL SOCIETY (at Burlington House), at 5.—G. S. Le Beau: A Property of Polynomials whose Roots are Real.—The late E. K. Wakeford: Canonical Forms.—E. Landau and A. Ostrowski: A Problem of Diophantine Analysis.—G. H. Hardy and J. E. Littlewood The Zeros of Riemann's Zeta-function.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. D. P. Sutherland: The Work of a Tuberculosis Department.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. F. G. Thomson, Dr. J. C. McClure, and W. P. Kennedy: Resumed Discussion on The Merits and Defects of the British Health Resorts.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. C. W. Kimmins: The Dreams of Children in Blind, Deaf, and Industrial Schools.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Major K. Edgcumbe: The Protection of Alternating-current Distribution Systems without the Use of Special Conductors.
OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street), at 7.—Dr. R. S. Morrell: Colloid Chemistry of Paints and Varnishes.
OPTICAL SOCIETY, at 7.30.—J. W. French: The Surface Layer of an Optical Polishing Tool.—Mrs. C. H. Griffiths: Aberration Effects in Star Images.—R. W. Cheshire and W. Shackleton: The Testing of Heliograph Mirrors.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (at 28 Victoria Street), at 8.—F. R. Cowell: Steering Gears.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. Rows: Anxiety States.
SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY, at 5.—Prof. C. H. Lees: Presidential Address.—Sir Arthur Schuster: Atmospheric Refraction during Total Solar Eclipses.—To be followed by the Annual General Meeting.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery (Hunterian Lecture).
MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.
JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—F. E. Henman: Gas Manufacture.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. M. Bayliss: The Volume of the Blood and its Significance.

SATURDAY, FEBRUARY 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation. III. Deflection of Light in the Sun's Gravitational Field.

MONDAY, FEBRUARY 16.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery (Hunterian Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—A. B. Eason: Automatic Telephony for Private Branch Exchanges.
ARISTOTELIAN SOCIETY (at 74 Grosvenor Street, W. 1), at 8.—A. F. Shand: Impulse, Emotion, and Instinct.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—P. Waterhouse: Education of the Architect.
ROYAL SOCIETY OF ARTS, at 8.—C. F. Cross: Recent Research in the Cellulose Industry (Cantor Lecture).
SURVEYORS' INSTITUTION, at 8.—Capt. W. H. Tapp: Survey on the Western Front.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H.E. the Spanish Ambassador: The Spanish Zones in Morocco.
MEDICAL SOCIETY OF LONDON, at 9.—Dr. H. R. Spencer: Tumours complicating Pregnancy, Labour, and the Puerperium (Lettsomian Lecture).

TUESDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. Wilson: Magnetic Susceptibility.
ROYAL STATISTICAL SOCIETY, at 5.15.—Prof. E. H. Starling: Food Conditions in Germany during the War.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. W. R. Ormandy: Recent Patents on Mixed Fuels.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—N. E. Luboshez: Fancy Lighting in Portraiture.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. Reid Moir: The Occurrence of Flint Implements of Man in the Glacial Chalky Boulder Clay of Suffolk.

WEDNESDAY, FEBRUARY 18.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Lt.-Col. A. H. W. Haywood: The Campaign in the Cameroons.
ROYAL SOCIETY OF ARTS, at 4.30.—S. Preston: English Canals and Inland Waterways.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery (Hunterian Lecture).
ROYAL METEOROLOGICAL SOCIETY, at 5.—Capt. C. J. P. Cave: The Status of a Meteorological Office and its Relation to the State and to the Public.—W. H. Dines: Atmospheric and Terrestrial Radiation.—D. Brunt: Internal Friction in the Atmosphere.
ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. R. C. Buist: The Salernitan Verses and their English Versions.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Civil Engineers), at 6.—Major C. E. Prince: Wireless Telephony on Aeroplanes.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Major P. Bishop: Aircraft Design in relation to Standardisation.
ROYAL MICROSCOPICAL SOCIETY, at 8.—Mrs. Agnes Arber: Studies on the Binucleate Phase in the Plant cell.—R. Beer and Mrs. Agnes Arber: Multinucleate Cells: An Historical Study (1879–1919).—C. Akehurst: Exhibition of Prof. Silverman's Illuminator for Opaque Objects.

THURSDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.
ROYAL SOCIETY, at 4.30.—*Probable Papers*: Prof. B. Moore and T. A. Webster: Studies of Photo-synthesis in Fresh-water Algæ.—Prof. W. M. Bayliss: The Properties of Colloidal Systems. IV. Reversible Gelation in Living Protoplasm.—Rev. F. J. Wyeth: The Development of the Auditory Apparatus in *Sphenodon punctatus*.
LINNEAN SOCIETY, at 5.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—T. B. Stevens and C. E. Blackett: The Use of Haloid Cyanides for the Purpose of Gold Extraction.

CHEMICAL SOCIETY, at 8.—S. B. Schryver and C. C. Wood: A New Method for the Estimation of Methyl Alcohol.—C. S. Gibson and W. J. Pope: ββ'-Dichlorethyl Sulphide.—W. K. Slater and H. Stephen: Some Derivatives of Fisetol.—M. F. Barker: Calorific Value and Constitution. Part I.—J. B. Firth: Surface Tension of Alcohol-Water Mixtures.

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY OF LONDON, at 3.—(Anniversary Meeting.)
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. G. Elliot Smith: The Evolution of the Cerebellum (Arris and Gale Lecture).
INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—E. M. Bergstrom: Recent Advances in the Utilisation of Water Power (Resumed Discussion).
CONCRETE INSTITUTE (at 296 Vauxhall Bridge Road), at 6.—H. K. Dyson: Some Points in Reinforced Concrete Design.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—A. Serner and Others: Discussion on State Ownership *v.* Private Enterprise.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. J. Russell: British Crop Production.

SATURDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.
PHYSIOLOGICAL SOCIETY (at Lister Institute), at 4.

CONTENTS.

PAGE

Asset and Obligation 621
Industrial Chemistry 622
The Origin of Plant-life on Land. By F. O. B. . . 624
Normal and Morbid Psychology 624
Aspects of Modern Science. By Prof. F. Soddy, F.R.S. 625
Our Bookshelf 626
Letters to the Editor:—
Euclid, Newton, and Einstein. (*With Diagram.*)—W. G. 627
Thermionic Valves on Aircraft.—Prof. R. Whiddington 630
Popular Science.—"Victorian" 630
Mirage Effects.—Spencer Pickering, F.R.S.; L. N. Norris-Rogers; Harry Hillman . . . 630
The Theory of Relativity. By Dr. A. C. D. Crommelin 631
The Flight from Cairo to the Cape. By Sir H. H. Johnston, G.C.M.G., K.C.B., and Prof. J. W. Gregory, F.R.S. 632
The Development of Spitsbergen. (*Illustrated.*) By G. W. T. 635
The League of Universities 637
Notes 637
Our Astronomical Column:—
Large Fireball on February 4 642
Relative Masses of Binary Stars 643
Long-period Variables 643
Australian Signposts. (*Illustrated.*) By Sidney H. Ray 643
Human Metabolism. By M. G. 644
Isostatic Compensation in the Earth's Crust . . . 645
Defensive Science in Gas Warfare 646
Visual Tests for Motor-drivers 646
Inertness of Industrial Explosives 647
Flow of Water through a Pipe 647
Applications of Amplifying Electric Valves 647
The Future of Tropical Australia 648
Plant-lice in the Tropics 648
University and Educational Intelligence 648
Societies and Academies 649
Books Received 651
Diary of Societies 651

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THURSDAY, FEBRUARY 19, 1920.

THE ORGANISATION OF SCIENTIFIC WORK IN INDIA.

THE reorganisation and development of scientific work in India are now under consideration, and important and far-reaching decisions on these questions will shortly be made by the Secretary of State. It has already been decided, both by the Government of India and by the Secretary of State, that large sums of money must be found at the earliest possible moment for the purpose of fostering the development of the Indian Empire by means of scientific research. The principle of State aid on a generous scale has been accepted, but the important question of the best method of utilising this form of assistance in the future development of India remains to be settled. These matters were referred to by the Viceroy on January 30 last in his speech opening the present session of the Imperial Legislative Council at Delhi. It is evident from the report of Lord Chelmsford's remarks which appeared in the *Times* of February 6 that the Government of India is now considering large schemes of expansion in regard to the scientific activities of the State.

Two policies at present hold the field: (*a*) Centralisation under a proposed Imperial Department of Industries of the Government of India in which chemists, botanists, zoologists, and so on will be formed into distinct, water-tight, graded services, each under the control of a departmental head; and (*b*) decentralisation under which the scientific workers at the various universities and research institutes will be given as free a hand as possible.

The policy of centralisation and the creation of graded scientific services have been strongly advocated by the Indian Industrial Commission, which was presided over by Sir Thomas Holland, formerly Director of the Geological Survey of India. It is favoured by a number of administrators in India who consider that some measure of official control is necessary for all scientific investigators, and it has also received the support of several of the scientific witnesses examined by the Commission. The arguments advanced by Sir Thomas Holland and his supporters in favour of centralised scientific services are set out in detail in chap. ix. of the Report of the Indian Industrial Commission, published last year (H.M. Stationery Office; Cmd. 51). The nature of these arguments will be evident from a study of the principles and the rules which they suggest should be adopted for the formation and control of the new Chemical Service. It is proposed to proceed with the creation of this service as soon as the committee now dealing with this matter in India has submitted its report.

The Industrial Commission considers that for administrative purposes the chemists now employed by the State in India, and at present distributed among the cadres of various services, should be brought together into one service to be called the Indian Chemical Service, and should be under the control, so far as their scientific work is concerned, of a senior officer styled Chief Chemist to the Government of India. The remaining members of the service would be divided into three groups—agricultural, mineral, and organic chemists—each group being under the supervision of a Deputy Chief Chemist located at a suitable centre. The junior members of the groups would be lent to Local Governments and to various Government Departments for periods normally limited to five years; they would carry out the routine duties required, in some cases including teaching, and undertake certain forms of research with the approval of the head of the service. All the members of the Chemical Service would carry on their duties on the following lines: (i) Whenever it is possible to lay down for any officer a programme of research work, such programme would not be sanctioned without the consent of the head of the service; (ii) the head of the Chemical Service would have power to inspect the scientific work of any of his transferred officers and to report thereon to the local authority; (iii) the results of scientific investigations would be reviewed by the head of the service, and would not be published without his consent. Ordinarily, such results would be given their first formal publication in the official journal of the service.

These details will enable men of science in Great Britain to understand how it is proposed that most of the future scientific work in India should be conducted. As soon as the organisation of chemists is completed, the Industrial Commission suggests that the botanists, zoologists, and entomologists working in India should be formed into similar centralised services.

The present system under which research is conducted in India may be described shortly as one of decentralisation, the work being carried out at the various university colleges and at a number of independent research institutes under the control of the Government of India, the Local Governments, the Indian States, and trusts, of which latter the Indian Institute of Science at Bangalore is the chief example. A large number of the most successful investigators working in the universities and at the various research institutes do not favour centralisation in separate scientific services, but consider that the present system should be developed and extended, and that in applied science the bond of union of the workers engaged should be the general subject investigated, such as agriculture or forestry, rather than the particular science involved. At present the investigators dealing with a many-sided subject like agriculture are collected at agricultural research institutes, and now belong to the agricultural department. A similar method of organisation obtains in forestry and at the centres of medical research like Calcutta and Bombay.

The present system has proved successful in practice, and the value of the work done in India in pure science, in tropical diseases, in agriculture, and in forestry has been widely recognised. Decentralisation, therefore, has been justified by success, and a very strong case will have to be made out before the workers at the existing institutes are re-grouped in centralised services under the control, as regards their scientific work, of the proposed Department of Industries of the Government of India.

Increased financial assistance on the part of the State would enable the present universities and research institutes to be developed and more workers secured. With such facilities, there should be the greatest possible freedom for the investigators carrying on original work. The general conditions under which the researches are conducted should be made as attractive as possible, and the policy to be adopted should be one which would secure the very best men available, and the provision of adequate means for their work. For original scientific investigators little or no official control is needed, and they should not be constantly called upon to furnish interim reports and programmes of work to an official chief, or to obtain his formal sanction before undertaking an investigation or publishing the results of their work. Such formalities waste valuable time, lead to constant friction, and are altogether foreign to the spirit which should reign in all centres of creative scientific research.

Briefly stated, the case to be decided is one between the advocates of a system of rigid centralisation and those who consider that in research work the man is everything, and that there can be no progress without freedom. Obviously, the conflict of opinion is a fundamental one, and much will depend on the wisdom and sympathies of the Secretary of State, with whom the final word lies, in deciding which policy is to prevail.

MODERN PHYSIOLOGY.

An Introduction to General Physiology: With Practical Exercises. By Prof. W. M. Bayliss. Pp. xv+238. (London: Longmans, Green, and Co., 1919.) Price 7*s.* 6*d.* net.

"THE task of physiologists is to refer, as far as they can, all phenomena of life to the laws of physics and chemistry." With this definition Prof. Bayliss presents the student with those fundamental principles of these sciences which are of primary importance in the study of physiology. It is quite remarkable how the author can compress these principles into a small compass, and at the same time give such a clear picture, not only of these parts of physics and chemistry, but also of their applications in physiology. It is essentially an introduction to the author's "Principles of General Physiology," and reference is constantly made to this larger book. The student would often welcome, at these places, a rather longer description, for he will probably not possess the larger book at this period of his science course.

The book is so full of interest that if it were a little longer the beginner would not be overwhelmed, but would gather all the more fruit. The first chapter, entitled "Life and Energy," contains those parts of physics concerned in vital phenomena, written in illustration of certain phenomena easily observed with an amœba. Brownian movement is the visualisation of the moving molecules in a liquid. Protoplasm is a liquid containing matter both in solution and in suspension, and is surrounded by a cell membrane. Surface properties are those mainly concerned, but no grasp of their complexity is possible without a knowledge of energy and its laws. A considerable section is devoted to this subject. The change of energy at the surface of the cell is the cause of extrusion of the pseudopodium. The entry into and exit of matter from the cell is connected with osmosis and the permeability of membranes. This is most lucidly explained. Electrolytic dissociation and the colloidal state are included in the chapter.

"Food—Digestion and Respiration" are dealt with in the second chapter. A short cut is made through organic chemistry so as to give a conception of sugar and amino-acids; it suffices at this stage if the student can differentiate the two classes of compounds, for the subject-matter is rather the origin and metabolism of carbon and nitrogen in Nature, and the supply of energy in the form of food. Food undergoes changes in the body as the result of enzyme action; the section on the nature of enzyme action is scarcely long enough, and reference must here be made to the "Principles." Respiration and oxidation are, in contrast, fully discussed. These two chapters are the chief ones in the book.

"Work—The Muscles and Stimulation—The Senses" are the subject-matter of chaps. iii. and iv. In the latter chapter there is a diagrammatic representation of the mechanism of the organ of Corti. Prof. Bayliss lays special stress upon a student getting a clear idea, even if it be erroneous, for it can be easily changed later, and it is far better than conflicting views which leave no impression. Chap. v. is a difficult one on "Adjustment—The Nervous System," and requires close attention to the text.

Chap. vi. is on "The Transport of Materials—The Vascular System." Here, again, we get an illuminating and fascinating description, while chap. vii., on "Growth and Reproduction," shows how the author himself has thought out his subject for explanation to the student.

Each chapter has a corresponding section on laboratory work, in which there is frequently some further explanation. The practical exercises illustrate the text, and are of varying difficulty. Many have been specially devised, while others are adaptations of existing experiments in physical chemistry or physiology. The value of experiments is very great, for science becomes a reality only in these circumstances. The average student may not appreciate the book, as it is not an "examination" manual. The time must soon come when the present system of practical examinations will be abandoned. Teachers should certify that their students have done a well-arranged course, and can do the experiments if given the proper opportunities.

Students of chemistry and physics will also find the book helpful in their work; many obscure points in their abstract information will be made clear by the descriptions here given. We agree with Prof. Bayliss that all beginners should have a course of *general* physiology, and we would fain see a return to the old system in which every science student worked through a course in physics, chemistry, and biology. The modern student has too restricted an outlook on one side or the other.

MENDELISM.

Mendelism. By Reginald Crundall Punnett. Fifth edition. Pp. xv+219+vii plates. (London: Macmillan and Co., Ltd., 1919.) Price 7*s.* 6*d.* net.

IN reviewing a new edition of a book so well known as Prof. Punnett's "Mendelism," it is unnecessary to notice more than the changes that have been made as compared with previous editions. The third edition (1911) was, in fact, a new book, and the fourth (1912) was substantially similar, with a certain amount of revision. Seven years have now passed, and although the war seriously interfered with genetic research in Europe, great progress in certain directions has been made in America, and it is to incorporate this new work that the chief changes in the present edition have been made. The first eight chapters are substantially unchanged, and comparatively little alteration has been made in the chapters on the economic aspect of genetics, on variation and evolution, and on man. To the chapter on intermediates there has been added an account of Nilsson-Ehle's theory of multiple factors as illustrated by his work on colour factors in wheat, by Davenport's work on mulattoes, and by Prof. Punnett's own work on the size-inheritance of fowls. Some special cases, such as that of doubleness in stocks, that were mentioned under various headings in previous editions are collected together into a special chapter on "Certain Complications." We note with regret that the hypothesis of "multiple allelomorphs," as illustrated by Nabours' experiments on grasshoppers and by certain characters in Drosophila—a hypothesis regarded by many as a preferable alternative to the presence-and-absence theory—is nowhere fully discussed.

The remaining changes and additions are almost entirely concerned directly or indirectly with the work of Prof. T. H. Morgan and his school on Drosophila—with the relations, that is to say, between Mendelian characters and sex, and with the theory that both Mendelian characters and sex are transmitted by chromosomes. Of the two chapters on sex, the first has been rearranged with some additions, but the revision has resulted (p. 92) in a reference to Abraxas as a case already described, while in fact it is not mentioned until p. 96. Incidentally, in this connection, it is an error to say that var. *lacticolor* has been recorded only in the south of Great Britain; the stock from which all or nearly all those now existing were derived came from Lancashire. We regret, also, that in this chapter the author has retained the notation *Ff* for female and *ff* for male, in birds and moths, when the symbols *Mm* for female and *MM* for male are so much simpler of application.

The second of the two chapters on sex, and that on the chromosome theory of heredity, are almost entirely new, and give a compact and useful summary of the outstanding facts derived from Drosophila and the hypotheses founded upon them. Since nearly all this work has been done in America, where students of genetics use the word "sex-limited" in a sense quite different from that in which it is employed in England, a few words on the use of the words "sex-limited" and "sex-linked" on the two sides of the Atlantic might have been a help to readers unfamiliar with the subject.

Although we have noted a few points in which we think the book might have been improved, we do so only because any blemishes, however small, are regrettable in a book of such general excellence. We still regard it, as we did in its earlier editions, as one of the best introductory treatises on the modern study of genetics.

L. DONCASTER.

AERONAUTICS IN ITALY.

(1) *Meteorologia Aeronautica.* By Prof. Giuseppe Crestani. Pp. xv+315. (Milano: Ulrico Hoepli, 1919.) Price 8.50 lire.

(2) *Dizionario Internazionale di Aeronavigazione e Costruzioni Aeronautiche. Italiano, Francese, Inglese, Tedesco.* By Mario Mele Dander. Pp. vii+227. (Milano: Ulrico Hoepli, 1919.) Price 6.50 lire.

(3) *L'Aviazione. Aeroplani, Idrovolanti, Eliche.* By E. Garuffa. Seconda edizione. Pp. xxiii+955. (Milano: Ulrico Hoepli, 1919.) Price 20 lire.

(1) THE introduction and development of aerial navigation have brought into existence new applications of nearly every branch of experimental study, but perhaps none have been brought into greater prominence than meteorology. The safety and success of the pilot involve the most careful study and observation of every element, since barometric pressure, temperature, wind velocity, and cloud formation all affect the navigation of the machine. Hence Prof. Crestani's book will meet a real demand on the part of those who are training as pilots. There is, however, no essential difference between aeronautical and ordinary meteorology, except that more is required of the former. The first part deals with instruments and methods of observation. It describes the principal apparatus used in an observatory, and is in no way limited to the special equipments required for aircraft. Part ii. treats of the principal aerial phenomena, including atmospheric electricity. In part iii. the author deals with weather charts, pressure areas, and the circulation of the atmosphere, while part iv. is concerned with weather prediction. As an introduction to ordinary meteorology treated popularly, the book serves its purpose quite well. Still, as we have said above, something more is required by the pilot. We should like to see more about the means of making observations with the limited equipment that can be carried on aircraft, the modifications in weather prediction dependent on change of position and altitude during a flight, measurements and studies of solar radiation considered with reference to airships, and so forth. There is certainly room for additional treatment in regard to meteorological observations which are peculiar to aeronautical work. Meanwhile, the pilot must gain this knowledge by experience, and his one duty is to learn to observe and interpret phenomena instinctively.

(2) Lieut. Dander's pocket book provides for pilots and aeronautical engineers a dictionary similar in scope and plan to that supplied for gunnery by the "Trilingual Artillery Dictionary" reviewed in NATURE of November 27 last. It possesses, however, several features which were not contained in the subject of the previous review. Thus German is included, as well as English, French, and Italian, and, what is also extremely useful, anyone who is in doubt as to where to find a particular word will see at the end an index in which words in all four languages mixed are arranged in a single, strictly alphabetical sequence. This index is in rather small print, but as it is scarcely likely to be required up in the air this does not much matter. It renders the dictionary equally useful for persons of any of the nationalities which it covers, but English readers would prefer that the *genders* should have been indicated in Italian and French as well as in German. Airships as well as 'planes are considered, and materials of construction, including the names of timber trees, are fully dealt with, though the mathematical as distinct from the technical side is practically unrepresented. There are a few examples of weird English in the work, such as "three-plane," "helicoptery," "cok pit," "vestment" (for costume), not to omit the American "airplane." On pp. 48–49 the author evidently overlooks the possibility of wanting to paint anything red or black or even brown, but these colours are in other dictionaries.

(3) If Dr. Garuffa's book is to be regarded as representative of the present state of development of aeronautical engineering in Italy, English

readers have little to gain in the matter of substantial knowledge from their Italian competitors. The standard of the book is very much on a level with the swarm of weekly illustrated popular journals which may be seen in the waiting-room of an English aircraft factory or on the table of the library at Central House or of the Royal Aeronautical Society. As an introduction to practical aeronautics, the book will provide the Italian student with an insight into the mass of detailed information which is required by aircraft mechanics and pilots. The best portion is undoubtedly the descriptive account of the different types of aeroplane and their component parts, and as the machines selected for illustration are mainly of Continental make, the book may be of use to English readers for purposes of comparison. As regards the theoretical side, the treatment is very elementary, and imperfect formulæ and calculations are indeed abundant, but most of these are not much more than replicas of what one can find in our elementary school text-books on geometry and mechanics. The misfortune of this practice is that things look like new principles which are as old as the hills. But we in England cannot say much when one of our own weekly journals has devoted a glowing paragraph to the announcement that an American professor has discovered that two similarly electrified bodies can overcome gravity and repel each other.

In the sections dealing with pressures on component parts of aeroplanes, considerable prominence is given to Eiffel's diagrams of experimental results. The main difficulty in practice is that the pressures on the various elements of an aeroplane are not mutually independent, and for this reason we should have preferred a section dealing with the wind channel and its use, since this has become an indispensable adjunct to our aircraft factories.

The so-called "stability" which figures in a few sections does not in any way represent stability proper as studied in this country and tested experimentally at Teddington and Farnborough.

The sections dealing with navigation describe the usual instruments found on aeroplanes, and methods which do the ordinary, easy things, such as determining the position and velocity of an aeroplane when seen from the ground, which is very different from enabling a pilot to find his way in a fog or on a dark night. A lot of algebra is expended (p. 876) over a method of finding wind velocity by making an aeroplane fly in a quadrilateral path when ruler and compass would do the whole thing at once. The section on the seaplane contains the usual theory of the metacentre; the further developments required to take account of the effects of air resistance are briefly epitomised.

On the whole, the book fairly well meets the requirements of the average pilot, mechanic, or draughtsman who is in a position to leave more theoretical considerations in the hands of scientific experts (if he can find them).

In the *Atti dei Lincei,* xxviii., (1), 7, 8, Dr. Oreste Mattirolo considers the use of wood in the longitudinal bars of an aeroplane, with special reference to the effects of growth on the strength of the timber. During the war the timber used in the construction of aeroplanes was tested and examined by the author, and the existing methods were found to be inadequate. Dr. Mattirolo directs especial attention to the effect of climatic and seasonal conditions on the growth of the rings, and to the difficulty of locating weaknesses in the structure, and he cites two cases of accidents in which the wood was sent for his inspection and the defects were discovered too late. He recommends that now the demand for aëroplanes has lessened the longitudinal beams of the wings should no longer be made of wood. It is interesting to note that similar investigations in this country have been carried out in greater detail at Farnborough and elsewhere, though a number of problems still await solution in this as in other aeronautical investigations.

In another issue of the *Atti dei Lincei* (xxviii., 1, 2), Dr. Mario Tenani refers to the influence of the density of the air on the efficiency of aeroplanes, and quotes the ordinary laws of variation of density with pressure, temperature, and altitude in support of his plea regarding the importance of a subject which has received much attention in our country both in connection with airships and in experiments with variable propellers at Farnborough.

Meteorological difficulties should not be so serious in sunny Italy as in our land of fogs, though the Italian mountains may be set against the brighter climate. At the Pisa meeting of the Italian equivalent of our British Association, a paper on weather prediction was read by Prof. Filippo Eredia, at the end of which a resolution was passed advocating the joint action of the Ministries of Agriculture, Industry, and Commerce in co-ordination with the Air Department to promote researches in weather prediction with the view of furthering the development of commercial aviation.

Papers dealing with aeronautical subjects have, however, been conspicuous by their absence from the proceedings of learned societies in this and other countries, and the *Atti dei Lincei* has been no exception to the rule. If this is a result of the war we may welcome the three papers as an augury for a better state of affairs in the future.

G. H. BRYAN.

THE RE-MAPPING OF THE WORLD.

The "Times" Survey Atlas of the World. Prepared under the direction of Dr. J. G. Bartholomew. Part i. (London: Office of the *Times*, n.d.) Price 2*s*. 6*d*. net.

THE first part of this atlas contains four maps numbered respectively 21, 60, 79, and 95. The parts of the world represented are the southern section of Scotland, Farther India, Lower Egypt (from a little above Luxor), and Mexico and Central America (from Costa Rica inclusive). Three of the maps are, and, no doubt, the majority of those in the atlas will be, drawn on the layering principle, which has the advantages of conducing to clearness and indicating the broad distribution of high grounds and low grounds at a glance. This has been done with a skill worthy of the reputation which the map-making firm responsible for it has long held for work of this class.

The layering adopted is not on a uniform scale. In the same map successive contours represent different intervals of altitude. That, however, we have even in our own Ordnance Survey maps. But there are different scales of altitude on different maps otherwise somewhat similar. On the map of the southern section of Scotland the steps in altitude are by 250 ft. up to 1000 ft., then by 500 ft. to 2000 ft., and after that by 1000 ft. The only isobath is that of 10 fathoms. On two of the other maps the only isobath is that for 100 fathoms, but whereas in Mexico the isohypses represent 100, 500, 1000, 2000, 3000, 4000, 5000, and 6000 ft., and then 8000 and 10,000 ft., in that of Farther India they are at intervals of 500 ft. up to 2000 ft., and then mark altitudes of 3000 and 6000 ft. respectively. In the map of Egypt there are no isobaths (in the main map) or isohypses. Hachures are used to indicate the margins of the plateaux on the inset map showing the environs of Cairo on the scale of 1 : 150,000.

One noteworthy feature of the maps is that they are so mounted as to be suitable for loose-leaf binding, which will have the important advantages of allowing the replacement of a map without replacing the atlas and of enabling one to detach a single map at will for close examination and frequent reference. This feature might perhaps be utilised to remedy one of the defects of the maps, the smallness of the lettering where the names are too crowded. New maps might be drawn for those who would prefer them with fewer names in a larger letter, the missing names being entered in the index with their compass bearing and distance from places that are named on the map, say from railway stations, which are very easy to find.

We are promised an index of more than 200,000 names, but are not told how the index is to be prepared. Presumably latitude and longitude are to be given, as there is no provision on the border for reference by letter and number to the degree rectangles. But if latitude and longitude are to be the means of reference, or, indeed, in any case, we hope that the maps still to be issued will have the divisions of degrees marked on the border. That is not done in the four maps of the first part, with the result that in Scotland, for example, we have an interval for latitude of one degree measuring $6\frac{3}{4}$ in. without any subdivision showing minutes. On each map also the projection used should be named.

PHYSICS FOR MEDICAL STUDENTS.

(1) *A Manual of Physics.* By Dr. J. A. Crowther. Pp. xx+537. (London: Henry Frowde and Hodder and Stoughton, 1919.) Price 16*s*. net.

(2) *Elements of Physics.* By Dr. R. A. Houstoun. Pp. viii+221. (London: Longmans, Green, and Co., 1919.) Price 6*s*. net.

STUDENTS of medicine are apt to regard physics as a subject outside the range of their medical studies, a subject imposed upon them by certain grandmotherly examining authorities, to be forgotten as soon as the examination is over. Teachers of physics have to contend not only with this attitude of mind, but also with the fact that writers of physical text-books for the most part show but little evidence of sympathy with the medical applications of their subject. The ideal text-book for medical students would be written by a trained physicist who has specialised in medical work and is imbued with the spirit of research in physics as applied to medicine. Instead of studying the common steelyard, the medical student might then find the principle of the lever illustrated in the human frame, and instead of having to wade through a chapter on terrestrial magnetism, he might be given further information on the subject of meteorological physics and the conditions determining climate. He might even learn something as to electric oscillations applied in high-frequency treatment, or as to the use of a saccharimeter. Both the volumes under review claim to meet the needs of first-year medical students; but the ideal book on physics for such students has yet to be written.

(1) Dr. Crowther has given us an excellent manual of physics suitable for beginners who have no special profession in view. He has devoted considerable space to the subject of

mechanics, and experienced teachers will agree that "a thorough grounding in this most fundamental of all the sciences is the beginning of all wisdom in physical knowledge." The treatment of the various subjects follows conventional lines, a short chapter on the discharge of electricity through gases being the only one which deals specifically with the results of modern research. The style is lucid and interesting, and the explanation of physical principles exceptionally clear. It is to be regretted that the price of 16s. net should be so high as to make it impossible for many students to purchase the volume.

(2) A smaller treatise on the elements of physics has been written by Dr. Houstoun, who has attempted to cover the same ground in less than half the number of pages. The matter is consequently somewhat compressed and the style curt. The author has been successful in including a section on simple harmonic motion, which is so important in the study of vibrations; and another on the characteristic features of wave motion, in which the difference between a stationary and a progressive wave is well brought out. The work should be useful as giving a compact systematic treatment of the whole subject.

Both books are furnished with useful collections of questions and problems, and answers are provided for the numerical examples.

H. S. Allen.

OUR BOOKSHELF.

Harmsworth's Universal Encyclopedia. Edited by J. A. Hammerton. No. 1. Pp. xix+128. (London: The Amalgamated Press, Ltd., 1920.) Price 1s. 3d.

This is, of course, a work of reference for the general reader, not the expert. The editor claims that it possesses the three necessary qualities, comprehensiveness, conciseness, and accuracy. All three are relative terms, and there is no absolute test by which his claim can be judged. But, since Mr. Hammerton is the acknowledged authority on What the Public Wants, the first claim may be conceded without further question. On the second the bare statement that A—*Afranius* occupies 128 closely printed but well-illustrated pages will enable the reader to judge for himself. On the third it is sufficient for Nature to record that the scientific articles appear all to be as completely accurate as the space allotted to them will permit, and that one of the introductory articles, by Lord Moulton on "Science and the Future," is a model expression of the obvious; originality or profundity could not be expected.

We think the production is one of which the Amalgamated Press may well be proud.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Relativity and the Displacement of Fraunhofer Lines.

In view of the uncertainty in the interpretation of Einstein's equations in the matter of the displacement of solar spectrum lines, and of the hope which has been expressed that experimental spectroscopic evidence may be forthcoming which will settle the point at issue, it may be of interest to give a brief account of the present state of the problem from the experimental point of view. There are really three questions to which answers are required:—(1) Is there any means whereby the displacements of solar lines relative to those of terrestrial origin may be disentangled from such disturbing causes as pressure, varying arc conditions, density gradients, etc.? (2) If so, what do the outstanding displacements amount to? (3) To what extent are they due to gravitation and line-of-sight motion respectively?

Upon (1) it is to be remarked that, since both gravitation and motion displacements vary directly with the wave-length, they are indistinguishable spectroscopically; moreover, the possibility of separating their sum from those due to other causes, which in general displace spectrum lines (I have enumerated some ten possible causes in a recent communication to the Royal Astronomical Society), depends upon the reputed invariability of the wave-lengths of the cyanogen bands in different parts of the arc, under pressure, under varying current densities, etc. Practically all other lines are affected by one or more of these influences, and must be ruled out of account. Further laboratory experiments are necessary before the cyanogen bands can be regarded as suitable criteria, particularly in view of a recent statement from the Bonn Laboratory that they are unsymmetrical, which for well-founded reasons brings them seriously under suspicion for astrophysical purposes.

Even if we assume for the present that the cyanogen bands are satisfactory standards, (2) presents a further difficulty in that the Mount Wilson observers find displacements varying from 0 to about one-third of that predicted by Einstein; whereas Evershed and three Continental observers find a displacement of about one-half the required amount. It is possible that the discrepancy is due to the observations being made on different dates, since at Kodaikanal, on different occasions, measures made at the pole of the sun varied from one-half to the full predicted displacement. Simultaneous solar observations at Kodaikanal and Mount Wilson are, unfortunately, impossible, and it is a pity that the Australian Solar Observatory is not yet in existence to link up the two.

If Mr. Evershed and others prove correct, the problem still remains to interpret the half-displacement observed; obviously, this can be done only if by some independent evidence the motions of the vapours are known upon that portion of the solar surface towards which the spectroscope is directed. This involves a deeper knowledge of the currents in the solar atmosphere than we at present possess. There has been a disposition to regard displacements at the polar limb as free from motion effects, but it is inevitable that there will be surface currents, and these need not be of excessive violence in order to give displacements of the order of magnitude of those observed. The problem, if we accept Mr. Evershed's data, resolves itself into choosing between (*a*) the absence of the Einstein effect, but the existence of currents of absorbing solar vapours moving away from the observer on the earth, and (*b*) the existence of the Einstein effect, together with solar currents of about the same magnitude as before, but in the opposite direction. The question thus involves an extensive knowledge of solar meteorology. There is, I fear, no immediate prospect of a rigorous solution of the problem of the displacement of the Fraunhofer lines with our present incomplete knowledge of the conditions necessary for the production of the cyanogen-band spectrum and with our present limited information regarding the circulation in the sun's atmosphere. W. G. DUFFIELD.

University College, Reading, February 8.

Statistics of Valour and Service.

IN the Weekly Edition of the *Times* for November 28, 1919, the following statistics relating to decorations awarded for services in the field are detailed:—

	V.C.	D.S.O.	M.C.	D.C.M.	M.M.
Decoration	576	8,862	36,707	24,391	114,517
1st bar ...	2	695	2,932	468	5,719
2nd bar ...	—	70	167	9	180
3rd bar ...	—	6	4	—	1

An analysis of these figures, with a consideration of the results arising from such an examination, may be not without interest.

The figures may be reclassified as follows:—

Number of Individuals who have Won Decoration

	V.C.	D.S.O.	M.C.	D.C.M.	M.M.
With 0 bar ...	574	8,167	33,775	23,923	108,798
,, 1 bar ...	2	625	2,765	459	5,539
,, 2 bars ...	—	64	163	9	179
,, 3 bars ...	—	6	4	—	1

In making this reclassification I have assumed that all the decorations were won subsequent to July, 1914. There may be exceptions—as, for instance, in the case of Capt. Leahy, V.C.—but as the number of such cases must be small, their influence may be neglected.

In analysing these statistics I shall employ a type of method which I have applied with considerable success to medical problems, chiefly of an epidemiological nature (*Science Progress*, 1914; Proc. Lond. Math. Soc., 1914; and various papers in the *Indian Journal of Medical Research*). The argument as applied to the present case is as follows: Let us assume the presence at the Front of a community of individuals, initially undecorated, who were capable of earning the decoration in question provided that opportunity offered and recognition came. Let v_x be the number of individuals who at any moment were in the grade x—that is to say, who had received the decoration with $x-1$ bars. Let $\phi_x f(t)dt$ be the probability that an individual in grade x may during the time dt pass from the grade x to the grade $x+1$. For such a passage to occur, both opportunity must offer and recognition must come. The function ϕ_x allows for variations in the probability of further attainment being dependent on the degree of anterior attainment. The function $f(t)$ is unknown; it describes the ebb and flow of the conflict. Variations in the number of individuals in the grade x are composed of influxes and effluxes. The degree of the former depends upon the number of individuals who have already attained to the grade $x-1$, and the degree of the latter upon the number of those who are in the grade x itself. Thus

$$dv_x = (\phi_{x-1}v_{x-1} - \phi_x v_x) f(t)dt.$$

Let us assume as an approximation that $\phi_x = b + cx$. Let μ_1 denote the mean grade, and μ_2 and μ_3 the second and third moments about the mean respectively. By differentiating these values according to the time, and by making use of the above differential equation, we find

$$\mu_1 = \frac{b}{c}(e^{c\theta}-1),\quad \mu_2 = \frac{b}{c}e^{c\theta}(e^{c\theta}-1),\quad \mu_3 = \frac{b}{c}e^{c\theta}(e^{c\theta}-1)(2e^{c\theta}-1),$$

where θ is written for $\int f(t)dt$; whence

$$c/b = (\mu_2 - \mu_1) \div \mu_1^2,$$

and

$$\mu_1(\mu_2 + \mu_3) = 2\mu_2^2.$$

Solving the differential equation for successive values of x, and eliminating the unknown function θ, we have, if we remember that the participating population N was initially undecorated,

$$v_x = \mathrm{N}\frac{b}{c}\left(\frac{b}{c}+1\right)\cdot\ \ \cdot\left(\frac{b}{c}+x-1\right)\frac{\left(1-\frac{\mu_1}{\mu_2}\right)^x}{x!}\left(\frac{\mu_1}{\mu_2}\right)^{b/c}.$$

In the present instance, as in very many epidemiological problems, we are ignorant of the value of N, *i.e.* of the number of individuals in the participating population. On the assumption that our hypotheses are applicable, we can, however, calculate its value by making use of the above eliminant between the moments which results from our hypotheses, and by taking advantage of the fact that, in calculating the values of moments about any selected grade, information regarding the number of individuals in that grade is unnecessary, as in each case this number is multiplied by zero. In the present instance, as we are ignorant of the number of individuals in the zero grade (*i.e.* of the number of the undecorated), we employ moments about the origin. Let us denote the second and third of these by μ'_2 and μ'_3 respectively, then by introducing the values $n_1 = \mathrm{N}\mu_1$, $n_2 = \mathrm{N}\mu'_2$, $n_3 = \mathrm{N}\mu'_3$, into the eliminant we find

$$\mathrm{N} = n_1^2(n_2 - n_1) \div \{2n_2^2 - n_1(n_2 + n_3)\}.$$

The results of these calculations are indicated in the following table:—

Number of Individuals having the Decoration

	V.C.	D.S.O.	M.C.	D.C.M.	M.M.
With 0 bar ...	574	8,158	33,769	23,925	108,789
,, 1 bar ...	2	638	2,784	460	6,555
,, 2 bars ...	—	58	152	8	169
,, 3 bars ...	—	6	6	—	3

The correspondence between calculated and actual values is good, as was in some measure to be expected, since the number of grades in the statistics in no case exceeds four, whilst the number of constants at our disposal is three. We may, however, conclude that, for particular values of these constants, our assumptions are sufficient to account for the facts, and proceed to examine the significance which attaches to these values in the light of our assumptions. The final test of the adequacy of the assumptions must clearly depend upon the reasonableness of such inferences as may obtrude themselves.

These values are as follows:—

	N	c/b	$b\int f(t)dt$
V.C.	41,763	−0·5	0·014
D.S.O. ...	215,498	+2·96	0·042
M.C.	240,477	−0·005	0·166
D.C.M. ...	1,103,730	+0·735	0·023
M.M.	1,077,444	−0·096	0·113

In the values of N we have the values of the participating populations. To recapitulate: They denote the numbers of persons at the Front who were capable of earning the decoration in question if opportunity offered and recognition came. The standard of the

V.C. stands pre-eminent. Amongst the other four we find that the populations calculated for decorations awarded to non-commissioned ranks are to those calculated for decorations awarded to officers as approximately 5 to 1.

In the values of c/b we have a measure of the amount of increase in the probability of attainment as the individual passes from grade to grade. Thus if the likelihood of winning the decoration be unity, the likelihood of obtaining a first bar is $1+c/b$, and of obtaining a second $1+2c/b$. The value of c/b is positive if the likelihood increases with the grade, and negative if it decreases. The actual values may clearly be the resultant of both positive and negative influences. For the V.C. and the M.M. these values are frankly negative, that for the M.C. is nearly zero, and those for the D.S.O. and D.C.M. are frankly positive. This would suggest that the decorations fall into two classes which are earned under different conditions. Take, for example, the effect of risk. The value $-0 \cdot 5$ for the V.C. would be accounted for if it could be shown that 50 per cent. of those who earned it died or were incapacitated in the winning. Thus the negative values of the first class of decoration can be accounted for by assuming a high degree of risk in the winning of them. Again, let us consider the questions of leadership and administrative ability. In these a positive value might indicate that although it was difficult for a soldier to get his opportunity in the first instance, once he had made his mark his opportunities for further distinguished service would be increased. The positive values found in the second class of decoration might thus be accounted for. Whether this explanation be the true one or not, it would appear that once the British soldier has got his foot on the ladder he makes good.

In the third column are tabulated values of $b\int f(t)dt$, calculated from $\log(N/v_0)$. If we assume that the ebb and flow of the conflict operate uniformly on the chance of winning each of these decorations, or that they do so within the respective classes, then the tabulated values may be taken as relative values of b, *i.e.* of the chance that an individual, potentially capable of winning the decoration, obtained it in the first instance. In this case also the factor is compounded of the chance that opportunity offers and the chance that recognition is received. Here again the V.C. stands pre-eminent. The low value for the D.C.M. is in agreement with what has been suggested in the preceding paragraph, viz. that it is relatively difficult for non-commissioned ranks to obtain a footing on the ladder. The high values for the M.C. and the M.M. would indicate that in this war of the trenches the opportunities for brave deeds were all too frequent. Taking the decorations separately, the results of this analysis are as follows:—

(1) The V.C. stands pre-eminent amongst the decorations, equally as regards the high standard which is required, the high degree of risk with which the winning is accompanied, and the difficulty of attainment even in the case of the individual who is admittedly of the required standard.

(2) The D.S.O. is an officers' decoration awarded both for deeds of valour, probably of a skilled kind, and for distinguished service of other sorts. The chance of opportunity offering and recognition being received may, in the first instance, be low, but, once obtained, there follows increasing opportunity.

(3) The M.C. is an officers' decoration in which probably the influences of both classes are combined, viz. risk and increasing opportunity. Opportunities of earning it were all too many.

(4) The D.C.M., for non-commissioned ranks, is of the same type as the D.S.O., though the chance of opportunity offering and recognition being received in the first instance is relatively less.

(5) The M.M., for non-commissioned ranks, belongs to the class of the V.C. It is characterised by the risk which the winning entails, and by the indication that the opportunities for the performance of brave deeds were many.

These, then, are the inferences which appear to me to emerge from the hypotheses which I have adopted. There may be others of which I am ignorant, but, such as they are, I venture to offer them as a tribute to the vast potentialities of the British Army, both for valour and for service—potentialities which even at the end of the great war remained to a large extent unexplored; and also as a tribute to the consistency and fairness which characterised the manner in which these decorations were awarded.

A. G. McKENDRICK,
Director.
Pasteur Institute of India, Kasauli,
January 1.

Sugar-beet Seed.

At a recent meeting of the Sigma Xi Society of the University of Colorado Dr. W. W. Robbins, botanist to the Great Western Sugar Co., read a paper on beet-seed production. Dr. Robbins related that so early as 1909 Mr. Hans Mendelson, a German in the employ of the company, undertook to grow beet-seed in Montana. In those days all the seed was imported annually from Europe, principally from Germany, Austria-Hungary, and Russia. It was held by experts that the climate and other conditions would not permit the growing of the seed in America on a commercial scale. Mr. Mendelson thought otherwise, and stated that the time might come when it would be impossible to get European seed. So he continued his experiments on a small scale; and when the war came, and the supply of seed was actually cut off, he had developed his methods to such an extent that it was possible to save the industry. In 1916 the United States was able to produce 5,211,000 lb. of seed, and in 1917, 5,546,000 lb. Furthermore, experimental work had already determined the fact that American-grown seed gave a larger tonnage and a greater amount of sugar per acre than imported seed. From this time the policy of raising American seed will be continued.

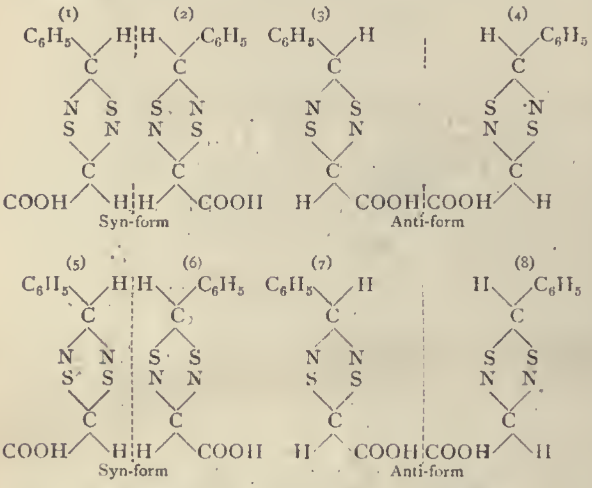
I hope that Dr. Robbins will later on tell the whole story of the sugar-beet in relation to the war. The various events are part of the significant history of human progress. But just now it is worth while to note the value to the country of such men as Mr. Mendelson, and the importance of giving them a chance to test their ideas. The public is too apt to think that scientific progress comes only through great discoveries, or requires a Darwin, a Newton, or a Kelvin. It is difficult to exaggerate our debt to the great men of science, but it remains true that the current work of the world does not rest so much on sensational discoveries as on the multitudinous minor facts determined by a host of patient workers. Even Darwin could not have done his work without the aid of such. We shall never get on a proper basis until the scientific worker—no genius, but a normal man (or woman) doing his day's work—is established as a member of the community on a par with the tailor, the baker, or the policeman.

T. D. A. COCKERELL.
University of Colorado, Boulder, Colorado,
January 18.

An Electronic Theory of Isomerism.

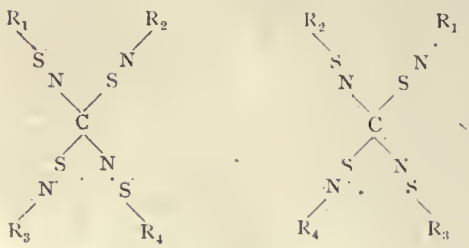
The application of the Bohr theory to organic chemistry suggests a possible explanation of the hitherto unexplained isomerism of certain organic compounds. The electrons rotating in pairs around the four carbon valencies may possess either clockwise or anti-clockwise rotation with respect to the central carbon atom (Ramsay, Proc. Roy. Soc., xcii., A, p. 451, 1915–16). On the assumption that two of these pairs of electrons rotate in a clockwise and two in an anti-clockwise direction, it is possible to deduce that eight isomerides of cinnamic acid may exist. It has long been known that four isomerides of cinnamic acid exist, whereas only two are possible on the ordinary structural formulæ.

Erlenmeyer has recently shown (*Biochem. Zeitsch.*, 1919, xcvii., pp. 198–245) that ordinary cinnamic acid can be obtained in two optically active isomerides. If the clockwise rotation of the electron gives a north-seeking character to the valency, and the anti-clockwise rotation a south-seeking character, it is possible to represent eight isomeric cinnamic acids as follows:



The formulæ are grouped in pairs, and only two of these pairs are mirror images, (5) being the mirror image of (6), and (7) of (8). None of the isomerides 1 to 4 are superposable, as can be readily seen from the solid models. (A north-seeking valency will be the mirror image of a south-seeking valency.) The new type of optical activity is due not to the asymmetry of the radicles, but to an asymmetric arrangement of the pairs of rotating electrons.

It may be that the dextro- and lævo-rotatory forms of an organic compound are not structural isomerides, but owe their optical activity to this asymmetric arrangement of the electrons:



There is thus possible a large number of such isomerides in organic chemistry which are, however, stable only in very few types of organic compounds. The case of the cinnamic acids is not an isolated one, for it appears from the work of Erlenmeyer that benzaldehyde is capable of occurring in the dextro- and lævo-forms (*Biochem. Zeitsch.*, 1914, lxiv., pp. 382–92), and also, according to Marckwald, methyl-ethyl-malonic acid occurs in optically active forms.

This theory differentiates between two kinds of valency, according to whether the rotation of the electrons with respect to the valency is clockwise or anti-clockwise, and may explain the peculiar characteristics of the physical properties of the homologous series, where those compounds containing an even number of carbon atoms appear to belong to one series, and those with an uneven number to another series.

All the isomerides which are obtained on this theory, except the optical pairs, should possess different free energies according to the arrangement of the rotating electrons. W. E. GARNER.

University College, London, February 2.

The Sociological Society.

MAY I beg the hospitality of your columns for two announcements? First, the Sociological Society is moving from the London School of Economics and Political Science to a house of its own at 65 Belgrave Road, Westminster, S.W.1. The society hopes to get installed there by the beginning of March.

The second is that the society's new house affords more accommodation than the society itself can use, and we should be glad, therefore, to hear from congruent societies or organisations which might desire to rent one or more rooms. The present housing pressure is, we understand, putting not a few societies into a considerable difficulty as regards accommodation.

As to the situation, the new house of the Sociological Society is about five minutes' walk south-east from Victoria Station. It is just over a mile in a direct line from Charing Cross, and two 'bus routes (24 and 24A) cross Belgrave Road, within a couple of minutes' walk of the house. T. J. C. FRASER DAVIES,

February 16. Secretary.

Mirage Effects.

WHILE a patient at the Red Cross Hospital for Officers, Brighton, the phenomenon described by various correspondents was observed by me on numerous occasions last autumn. It was particularly noticeable on hot, sunny days along the Marine Parade, Kemptown. From a point opposite the Hotel Bristol, the road a quarter of a mile distant, *in either direction*, appeared as if flooded by a water-cart. Indeed, the illusion was so complete that the first time I witnessed it, being confined to a spinal chair, I instructed my attendant to make a detour.

ROBERT ROSS.

3 Sudeley Terrace, Brighton.

AN excellent place to observe mirage round our coasts is Morecambe Bay on a sunny afternoon when the tide is out and a fresh breeze is blowing in from the sea. Viewed from the low shore by Hest Bank, the Furness shore is clearly reflected in detail, even the steam of trains on the Furness Railway. Also, the bay towards Carnforth appears to be full of water where there is only dry sand.

Mirage effect on an asphalted pavement may be seen on the North Road between Newcastle-upon-Tyne and Gosforth when the sun is shining warmly and at the same time a cool wind from the north-east is blowing across it. The effect is observable to anyone walking up the road and approaching a level portion or slight depression. ALBERT TARN.

Barrow Hedges, Carshalton, February 15.

UNEXPLORED PAPUA.[1]

IN an interesting book on his experiences as a magistrate in the western division of Papua, Mr. Wilfred Beaver has given a vivid description of life in a practically unknown portion of that little-known land.

The western division is the largest in the territory, and has only partly been brought under Government control. It comprises the basins of the Fly River and the rivers east and west, from the Dutch boundary to the north-western portion of the Gulf of Papua. The people on the coast about Kiwai Island appear as a black, frizzy-haired race of medium height, narrow-headed, with the arched and prominent nose called Semitic. Inland skins are lighter, and noses shorter and straighter, while towards the east there are still other variations, but nowhere in this division is there any trace of the mixed people whom Seligman has described as Papuo-Melanesians.

After short sketches of Papua in general and of the western division and its history in particular, the author takes each river system or its hinterland in turn, as forming the most convenient means of describing the natives and the districts themselves.

In Kiwai the native houses are communal, varying from 250 ft. to 450 ft. in length. The whole roof is supported on the side posts, and, being carried forward over the end of the flooring, forms a verandah. The interior is divided into family compartments, each with its own fireplace. These compartments are open in the Fly River houses, and closed in those further east. All are now giving place to smaller houses, where married men sleep with their families.

Inland from the Fly River and at the western end of the division the bush people differ from those on the coast. The excessive use of *gamada* (*Piper methysticum*), the kava of Polynesia, has had to be prohibited by a Government regulation. In all this region the population is decadent, in the bush through pulmonary disease, on the coast through raids of tribes from the west.

The eastern part of the division on the coast and inland from the Papuan Gulf has scarcely yet been brought under control. Mr. Beaver gives an account of a pacificatory visit and the genesis of a Government station at Goaribari, where the Rev. James Chalmers and his party were killed in 1901. Cannibalism in this district was common, the stronger tribes gradually eating up the weaker. Yet these people are among the best physically in the possession, and, being quick, intelligent, and imitative, are now becoming employed in increasing numbers by white planters. The whole country being a region of swamps and morasses, the natives are naturally expert canoe-makers, and sago, both here and in the Fly basin, is the staple vegetable food, with bananas and yams when the soil is suitable.

Both at Kiwai and Mawata the natives are becoming "civilised," civilisation consisting in the wearing of European clothes, the use of European tools, and the laying out of the village in two streets of pile houses, each occupied by two families. "There is a flagstaff and a small court-house, a wooden church, and a trader's store." Amusing instances are given of the mingling of old and new ideas. Women make proposals, and brothers and sisters are exchanged in marriage, while the court for native affairs deals with affiliation orders and fines of thirty shillings for "philandering" with other men's wives.

FIG. 1.—Bamu River archer in full fighting dress. The gauntlet is worn on the left arm to protect it from the bowstring. The bamboo beheading knife is carried slung around the neck. The head-carrier is carried over the left shoulder. From "Unexplored New Guinea."

It is impossible to give an adequate view of these interesting chapters within the limits of a short notice. Mingled with descriptions of scenery and personal sketches of prominent natives are interesting accounts of native arts, fishing by means of the sucker fish, and the spearing of dugong from platforms on the reef. Dress or the lack of it, pigs and cassowaries, swamps and gardens, sorcerers' magic and charms, births, marriages, and deaths, are all dealt with in a most unconventional way. A chapter on property and inheritance and Dr. Landtman's account of the religious beliefs of the Kiwai people conclude the book.

The spirit in which Mr. Beaver wrote this most picturesque book is shown when he says: "There is a mystery about Papua that seems to enhance its

[1] "Unexplored New Guinea: A Record of the Travels, Adventures, and Experiences of a Resident Magistrate amongst the Head-hunting Savages and Cannibals of the Unexplored Interior of New Guinea." By Wilfred N. Beaver. With an Introduction by Dr. A. C Haddon. Pp 320. (London: Seeley, Service, and Co., Ltd., 1920.) Price 25s. net.

fascination. What that fascination is, and why there should be any at all, is hard to say. . . . Papua is a land of disappointment, a land where nothing happens as you anticipate, where the unexpected usually happens, and the impossible is achieved."

An introductory sketch by Dr. Haddon gives a short biography of the author, who was killed at Polygon Wood, in France, in September, 1917. His death deprived ethnology of a keen and intelligent observer, and the Papuan Government of a most zealous and successful magistrate, loved by his fellow-officers, and trusted by the natives, whom he understood and with whom he sympathised.

FIG. 2.—Babiri man from near Dutch boundary. From 'Unexplored New Guinea."

SIDNEY H. RAY.

ALPINE PLANTS FOR ROCK-GARDENS.[1]

"PROCLAMATIONS of purpose are often confessions of failure to achieve it," is the opening sentence of the Introduction of Mr. Farrer's book. His volume is "vast," and from the nature of the subject justly so. Mr. Farrer has not only given an account of the rock-garden plants which now figure in the nurserymen's catalogues, but has also unearthed from botanical treatises a large number which no doubt will some day come into cultivation, so that his book is of more than present-day value. In addition to this, he has been at great pains to discover the correct names of the plants he records, which has entailed considerable research into botanical literature, and for this valuable labour he is deserving of high praise. He also gives some useful information as to rock-garden construction, and throughout the volumes there are good practical instructions as to the cultivation of the various plants.

But Mr. Farrer has unfortunately failed to sink either his own individuality or idiosyncrasies in the volumes before us, so that instead of presenting us with a lucid and useful account of rock plants suitable for English gardens easy to be understood, he has expressed his own ideas and opinions with an exuberance of persiflage that is very irritating. In his Introduction of eighty-four pages and throughout the book the author seems far more interested in striving to commit extravagant excesses with the English language than in conveying useful information about Alpine plants, and in consequence many of the really valuable portions of the book tend to be overlooked. With regard to his descriptions of the plants, moreover, we cannot say that his work is very helpful. After his diatribes on the wearisome jargon of botanists one does not feel that the following description of *Dianthus arenarius* is either very intelligible or informing: "Related to *D. squarrosus*, is much laxer in the habit with fewer flower stems, taller and frailer and larger, with very fringy whirligigs of white or pale pink." Nor is this seven-and-a

[1] "The English Rock-Garden." By Reginald Farrer. Vol. i., pp. lxiv+504+52 plates; Vol. ii., pp. viii+524+50 plates. (London and Edinburgh: T. C. and E. C. Jack, Ltd., 1919.) Price 3*l*. 3*s*. net two vols.

half-line sentence on *Primula Winteri* particularly illuminating: "It is unfair to say that the name of *P. Winteri* is a base and unpardonable pun, yet true it is that in midwinter always seem to emerge the crowded new rosettes of powdered, rounded, toothed leaves on their firm footstalks, and in their heart an interminable cabbage of these glorious, wide, lavender-lilac flowers with their fringed lobes and noble outline, succeeding each other for many months, in a rivalry of beauty, against the grey and mealy beauty of the robust leaves, if only the weather will allow. There is no other fault than this—which perhaps is merely due to the plant's inexperience—to be brought against this unparalleled introduction. . . ." A barren superfluity of words indeed!

Many extracts from this riot of verbiage might be made, but only one or two can be given. Of "the moonlight radiance of *Roscoea cantlioeides*," Mr. Farrer remarks: "Its nearest match is in the lucent citrons of *Meconopsis integrifolia*, but here the tone is yet blander and more serene, shining with a solemn and unearthly radiance as the blossoms, like ghostly butterflies of light, hover pale and vivid upon the background of dark pine-branches."

Then, again, when he speaks of *Aster lichiangensis* as "a bonus of the gods," or of *Anemone alpina*, almost blasphemously, as "the Great King of Glory," or of a double form of this species as "windmill-whirling," one feels tempted to relegate the book to "the dust and silence of the upper shelf."

Yet despite these adverse criticisms, which perforce bulk largely in a notice of the book, it is a real compendium of sound information and learning, though unduly biased in certain respects. On the genus Primula, for instance, which occupies nearly 100 pages, and on Saxifrage and many other genera, Mr. Farrer speaks as an authority, and we welcome his useful marshalling of information. Why he should dismiss Rhododendron in half a page because he says it "asks for a book" we fail to see. He appears to forget both here and elsewhere that only certain species in a genus are rock or Alpine plants. In a few pages ample accounts could have been given of *Rhododendron intricatum*, *R. fastigiatum*, *R. hippophaeoides*, and the few other Alpine forms, whereas he alludes to *R. praecox*, *R. dauricum*, and *R. ciliatum*, which are certainly not "rock-garden" plants in the usually accepted sense.

FIG. 1.—*Gentiana Farreri*. From "The English Rock-Garden."

The book is admirably illustrated with an excellent series of some 200 photographs. In reproducing the picture of *Gentiana Farreri*, a plant for the introduction of which gardeners will always hold Mr. Farrer's name in grateful remembrance, we cannot refrain from quoting his exuberant description: "*G. Farreri*, which sends out many flopping, slender shoots from the stock, clad in very narrow foliage, and ending each in a single huge, up-turned trumpet wide-mouthed, and of an indescribably fierce, luminous Cambridge blue within (with a clear white throat), while, without, long vandykes of periwinkle-purple alternate with swelling panels of nankeen, outlined in violet, and with a violet median line." *Non equidem invideo; miror magis!*

The publishers have also assisted to increase the reader's irritation with the book, which, in spite of its too obvious faults, has many excellent qualities, by leaving the pages uncut and untrimmed—surely an unreasonable offence in a book of this character.

A NEW COPPER-REFINING INDUSTRY IN GREAT BRITAIN.

IN the last year of the eighteenth century Great Britain produced about 75 per cent. of the world's output of copper. The Cornish miners supplied most of the ore, and the Swansea smelters extracted and refined the metal. In the United States of America only a few tons were made. In 1913 the positions were reversed. Great Britain smelted and refined barely 6 per cent. of the world's production of this metal, and all but an insignificant fraction was derived from imported ores, matte, blister copper, and precipitate or cement copper. In the same year the United States of America furnished more than 55 per cent. of the world's total, and by far the greater part of this was obtained from home supplies of ore.

Whether in peace or war, copper is, and has long been, second in importance only to iron, not only in the various types of the commercial metal, but also in its numerous alloys. The enormously greater extent to which it is now used is not, however, generally realised. In 1800 the world's production did not exceed 10,000 tons, and that was probably the high-water mark of the annual production up to that time; in 1900 it had risen to about 500,000 tons, and in 1912 to about 1,000,000 tons. Thus, in little more than a hundred years, the production had increased a hundredfold.

During the war the whole question of the future of the copper-smelting and refining industries of this country was examined and considered by the Non-Ferrous Metal Trades Committee of the Board of Trade under the chairmanship of Sir Gerard Muntz. In due course the Committee reported, but the report has not been published. The announcement is now made in a recent issue of the *Times* that a syndicate has been formed to set up a large copper refinery in Devonshire, and has chosen a site near Newton Abbot, and that it is proposed to spend nearly 10,000,000*l*. on the scheme. The chairman of the syndicate is Sir Gerard Muntz. It is stated that Mr. H. J. Wilson, who originated the scheme, at first intended to harness and utilise the water-power of the Dartmoor plateau, but so much opposition was shown in some quarters that this proposal has been abandoned, at any rate for the time being. It has been decided to utilise a large deposit of lignite, of which it is estimated that more than 800,000,000 tons are available for the generation of the electric power required. At the site chosen there are tide-water facilities. By-products will be collected and marketed. The power generated will be mainly devoted to the electrolytic refining of copper, but it is considered that it will be so cheap as to enable current to be supplied in bulk to all the towns in South Devon, as well as to the industries which may be attracted to the neighbourhood.

The lignite deposits have only been used locally to a small extent. The *Times* states that a few months before the outbreak of war a party of Germans conducted a series of experiments and acquired a considerable tract with the evident intention of developing it on a large scale.

In the years immediately preceding the war the United States of America refined electrolytically more than 90 per cent. of the world's output of crude copper. Most of this production was absorbed by the electrical industry. Great Britain, accordingly, was obliged to obtain the bulk of this type of copper from America, and in 1913 imported about 100,000 tons. In view of the great importance of the home electrical industry, it will be obvious that the proposal to establish a large electrolytic refinery in a suitable locality possesses value which it is not easy to exaggerate. It should be pointed out, however, that the refinery will have to depend mainly upon imported blister copper for its raw material, since only a small amount of this metal is smelted in Great Britain at the present time. There are no longer any considerable home deposits of copper ore, and the few smelters who do exist have found it more and more difficult to obtain smelting materials. The United States of America, by virtue of the extent of its control of its own deposits and of those in Chile, is able largely to influence the price of copper, and the policy pursued by the works there is to attract smelting materials from other countries for treatment. The Americans can afford to pay high prices for imported ores, because the remainder of this raw material is produced at home at a price which is so low that a low average selling price for the whole serves to secure an adequate profit. In Great Britain only a few copper manufacturing firms and one or two companies owning mines abroad can afford to operate smelting works under these conditions. This consideration has no doubt been given its due weight by the syndicate, but it has not been made clear upon what sources they will rely for their blister copper.

In conclusion it must be stated that in this country a small amount of electrolytic refining is carried on, and that there are a large number of manufacturers who are engaged in the furnace-refining of blister, Bessemer, and other varieties of the crude metallic copper, and in producing the "tough" and "best selected" brands of the metal. The "tough" quality is used chiefly by the engineering and shipbuilding industries, and the "best selected" for the manufacture of alloys. In the production of this class of material the works in Great Britain are, and have long been, pre-eminent. If, therefore, the plans of the syndicate are successful in providing British manufacturers with sufficient supplies of electrolytically refined metal for their purpose, the production of this commodity in Great Britain will be placed on a much more satisfactory footing than it has been for many years.

H. C. H. CARPENTER.

THE "TIMES" AFRICAN FLIGHT.

DISCOVERY OF A NEW VOLCANIC FIELD.

NEWS has been received with great disappointment that, owing to the failure of the engine, Dr. Chalmers Mitchell's trans-African flight was checked on February 11, when a descent had to be made in the bush, and then the machine was taken to Jebelein for repairs. The South African machine, the *Silver Queen*, has been irreparably smashed by a forced descent at night at Korosko. The troubles of both machines may be due to their having been unduly forced, owing to the supplies of petrol in some southern stations being apparently adequate for one machine only. The flight was resumed on February 14, and a point twenty miles from Mongalla was reached at 4 p.m. on that date. On the following day the short flight was taken to Mongalla, where Dr. Chalmers Mitchell expected to be detained for three days. In his latest message, dated February 16, he says:—

I consider the Cairo-Khartum part of the route satisfactory if relays of aeroplanes are available. The arranged landing-grounds are good and forced descents fairly practicable. The stage from Khartum to Mongalla is extremely dangerous, as the arranged aerodromes are difficult to locate and forced descents require luck and unusual skill. Bush fires destroy visibility, and render the smoke fires on the aerodromes useless as guides. The positions of the wireless station and the telegraph wires at Mongalla are extremely dangerous. The pilots, the mechanics, and the Vickers' "Vimy" machine are excellent. We hope that the worst of the trip is over, but must proceed slowly.

Dr. Chalmers Mitchell has thus successfully achieved more than one-third of the journey along Africa, and has shown how valuable aeroplane surveys may be by a discovery of first-class importance. After leaving Assuan, on approaching the section of the Nile flowing from south-west to north-east from Dosha to Korosko, he remarked many high hills with steep walls running north-east and south-west. These steep hill-fronts may indicate that both the section of the Nile above Korosko and the parallel section from Korti to Abu Hamed were determined by earth-movements, which have a wide influence in this part of Africa; for the section of the Nile flowing from Abu Hamed south-west to Korti is in line with a remarkable breach through the mountain rim of the Red Sea basin. The mountains which extend west of the Red Sea from behind Kosseir, southward past Berenice and Mersa Shab, end to the south-east in the group of Adal Qaqa (about 5925 ft.). The geology of this group is known by the monograph by Dr. J. Ball (1912), whose maps indicate the existence of faults of late Cretaceous or post-Cretaceous age, some of which trend north-west to south-east, and others from north-east to south-west. South-east of Adal Qaqa the highlands are resumed by the mountains which extend south from Gebel Elba, west of Cape Elba, through Gebel Shendil (6275 ft.) and Gebel Asotriba (7270 ft.). The Adal Qaqa and the south-eastern groups are separated by a deep depression formed by the plains of Nafab and by the broad valley of the Wadi Di-ib which discharges to the Red Sea. The divide between the Nafab and Wadi Di-ib is probably less than 2000 ft. above sea-level. The straight course of the 1000-metre contour line on the south-eastern side of the Adal Qaqa group, as shown on the 1 : 7,500,000 map of the Nile Basin by the Egyptian Survey (1906), occurs on the extension of the line of the Nile from Abu Hamed to Korti. On the continuation of this line across the Red Sea the irregularities in the front of the Arabian plateau between the coastlands of El-Gof and Medina may be due to the same tectonic cause.

The representation of the 1000-metre contour near Adal Qaqa may be untrustworthy, or its continuation on the line of the Nile from Abu Hamed to Korti may be only a coincidence. But the probability of a long north-east to south-west fracture is strengthened by the discovery by the *Times* Expedition of a group of extinct volcanoes in the Bayuda Desert, half-way between Merowe and Berber.

The discovery is quite new, since this volcanic field was unknown to so alert an observer as Mr. G. W. Grabham, the Government Geologist of the Sudan. Mr. Grabham has, however, been able to support Dr. Chalmers Mitchell's identification, as he had received some volcanic tuffs obtained by Sir Herbert Jackson about fifty miles distant from the craters seen by Dr. Chalmers Mitchell. There was apparently no evidence as to the age of these tuffs, or whether they came from modern volcanoes, but Dr. Chalmers Mitchell concludes from his observations that the eruptions were not later than the Kainozoic, and as he refers to the hills as craters they were probably formed late in that era. The great earth-movements along the Rift Valley are frequently associated with volcanic outbreaks, due to material compressed by the subsidence, being forced up the adjacent fractures. Dr. Chalmers Mitchell's discovery, therefore, suggests that one line of crustal fractures explains the bend of the Nile south-westward from Abu Hamed to Korti, the Nafab—Di-ib depression, and the Bayuda volcanic field.

Col. Lyons has shown that the course of the Nile from Berber to Korosko is comparatively young, and that above Berber, as at the Shabluka Gorge, it has re-excavated a new channel through the comparatively soft rocks which have filled up an older valley. It therefore seemed possible, from the information previously available, that the disturbances which have given the Nile its S-shaped course from Korosko to Khartum were due to earth-movements contemporary with the breach through the Red Sea rim near Berenice. This conclusion is strengthened by the discovery of the Bayuda volcanoes. The movements doubtless happened during the Kainozoic era, and Dr. Chalmers Mitchell's observations on the condition of the volcanic hills of the Bayuda will probably indicate a more precise date.

J. W. GREGORY.

THE NATIONAL RESEARCH COUNCIL OF THE UNITED STATES.

AN account has recently been published of the organisation established by the National Research Council of the United States for the carrying out of its work. Americans are proud of their organising ability, and it is very interesting to study the efforts of the men of science of America to develop their scheme of mobilising the whole strength of American science for the promotion of the national well-being and for the advance of science itself.

The National Research Council was established to deal with war problems. It was started by the men of science themselves; they recognised that although the Government had already strong scientific bureaux, there were many other workers who in the isolation of their own laboratories were almost unavailable, but eager for opportunity to help. This organisation is now being completed and put on a permanent basis. We are told that it differs from organisations for similar purposes in England, Canada, Australia, and Japan in that, while recognised by Government, it was not initiated or organised by Government, and is not supported by it. Its support is derived from funds contributed by private sources.

The machinery is somewhat elaborate. There are seven divisions devoted to special branches of science and technology. These divisions are physical science, engineering, chemistry and chemical technology, geology and geography, medical science, biology and agriculture, and anthropology and psychology. The members of each of these divisions include representatives of societies dealing with cognate subjects, other scientific workers, and representatives of firms. Attached to each division there are a very large number of committees to give attention to special problems. But in addition to this classification into seven divisions there are six "general relations" divisions—a Government division, a division for foreign relations, a division of States relations, a division of educational relations, a division of industrial relations, and a division of research information. The idea underlying these divisions may be seen from their constitution. For example, the educational division has a membership including representatives of all the principal university associations, the United States Bureau of Education, the Carnegie Foundation for the Advancement of Teaching, etc. The division for research information will, we are told, be a national centre of information concerning American research work and research workers, with all its information promptly available to institutions and individuals interested in knowing at any time what problems are under investigation in America and their status.

The National Research Council has permanent headquarters in Washington, with an executive staff of men of science giving their whole time to the work of their respective positions. Each of the divisions has a resident chairman and a small office staff in Washington.

It is not yet possible to say much as to the actual work of the new Council. From the list of subjects being studied by the numerous committees of the different divisions, it would appear that problems of wide national interest are receiving first attention. If we compare the American organisation with that of our own Research Department as shown in its annual reports, it would seem that in America the scientific worker is organised to a greater, and the industrial leader to a less, degree than in this country. There is nothing in the American scheme that quite coincides with the research associations for each large industry established by our Research Department. It is clear that both the American Department and our own will have much to learn by watching each other's development, and it is to be hoped that some degree of co-operation may be established in connection with problems of interest and importance to both nations.

The official organ of the National Research Council for the publication of accounts of research work and of committee and other reports will be the Proceedings of the National Academy of Sciences, but in addition the Council proposes to publish a Bulletin at irregular intervals. The first number of the Bulletin contains articles by Dr. G. E. Hale and other writers on different aspects of the national importance of scientific and industrial research. Dr. Hale gives an account of the origin of the Council and outlines its objects. He argues against the view that organised effort in science may hamper the individual investigator and hinder personal initiative. In his opinion, well-planned co-operation stimulates the individual and brings out his best and most original efforts. The Council will favour this type of co-operation, but is opposed to all attempts at a central control of research.

The Hon. Elihu Root writes on the need for organisation in research, and holds that science has been arranging, classifying, methodising, and simplifying everything except itself. One fears that the degree of organisation suggested by Mr. Root would almost amount to the control which Dr. Hale tells us the Council has no wish to attempt. Other articles dealing with the relation of research to industry are written by men of wide experience in large industrial concerns, and the Bulletin concludes with an account by Mr. Howe of the organisation of scientific and industrial research in the United States, the British Empire, France, Italy, Japan, and Belgium. An appendix contains a list of non-military researches undertaken by the Council covering a wide range of subjects, and especially numerous in the section of medical science.

THE SECONDARY SCHOOL CURRICULUM.[1]

THE Secondary School Examinations Council is an august body the members of which have for the most part more experience of university work and of administration than of secondary schools. The council was therefore well advised in selecting, for the investigation of the methods and standards of award of the seven approved first examinations, "panels" of experienced teachers. These have now made their reports, which are published for the information of all concerned. The conclusions reached are not so startling as to make the non-committal preface appear necessary in the eyes of a schoolmaster.

The mathematical investigators in particular have not exceeded their terms of reference, though a hint is thrown out that the present forms of compulsion may require revision. Thus "elementary mathematics should include arithmetic" seems a harmless proposition. To some examining bodies, however, "elementary mathematics" means algebra and geometry, and is not compulsory. Later there follows the sentence: "So long as mathematics is a compulsory subject for exemption purposes, the present standards for credit cannot well be raised, but they are in themselves unsatisfactory." It may be inferred that compulsory algebra is viewed with disfavour, a view which is shared by many examiners who have realised the appalling waste of time involved for half the boys and girls who try to learn algebra without attaining the power or even the need to apply it in the simplest way. Compulsory arithmetic is much more defensible, and it is a pity that the investigators have not maintained a clearer distinction between the two. In geometry it is recommended that the theorems on congruence of triangles, parallel lines, and angles round a point (*i.e.* Euc. i. 4, 8, 26; 27, 28, 29, 32; 13, 14, 15) should be omitted. We may infer that only the proofs of these theorems are indicated, and that the enunciations (*pace* Einstein) are to be assumed.

The science investigators have had to cover a wider field and to consider a greater variety of practice on the part of the different examining bodies. Thus in one examination a paper is set on "Elementary General Science," covering a very elementary treatment of heat, hydrostatics, chemistry, and botany, this paper having been recently introduced for the benefit of rural secondary schools. The "panel" is of opinion that further investigation of this general science work is particularly desirable. We may remark here that it would greatly help the movement if specimen copies of the paper referred to could be circulated among teachers and examining bodies. To quote the report: "The examination, like the syllabus in the schools up to the sixteen-year-old stage, should be suited to the capacity of the average pupil of sixteen, should cover a reasonably wide range, and should not encourage instead advanced work within a limited field. Further, it should not be confined to an abstract and academic treatment of the subject, but should require a knowledge of the applications of the sciences to everyday life. It must be remembered that at this age pupils obtain far more value from a concrete than from an abstract treatment of science, and this should be borne in mind both in drawing up a syllabus and in setting a paper. The investigators direct attention in this connection to the observations contained in paragraphs 47, 50, and 51 of the Report of the Government Committee on Science." Most teachers of science in schools will assent to this. The generation of science masters who began their science at the university is rapidly passing away. On them must partly rest the responsibility for the effort which has been made in the last thirty years to impart an appreciation of "scientific method" to boys at too early a stage. Now they are being followed by a generation of teachers who may have begun the systematic study of science at the age of twelve, and in some cases find themselves deficient in literary attainments. An undergraduate starting on geometrical optics is at a disadvantage if he has never handled lenses or prisms in such a way as to know their peculiarities; but if he has done this, and knows the meaning of the words used, he need not have been through a prolonged course of optical measurements, nor need he belong to the class of natural science students who come up "knowing how to measure every physical quantity, but with no ardent desire to measure any."

It may be remarked here that "general science" is no more than a branch of English, and that its teaching implies the demonstration to the various senses of the meaning of a number of English words. This has evidently been realised by the "panel" of geographers, whose remarks are worthy of quotation. They "are of opinion that geography should be a subject in Group I.; but they are of opinion that it should be a subject in Group III. also." Geography, in other words, is not only a branch of English, but also a branch of science. This is a bold saying, and it may possibly account for the cautious prefatory statement: "It must not be assumed that either the council or the board are at present committed to any or all of the suggestions." If geography is to belong to two groups, why not also general science? And why should not algebra find a place among the foreign languages? The insidious suggestion might lead to the collapse of all the walls of partition and to the survival of English as the one essential subject, as seen in a vision by Sir Arthur Quiller-Couch. For the investigators in English report thus: "They are of opinion that (in the interests of the language and of lucidity of expression) a reasonable standard of English should be required in all subjects of the examina-

[1] Secondary School Examinations Council. Reports of the Investigators Appointed to inquire into the Methods and Standards of Award in the Seven Approved First Examinations held in July, 1918. Group I., English, History, Geography; price 6*d*. Group II., Classics, Modern Languages; price 4*d*. Group III, Mathematics, Science; price 4*d*. (H.M. Stationery Office.

tion." Again: "No candidate should obtain a certificate who does not show a good command of English and the power of writing it intelligently." If to this were added the power of reading English intelligently, which implies a knowledge of the meaning of a number of words in common use under the headings of geography, history, and general science, and, finally, the power of doing simple arithmetic, is it not conceivable that a candidate possessing these three powers might be thought fit to continue his studies at any university of the realm?

NOTES.

BOTANISTS in Great Britain have been considering the practicability of holding an Imperial Botanical Congress in London at which botanists from the overseas Dominions might meet their colleagues at home for the discussion of matters of common interest. Many subjects are ripe for discussion, such as the methods of training botanists for service abroad, the relation between the pure science and its applications and between the botanist and the commercial men interested in industries in which botanical knowledge should play an important part, more helpful co-operation between the home and the overseas botanist, botanical surveys of overseas Dominions, and others. After careful consideration it has been decided that it would be inadvisable to hold such a congress during the present year.

M. LUCIEN POINCARÉ, Vice-Rector of the University of Paris, will be entertained at dinner by the Groupe Inter-Universitaire Franco-Britannique on Monday, February 23. The dinner is being organised in connection with the formal opening of the British Bureau of the Office National des Universités et Ecoles Françaises by M. Poincaré. The chair will be taken by M. Petit-Dutaillis, Director of the Office National. Amongst the members who have intimated their intention of being present are his Excellency the Belgian Ambassador, his Excellency the Greek Minister, the Lord Chancellor, the Earl of Reading, Viscount Burnham, the Right Hon. H. A. L. Fisher (President of the Board of Education), the American Consul-General, Mr. Austen Chamberlain, and the Lord Mayor and Lady Mayoress.

THE anniversary of Sir Francis Galton's birth, February 16, was celebrated by the Eugenics Education Society as usual this year. Prof. Arthur Keith delivered the Galton lecture, and this was preceded by a dinner at the Connaught Rooms. These annual gatherings have been held since 1914 in every year but one, when war conditions stood in the way. In his interesting lecture, which will be printed in full in the next issue of the *Eugenics Review*, Prof. Keith gave a sketch of Galton's life in so far as it affected his work, and a broad and general account of his investigations and theories. The main thought running through his address was that Galton's work had not been adequately appreciated during his life, and that his reputation would increase as time went on. In Galton's day anthropologists concentrated their attention on the individual man, whilst it was equally necessary to consider the distribution of men according to their qualities. Hence Galton's teachings made slow progress because they fell on unprepared ground, whereas in the future he would come to be recognised as one of the greatest men of science produced in England during the nineteenth century. Major Leonard Darwin was in the chair, and said that Galton always had practical aims in view and always had the courage of his opinions. If ever the *name* of eugenics came to be captured by cranks it would be because scientific men did not follow his example, and, through fear of contact with cranks, gave this important subject lukewarm support. The *science* of eugenics could never suffer in this way, because it was founded on indisputable truths. The proceedings terminated by a vote of thanks moved by Sir Robert Blair and seconded by the Dean of St. Paul's.

AT the National Conference of Manufacturers and Producers, held at Kingsway Hall on February 11, Sir Robert Hadfield, representing the Federation of British Industries, proposed a resolution appreciating the work of the Department of Scientific and Industrial Research; and strongly urging all manufacturers, either individually or collectively by trades, to organise and maintain research facilities. In the course of his remarks Sir Robert Hadfield affirmed that science and industry are now in indissoluble partnership, and that further steps should be taken to organise research more thoroughly and efficiently than has been done in the past. We must recognise that, in these days of international competition, the prosperity of every British manufacturer and trader is bound up with that of British trade as a whole, and hence research must be regarded as a national rather than as an individual matter. While admitting the necessity for, and the value of, the research work done by big firms along the lines of their special activities, Sir Robert Hadfield pointed out that there are also a number of questions affecting whole industries the solution of which can be obtained only by the co-operation of many workers investigating special branches of the subject. In these cases everything is to be gained by carrying on the work of research in combination and making its results available to the whole of the organised industry. This is what the Department of Scientific and Industrial Research enables to be better accomplished, at any rate in certain trades and lines of work.

THE third annual Silvanus Thompson memorial lecture of the Röntgen Society will be delivered by Prof. W. H. Bragg in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, at 8 o'clock on Tuesday, March 2. The subject will be "Analysis by X-rays." Admission will be free.

PROF. A. DEPAGE (University of Brussels), Drs. Pierre Duval and A. Gosset (Paris), Prof. J. M. T. Finney (Johns Hopkins University), and Dr. Charles H. Mayo (Rochester, U.S.A.) have been elected honorary fellows of the Royal College of Surgeons of England.

At the recent annual general meeting of the Optical Society Mr. R. S. Whipple was elected to the presidency; Prof. F. J. Cheshire, Sir Herbert Jackson, and Mr. H. F. Purser were elected vice-presidents; Mr. I. G. Aitchison, hon. treasurer; Mr. J. H. Sutcliffe, hon. librarian; and Messrs. W. Shackleton and L. C. Martin, hon. secretaries.

The following officers and council of the Malacological Society of London for 1920 were elected at the annual meeting on February 13:—*President:* G. K. Gude. *Vice-Presidents:* H. O. N. Shaw, T. Iredale, J. R. le B. Tomlin, and A. S. Kennard. *Treasurer:* R. Bullen Newton. *Editor:* B. B. Woodward. *Secretary:* A. E. Salisbury. *Other Members of Council:* A. Reynell, C. Oldham, Major M. Connolly, H. Woods, the Rev. A. H. Cooke, and H. H. Bloomer.

The following officers and members of council of the Royal Astronomical Society were elected at the anniversary meeting on February 13:— *President:* Prof. A. Fowler. *Vice-Presidents:* Sir F. W. Dyson, Prof. A. S. Eddington, Major P. A. MacMahon, and Prof. H. F. Newall. *Treasurer:* Mr. E. B. Knobel. *Secretaries:* Dr. A. C. D. Crommelin and the Rev. T. E. R. Phillips. *Foreign Secretary:* Prof. H. H. Turner. *Council:* Prof. A. E. Conrady, Dr. J. L. E. Dreyer, Dr. J. W. L. Glaisher, Mr. J. Jackson, Dr. Harold Jeffreys, Mr. H. S. Jones, Prof. F. A. Lindemann, Mr. E. W. Maunder, Dr. W. H. Maw, Prof. J. W. Nicholson, Mr. J. H. Reynolds, and Lt.-Col. F. J. M. Stratton.

The war memorial of the Institution of Mining and Metallurgy is to be a sculptured figure, to be placed in the house of the institution, and a record of those who served in his Majesty's Forces. The full scope of the memorial cannot be decided until the council knows the extent of the response to an appeal now being made, but it is hoped that a fund of about 4000*l.* may be available. A member of the institution, Lt.-Col. Peter N. Nissen, has prepared a design for the figure, which has been accepted, as has also his offer to model the figure and friezes. These will be executed in bronze and the pedestal-base in malachite, with four silver-alloy plates upon which an appropriate inscription and the roll of honour will be engraved. This work is already in progress. Members of the institution and others interested in the mining industry are invited to contribute to the war memorial fund. Subscriptions should be sent to the secretary of the institution, 1 Finsbury Circus, London, E.C.2.

The report printed in Nature of January 8, presented by the Joint Committee of the British Medical Association and the British Science Guild, regarding awards for medical discovery is published in the Journal of the British Science Guild for January. Advances in medical treatment of great value to humanity frequently convey no additional remuneration to the discoverers, and may even involve monetary loss, and it is suggested that rewards should suffice to meet this latter contingency. The principle was accepted by Parliament in the case of Jenner in 1802 and 1807, but the 60,000*l.* annually disbursed by the Government under the Medical Research Committee subsidises only investigations in progress, and not discoveries already made. Honours, medals, and prizes bestowed by H.M. the King or public bodies are acts of grace falling outside the consideration of the committee, which deals with pecuniary reward. It is accordingly recommended that Parliament should provide an annual sum of not less than 20,000*l.*, enabling pensions amounting to between 500*l.* and 1000*l.* a year to be awarded as compensation for losses incurred in achieving medical discoveries.

The annual general meeting of the Institute of Metals will be held in the building of the Institution of Mechanical Engineers, Westminster, on Thursday and Friday, March 11 and 12, under the presidency of Prof. H. C. H. Carpenter. The president-designate is Engineer Vice-Admiral Sir George Goodwin, K.C.B. The following are among the communications to be submitted:—Fifth Report to the Corrosion Research Committee, Dr. G. D. Bengough, R. M. Jones, and Ruth Pirret; The Action on Aluminium of Hard Industrial Waters, Dr. R. Seligman and Percy Williams; Zinc Alloys with Aluminium and Copper, Dr. W. Rosenhain, J. L. Haughton, and Kathleen Bingham; Tin-Phosphorus Alloys, A. C. Vivian; Effect of Hydrogen on Copper, W. C. Hothersall and E. L. Rhead; Influence of Cold Rolling on the Physical Properties of Copper, F. Johnson; Study of Thermal Electromotive Force as an Aid to the Investigation of the Constitution of Alloy Systems, J. L. Haughton; and Idiomorphic Crystals of Electro-deposited Copper, W. E. Hughes. On June 10 (not on May 5, as previously announced) Prof. Carl A. F. Benedicks, of Stockholm, Sweden, will deliver the tenth May lecture, his subject being "Recent Progress in Thermo-electricity."

By the death of Dr. Vincent Arthur Smith at Oxford on February 6 India has lost an eminent historian, archæologist, and numismatist. Born in Dublin in 1848, Dr. Smith was educated at Trinity College in that city, and passed thence into the Bengal Civil Service in 1871, being posted to the United Provinces of Agra and Oudh. He served in this Province until 1900, passing through all the grades of the Service, his last appointments being those of Magistrate-Collector, District Judge, Commissioner, and Secretary to Government. During his service he paid much attention to the local history, archæology, and numismatics, and contributed numerous papers on these subjects to the Journal of the Asiatic Society of Bengal and to the *Indian Antiquary*. On his retirement he devoted his life to historical literature, and wrote a series of valuable works. In "The Early History of India" Dr. Smith for the first time evoked order from chaos, and established the chronology, hitherto uncertain, on a firm basis. This was followed by "The History of Fine Art in India and Ceylon," biographies of Asoka, the Buddhist Emperor, and of Akbar, the Great Mogul, and the Oxford "History of India," from the earliest period down to the present day, which appeared only a few months before his death. In numismatics he investigated the series of Gupta coins, and catalogued the collection of Indian coins in the

Calcutta Museum. Dr. Smith leaves many friends, to whom he was always ready to impart his wide stores of learning, and the charm of his personality will be to them a lasting memory.

AN account of the mammals collected in Eastern Cuba during 1917 by Dr. H. E. Anthony appears in the Bulletin of the American Museum of Natural History (vol. xli., art. xx.). Though but a brief preliminary survey of the material collected, this contribution is one of very considerable interest. It forms, indeed, the complement to Dr. Anthony's recent memoir on the indigenous mammals of Porto Rico, living and extinct. Two species of that extinct and extremely primitive insectivore Nesophontes were found, and one of these is new to science. This he has named *Nesophontes longirostris*. The other species, *N. micrus*, bears a close resemblance to *N. edithae* of Porto Rico. Of the Hutias (Capromys), which occur also in Jamaica and Porto Rico, two species were obtained, and several species of bats. All the remains found were from caves, and it would seem that they were deposited in the form of "castings" from the barn-owl. This is a point of some interest, since it helps to explain the great accumulations of small mammal bones found in similar situations in other parts of the world.

THE Archives of the Cambridge Forestry Association for 1919 is a brief pamphlet recording the progress of this society since its foundation in October last. The members are mainly past and present students of the School of Forestry, who meet together to promote research and to render assistance in various ways to this important teaching centre. The secretary invites contributions of apparatus, specimens, books, and periodicals to the museum, which is worthy of support, as it already contains a remarkably fine collection of foreign and home timbers, as well as many instructive objects and photographs, illustrating the uses of wood and the diseases, defects, and abnormalities of trees. The income of the school is very meagre, amounting in 1919 to only 576*l.* 13*s.*, a sum insufficient to pay salaries and incidental expenses, there being an actual deficit of 123*l.* 1*s.* 4*d.* From this it is evident that there are no funds available for the purchase of apparatus or specimens. The lists of desiderata and of recent additions to the collection given in the pamphlet ought to stimulate donations to the School of Forestry at Cambridge. The other contents consist chiefly of short notes on various objects in the museum, with an account at some length of experiments on the swelling and shrinkage of wood which have been carried out recently by Mr. Herbert Stone. Forestry has lately attracted a great number of students to the universities where the subject is taught, and societies similar to that at Cambridge have been founded during the past year also at Oxford and Edinburgh.

THE folding and faulting that characterise the Rocky Mountain belt in Alberta are well shown in the small coloured sections accompanying Memoir 112 of the Geological Survey of Canada (1919) by Mr. J. S. Stewart. The contrast between the region uplifted in Early Eocene times by the "Laramide revolution" and the level or undulating Cretaceous strata to the east is as marked as that between the Juras and the Paris basin. The Oligocene beds in this eastern region represent the river-outwash from the Laramide surface of denudation, and subaerial action in succeeding ages has dissected the country to depths of 2000 ft.

DR. CHARLES SCHUCHERT (Bull. Geol. Soc. America, vol. xxix., p. 245, 1918) reviews the stratigraphical position of the American Morrison and the East African Tendaguru formations, which are rich in Dinosaurs. He retains the former in the Jurassic, while suggesting a break in the latter, the lower Dinosaur zone in East Africa being Early Jurassic, and the two main later zones bridging the time from Jurassic to Cretaceous. The discovery of great sauropod Dinosaurs in the south of the late German colony in East Africa dates only from Fraas's work in 1907, and the importance of the deposits is greatly enhanced by the evidence as to age given by the intercalation of strata with marine molluscs. A recent communication to Dr. Schuchert from Prof. Branca in Berlin is mentioned, and may be welcomed as one of the signs of a *rapprochement* between scientific workers.

BULLETIN 688 of the United States Geological Survey, on "The Oilfields of Allen County, Kentucky," contains a neat little coloured geological map on the scale of 1/1,000,000 of a very much wider and a very interesting area of oil-producing country in Kentucky and Tennessee, west of the Alleghany range. The folded strata of the great range are included at the south-east angle. The authors, Messrs. Shaw and Mather, describe the occurrences of what are known as oil "sands"—that is, oil accumulations in a variety of rocks in strata of Silurian, Devonian, and Carboniferous age—and believe the original source to have been mainly decaying vegetation. The country dealt with in detail is mainly a gently undulating plainland, with lakelets in sink-holes caused by the solution of the underlying St. Louis limestone, an important stratum of Lower Carboniferous age. The prospector, whose zeal for the discovery of anticlines is now known even on the Stock Exchange, is warned of the occurrence of "pseudo-anticlines" (which, by the way, are true anticlines for the geologist), due to local features of surface-slip and solution.

THERE is something fascinating in looking across the Hudson from the higher platforms of New York City, and seeing in the uplands of New Jersey the foothills of a country that "needs no embellishment, for in the woods, the streams, the waterfalls, and mountain outlooks Nature has provided the best." We quote from the Report of the Department of Conservation and Development of New Jersey for 1918 (published 1919), which presents a model record of local government and local watchfulness. The director, Mr. Alfred Gaskill, may well be proud of his Department, which has, perhaps, its nearest counterpart in our islands in the Department of Agriculture and Technical Instruction for Ireland. One of Mr. Gaskill's Boards proposes the reservation of a mountain-park, where summer camps and children's playgrounds can flourish along thirty-six miles of practically uninhabited country; the geological division conducts soil surveys in lands where profitable patches require indication; it also presides over matters of water-supply, and, curiously enough, over the State Museum, with its permanent and loan educational collections; and the forestry division furnishes admirable illustrations of trees in relation to highways, and of the necessity for maintaining its reserves. It is characteristic, and due to climatic conditions, that the Fire Warden's report should be a considerable feature in this attractive little volume. The use of glauconitic marl as a source of potash is now in the hands of the Spilsbury Engineering Co., of New York, which proposes to produce 100 tons a day of a chemical extract the nature of which is not specified.

From Freiburg-im-Breisgau, the picturesque Rhine town that so often suffered in return for the savagery of German air-raids, there comes once more the *Berichte* of the local *naturforschende Gesellschaft* (Bd. xxii., Heft 1, 1919), which in happier years maintained our scientific knowledge of the Rhinelands. This part is devoted to a fourfold disquisition ("Vier Kapitel") by Prof. W. Deecke on petrographic subjects, the first section being on "Konglomeratbildung." A number of points commonly overlooked in teaching are shrewdly emphasised, such as the necessity for a hollow of erosion or of sinking for the accumulation of a big pebbly mass, and for some form of almost contemporaneous cementation if the conglomerate is ultimately to be preserved. In the section on the "Diagenesis" of sediments Prof. Deecke points out that under varying conditions subaqueous sediments are preserved from remote ages as loose material (the sands with bucklered ganoids of Dorpat are an instance), or as consolidated and resisting rocks. The influence of heat and pressure on gels in the interstices between the grains leads to firm cementation, as when iron hydrates pass into magnetite, and garnet develops from calcium carbonate, quartz, and kaolin by removal of water from the mixture. Next, the mystic words of Suess, "Sal" and "Sima," are critically discussed; the author remarks that there is a "good form" even among geologists (do we not know it in university circles?), which maintains the use of such terms beyond their true importance. Dr. Holtedahl's essay on these magmas was referred to in Nature of January 29, p. 574. Lastly, we have an excellent review of fossil reef-formation, in which the tendency of similar conditions to produce similar groupings of animal types is excellently impressed upon us.

English mining engineers may be interested to find that the flotation process is beginning to attract attention in France, as is shown by a lengthy article on the subject in the *Revue générale des Sciences* for January 15, though it must be admitted that the information therein given is far from being either up-to-date or quite trustworthy. It seems curious that so recent an article should make no mention of Sulman's important contribution to the theory of flotation read before a meeting of the Institution of Mining and Metallurgy in November last, the French author being apparently quite unaware of it. It is strange to read two months after the publication of so exhaustive a treatment of the subject that "the time still appears far distant when a theory capable of explaining the observed phenomena can be established." Whilst his knowledge of the theory of the process is thus defective, the author of the article in question commits not a few errors in regard to its technology. It is scarcely correct to say that flotation is applicable only to ores carrying sulphides, and English readers will be interested to learn that the Murex process is stated to have been devised by an inventor of that name!

The Canadian Department of Mines has issued the statistics of the mineral production of Canada for 1918 in two reports, one devoted to coal and coke, the other to the metals. The former is, perhaps, the more interesting in view of the immense importance to the whole world of coal output at the present moment. It is pointed out that the term "coal production" is used in a perfectly definite sense, namely, the total of coal sold *plus* coal used by the producers, and this must not be lost sight of in comparing Canadian production with that of other countries, *e.g.* Britain, which latter includes coal lost or unsaleable and coal put into stock. The Canadian production was 13,373,148 statute tons, as compared with 12,541,749 tons in 1917; there were employed 25,419 men, whose average earnings for the year were 1294 dollars (or 270*l.* at par), equal to 2.46 dollars or 10*s.* 3*d.* per ton. It should be specially noted that the output per man was 526 tons for the year—a figure that contrasts most favourably with the British figures. The colliery consumption and coal supplied to workmen amounted to 9·6 per cent. of the production. Of the more important metals, the copper production was 118,769,434 lb., the highest ever attained; the production of lead was 51,398,002 lb., the highest since 1906; of nickel, 92,507,293 lb., the highest ever recorded; the silver production was 21,383,979 oz., a falling-off of 3·7 per cent. as compared with 1917; and the gold production was 699,681 oz., or 5·3 per cent. below that of 1917.

Mauritius meteorological, magnetical, and seismological records are issued in the monthly and annual reports of the Royal Alfred Observatory, under the directorship of Mr. A. Walter. The annual report for 1918 and the monthly reports to August, 1919, have been received. Continuous photographic registration is made of atmospheric pressure, temperature of the air and evaporation, and automatic registration of direction and velocity of wind, of rainfall, and of bright sunshine. The photographic registrations have been checked at regular intervals by eye observations, and daily observations are made of terrestrial radiation and of thermometers ranging from 3 in. to 118 in. below the surface soil. Monthly, quarterly, and yearly departures from the normal are given for the several elements. In 1918 the temperature of the air was below the normal in all months except December. The defect was marked in July, August, and September. During 1918 a daily journal of the weather over the Indian Ocean was kept by means of observations obtained from ships' log-books. The logs of sixty voyages were copied. So far as is known, there were five cyclones in the South Indian Ocean during the year 1918. The daily records of observations published each month are of considerable value in adding to our knowledge of the physics of the globe. Epochs of diurnal range are regularly shown by the several instruments. The velocity of the wind at the Mauritius Observatory is seen to increase very regularly at the midday hours and to fall off during the night, the range frequently being shown even on days when the normal trade winds are interrupted. The seismograms record sixty-seven earthquakes during 1918.

THE January number of the "Abstracts of Papers" issued by the Institution of Civil Engineers contains 235 pages, twelve of which are devoted to name and subject indexes. The abstracts, of which there are 387, are classified under the six heads: Measurement, Materials, Structures, Distribution of Energy, Appliances, and Specialised Practice. Each head is, as a rule, subdivided into sections. It is impossible to read through the abstracts without realising the importance to the future of the engineering profession in this country of a knowledge of the progress which is taking place in the practice of engineering throughout the world. From the number of abstracts devoted to it, the question of fuel economy appears to have been taken up with vigour in America and in Germany. In the former country the use and advantages of pulverised low-grade coal have been investigated, and it appears that 75 to 80 per cent. efficiencies can be obtained with it in boilers of all sizes. In Germany the utilisation of the waste heat from iron and steel furnaces to generate steam in boilers is being strongly advocated as the best form of economy.

THE reviewer of part i. of "The *Daily Telegraph* Victory Atlas of the World," in NATURE of November 13, 1919, remarked, towards the end of a favourable notice: "The changes due to the Peace Treaty are incorporated, but a mistake is made in the area of the Slesvig plebiscite." The publishers of the map, Messrs. Geographia, Ltd., wrote at the time to say that the boundary shown on their map was correct. The reviewer's comment, as stated in our issue of December 25, p. 419, was based upon the abstract of the Treaty of Versailles, and the recent publication of the Treaty has enabled him to compare its wording with the large-scale map of Slesvig. He now writes to acknowledge the correctness of Messrs. Geographia's map in this respect, and to apologise for his mistake. We on our part much regret that, on a point of fact, a review in our columns should have contained a statement which now proves to be in error, and that, in consequence, the accuracy of a particular frontier line on Messrs. Geographia's production was wrongly questioned.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press "The Theory of Direct-current Dynamos and Motors: A Text-book for University Students of Electrical Engineering," by J. Case, which has been written to fill the gap between books of general electrical engineering and the specialised ones dealing with designs. The aim has been to furnish the student with a fairly comprehensive study of the principles and theories underlying the design of direct-current dynamos and motors, and the work will contain many worked examples; also exercises for the student. The notation adopted is that of the International Electrotechnical Commission.

MR. C. BAKER's classified list (No. 68) of second-hand scientific instruments includes in one of its sections a number of microscopes and accessories which should be of particular interest at the present time to students and other workers. There are also sections on surveying and astronomical instruments, spectroscopes and projection apparatus, and other instruments.

MR. L. T. HOGBEN wishes to direct attention to an omission in the abstract of his Royal Society paper, "Studies in Synapsis," i., reprinted in NATURE of February 12 (p. 649). He does not conclude that abortive spindles characterise the Hymenoptera in general, but only the Hymenoptera parasitica.

OUR ASTRONOMICAL COLUMN.

MERCURY AS AN EVENING STAR.—This planet will reach its greatest easterly elongation (18° 11′) on March 3, and set at about that date rather more than an hour and three-quarters after the sun. This will be the most favourable period of the year for viewing Mercury in the evenings. The intending observer should look towards the east-by-south region of the horizon, and when the atmosphere is clear the planet will be seen about an hour after sunset at a low altitude. It will set on February 26 at 7.5 p.m., on March 4 at 7.31 p.m., and on March 11 at 7.23 p.m.

CENTENARY OF THE ROYAL ASTRONOMICAL SOCIETY.—At the annual general meeting of this society held on February 13, the president, Prof. A. Fowler, gave an address on the foundation of the society just a century before. The four men who were most influential in its formation were the Rev. William Pearson, Mr. Francis Baily, Sir John F. W. Herschel, and Mr. Charles Babbage. The two latter both lived until 1871, and there are no fewer than fifteen surviving fellows whose fellowships overlapped with theirs. One of these, Mr. Inwards, said that he remembered speaking to Sir John Herschel at a meeting of the society. There was at first a good deal of opposition to the new society on the part of the Royal Society, and the Duke of Somerset, who was elected the first president, quickly resigned this office owing to the pressure brought to bear upon him. He was succeeded after an interval by Sir William Herschel, who was then eighty-two years of age, and died in 1822. Mr. Stephen Groombridge, well known for his Star Catalogue, was another of the original members. They were not called fellows until 1830, when the Royal Charter was granted, giving the society its present title; it was previously called the London Astronomical Society. The earliest publications of the Society were in the form of memoirs; the Monthly Notices did not commence until several years later, and were at first only small pamphlets containing ephemerides of comets and other matters of transient interest.

IS VENUS CLOUD-COVERED?—Mr. Evershed has taken many photographs of the spectrum of Venus in recent years, for the purpose (*inter alia*) of endeavouring to detect the Einstein shift, and of testing his own hypothesis that the earth has an effect on the atmospheric circulation of the sun. In the course of this work he found, to his surprise, that a much longer exposure-time was needed than was the case in photographing the spectrum of a cumulus cloud on which the sun was shining (Monthly Notices R.A.S., November). Mr. Evershed expected the time to be shorter, for the intensity of sunlight on Venus is 1·92 times as great as on the earth. Allowing for the absorption of Venus's atmosphere, he concludes that if Venus were covered with clouds similar to our cumulus clouds, the exposure-time would be less on the former than on the latter in the ratio of 1 to 1·3, whereas the contrary is the case. He concludes that the atmosphere of Venus is not cloud-laden, but that its lower strata contain much dust in suspension, veiling the surface features. This conclusion is similar to that reached by Prof. Lowell from his observations at Flagstaff.

Mr. Evershed thinks that the values of the colour-indices assigned by Prof. H. N. Russell to the sun and Venus (+0·79m. and +0·78m.) are mutually inconsistent, since they imply that no selective absorption takes place in Venus's atmosphere. Mr. Evershed finds evidence of decided selective absorption in the violet, as compared with his cloud spectra.

PROFESSIONAL METEOROLOGY.

SIX parts of the new Professional Notes of the Meteorological Office have now been issued. The first[1] deals with the relation between cloud and wind direction at Richmond, and gives tables for each month for 10h., 16h., and 22h. for fifteen years, showing the number of times each cloud amount was associated with each wind direction or with calms; it would perhaps have been clearer if percentage values had been given. Several important points come out, such as the well-known tendency of cloud to disperse at night, but it is also shown that this tendency is not the same for all winds or for all seasons. Cloud forecasting became important during the war, and will in future be of wide application; it is to be hoped, therefore, that Lieut. (now Capt.) Brunt will fulfil his intention of continuing this research. Tables also give values for Greenwich for January and July, and various differences from Richmond are apparent; Richmond had only 59 calms in 180 months, while Greenwich had 58 in 20 months, which indicates, perhaps, a difference in estimating light winds. Greenwich had more south-west and fewer south and north-west winds than Richmond, due probably to local exposure.

It would be more satisfactory to compare cloud amount with wind at cloud-level or with gradient direction, for Mr. Newnham's paper[2] on a night valley wind shows that surface winds may be shallow and more or less unrelated to upper-air phenomena. Cold air flows down valleys at night in radiation weather, and if, at so open a station as Benson, the wind at night sometimes blows "very steadily from east-by-south to east-south-east regardless of what the direction had been during the previous day," the need for caution in dealing with surface winds is obvious. But in the case of fog it is the surface wind that is of importance, as appears in Mr. Brooks's paper[3] on the fog in London on January 31, 1918, when the incidence of the fog seems to have been influenced by "shallow streams of cold air flowing down the sides of hills." The isobaric maps in this paper show a bend in the isobars over the Thames estuary which Mr. Brooks thinks is real, but possibly exaggerated "by slight inaccuracies in some of the barometer readings." Those who draw isobars know how peculiar are some of the readings, and would welcome a future Professional Note on these peculiarities.

A vast amount of information was obtained during the war on upper-air temperatures and winds, and it would be a real loss to meteorology if this were unused or lost. Lieut. Stacey and Capt. Chapman are therefore to be congratulated on having made use of some of these records. Lieut. Stacey[4] deals with upper-air temperatures at Martlesham Heath from February, 1917, to January, 1918, and sets out the information clearly on the whole, though several misprints are noticeable. Unfortunately, "no information is to hand of the type and exposure of the instruments used," which is to be regretted, especially as one would suppose such information could have been obtained; as a matter of fact, the thermometers were exposed on the wing-struts of the aeroplanes, but the type of thermometer varied from time to time, and therefore the early records are probably not strictly comparable with the late ones; but these facts are not recorded in the paper. It is very desirable that all details of meteorological war-work should be collected before it is too late to obtain them.

Capt. Chapman[5] reviews formulæ connecting increase of wind velocity with height. Many of the early ones were linear, but linear formulæ are unlikely, and were probably only intended as working guides until more observations were available. From a consideration of many observations, including 190 in north-eastern France, the author deduces the formula $V = a \log H + b$ (where V is the wind velocity, H the height, and a and b are constants), which fits most of the observations below the height at which the mean gradient velocity is reached. The whole paper deserves careful study. In another publication[6] Capt. Chapman discusses the normal curve of errors in connection with what meteorological observations should be classified as unusual or exceptional.

Meteorology has advanced rapidly in recent years, and these publications, and others, show that the advance in this country is due largely to the Meteorological Office, and it is to be hoped that its future activities may not be hampered by the proverbially unscientific attitude of Government Departments.

[1] "On the Inter-relation of Wind Direction and Cloud Amount at Richmond." By Lieut. David Brunt. (Meteorological Office, 1918.) Price 3*d*.

[2] "Notes on Examples of Katabatic Wind in the Valley of the Upper Thames at the Aerological Observatory of the Meteorological Office at Benson, Oxon." By E. V. Newnham. (Meteorological Office, 1918.) Price 3*d*.

[3] "Incidence of Fog in London on January 31, 1918." By C. E. P. Brooks. (Meteorological Office, 1918.) Price 3*d*.

[4] "Upper-Air Temperatures at Martlesham Heath, February, 1917, to January, 1918." By Lieut. W. F. Stacey. (Meteorological Office, 1919.) Price 1*s*.

[5] "The Variation of Wind Velocity with Height." By Capt. E. H. Chapman. (Meteorological Office, 1919.) Price 1*s*.

[6] "On the Use of the Normal Curve of Errors in Classifying Observations in Meteorology." By Capt. E. H. Chapman. (Meteorological Office, 1919. Price 6*d*.

STEAM BOILERS AND ECONOMISERS.

AS chief engineer of the Manchester Steam Users' Association Mr. C. E. Stromeyer prepares a yearly memorandum. The memorandum for the year 1918–19 deals with fuel economy and with economiser and furnace collapses. Some industries require much power and little steam for heating and boiling; others much steam and little power. If two such industries could combine, the cost of 1 h.p. could be reduced from, say, 2 lb. of coal to $\frac{1}{3}$ lb. If, for instance, a spinning mill consumes 20 tons of coal for power alone, and a sugar factory an equal quantity of coal for boiling purposes, some means ought surely to be found to bring them together, and thus satisfy both demands with a consumption of 23 tons instead of 40 tons.

In discussing the question of the safety of cast-iron economisers, Mr. Stromeyer gives a summary of all the economiser explosions—seventeen in number—reported upon by the Board of Trade since 1882. Only nine of these explosions were destructive, but, unfortunately, none of the inquiries into these mishaps have revealed their true causes. If the Board of Trade inquiries into boiler explosions are to be of value, they ought to be conducted in such a manner that the study of the reports may be of service to engineers who have to design and use the appliances. It would appear, however, that the object which Mr. Stromeyer's association had in view in drawing up the Boiler Explosions Act, 1882, has been entirely lost sight of. It was intended that every explosion should be investigated by an expert, but it was found necessary, in order to get the Bill through Parliament, to add one competent lawyer to the engineering experts. The lawyer has always been made president of the commission, with results which may be imagined. Further, there are probably very few "competent and independent engineers" who are, as required by the Act, "practically conversant with the manufacture and working of boilers," since few engineers pass through the boiler-shop, and fewer still have had to work them. But the Board of Trade has no hesitation in appointing men to make these inquiries who have never even seen the objects which they have to investigate. At a recent inquiry two investigators, both marine engineers, confessed that they knew nothing about land economisers, neither their design, material, manufacture, nor mode of working. As the Board uses a rota, the chances are that these engineers will never again be called upon to inquire into an economiser explosion, despite the knowledge they doubtless gained in the course of the inquiry. In these circumstances it is but natural that many preliminary reports, and nearly all Commissioners' reports, dismiss the cause of explosions with a non-committal remark to the effect that "the boiler burst because it could not withstand the steam pressure."

Mr. Stromeyer suggests, and we strongly support the suggestion, that the duty of investigating boiler explosions should be entrusted to an enthusiastic engineer, who would certainly go into details, and make experiments on the strengths of materials, especially upon the parts of burst boilers, which is scarcely ever done at present; he would also take steps to become acquainted with the influences of working conditions.

The memorandum contains ample evidence, extracted from Board of Trade reports, to justify Mr. Stromeyer's remarks. For example, Report No. 2470, on an economiser explosion, omits to mention certain old fractures. The two "competent and independent engineers" (selected by the Board from among its own staff), together with other engineers, refused in their evidence to admit that an open damper could have caused the failure of any of the pipes, and attributed the explosion to the old fractures. By withholding this information the report deprives the engineering profession of the means of studying the problem of economiser safety.

The fact appears to be that the investigations are carried out by the solicitor of the Board of Trade, who brings forward sworn evidence, though the swearing is not required by the Act, and without any warning to the witnesses, these may now be cross-examined both by their own side and by the Commissioner, and then very often their own sworn evidence is used against them. It is unfair to witnesses who wish to give the Commissioners every assistance, and as the whole atmosphere is now a legal one (even a Lord Advocate once appeared for an insurance company) the technical causes of explosions are scarcely inquired into.

THE BELGIAN ROYAL OBSERVATORY.

IT is pleasant to see that the Brussels Observatory is in a position to resume the publication of its memoirs (Annals of the Belgian Royal Observatory, vol. xiv., part 2). After a discussion of the division errors of the Repsold meridian circle, Prof. Stroobant contributes an interesting essay on the constitution of the ring of minor planets. Tables and diagrams are given of the distribution of the various elements; the striking grouping of the perihelia towards Jupiter's perihelion is already well known, and Newcomb gave an explanation of it from theory. The eccentricities show a similar grouping, high eccentricities being most frequent in the quadrants where the perihelia congregate; this can also be explained by the action of Jupiter. The formulæ expressing the perihelion density (N is the number of perihelia in an arc of 30°) and the eccentricity are:

$$N = 66{\cdot}75 - 31{\cdot}7 \sin (\varpi - 106{\cdot}7^\circ)$$
$$e = 0{\cdot}141 - 0{\cdot}028 \sin (\varpi - 86{\cdot}5^\circ).$$

The ascending nodes show a slight tendency to group towards Jupiter's ascending node; it would probably be easier to study the relations of nodes and inclinations if the elements were referred to the plane of Jupiter's orbit rather than to the ecliptic.

There is an interesting study of the probable total number of asteroids brighter than magnitude 20. From some very faint asteroids discovered by photography at the Lick Observatory, combined with the area of sky covered by the plates, the total 57,000 is obtained. From a study of the number of known planets of different magnitudes the empirical law is deduced that the number per magnitude doubles for a fall of one magnitude. On this basis the total number brighter than magnitude 20 is 100,000. The two estimates are in satisfactory accordance, bearing in mind the large measure of extrapolation employed in each method.

It is estimated that very few asteroids (say twenty) brighter than the 12th mag. at opposition remain to be discovered.

Taking the mean albedo as 0·108 (midway between those of Mercury and Mars) and the density the same as the moon's, the total mass is 1/22 of that of the moon, the planets brighter than magnitude 10 contributing one-third of this total, and those between magnitudes 10 and 11 another one-third.

The third memoir in the volume is on the brightness, colour, position, and parallax of Nova Aquilæ; a large-scale light curve is given extending from 1918 June 10 to November 23. From the end of June until the middle of August there were fairly regular oscillations in the curve, the period being thirteen days. Prof. Stroobant notes two cases of apparent rapid change of light. On August 29 the brightness increased 0·7 mag. in twelve minutes; on October 6 it fell 0·3 mag. in five minutes. Changes like this need verification from more than one station to make sure that they are not due to a local variation in the transparency of the air.

The position and parallax were obtained by observations with the meridian circle. Screens of muslin were placed over the object glass for the brighter stars. The thickest screen reduces the light by

3·2 mag. Two determinations of the parallax are given:

(1) 0·20″ ± 0·05″ M. Philippot.
(2) 0·06″ ± 0·07″ M. Delporte.

Both determinations appear to be improbably large, judging by the small proper motion and the values obtained for other novæ.

A. C. D. CROMMELIN.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE.[1]

THE issue of the thirty-third annual report of the Liverpool Marine Biology Committee, and, as we are informed, the last of the series, is an opportune moment for the publication of a review of the important work that has been done since the formation of the committee in 1885. This report is not the swan-song of a dying enterprise, but rather the triumphant cry of those who have achieved an initial victory that gives hope for a rapid and continuous advance in the future; and, although the old L.M.B.C. ceases to exist, there is every reason to believe that its work will be carried on with increased efficiency by the newly organised staff of the oceanography department of the University of Liverpool.

In the short history of the work of the committee that is published in this report it is clear that a very substantial contribution has been made to our knowledge of the species of animals and plants that inhabit the waters of the Irish Sea, and that valuable information has also been acquired about the many characters of the sea-bottom round the Isle of Man and the north coast of Wales.

All this is necessary pioneer work, although much of it may seem dull and uninteresting when in print. The workmen must learn the use of their tools before undertaking the more serious work of production. But we see in the L.M.B.C. memoirs, of which twenty-three have already been published, in the important investigation of Prof. Herdman and his colleagues on the fluctuations of the plankton, and in the biochemical researches of Prof. Moore and others, that these valuable contributions to our scientific knowledge of the sea have outgrown the "Records" of the early years of the life of the committee.

The work of recording and describing the booty of the sea must, of course, continue; but with the ripe experience of thirty-three years, with the more complete equipment of laboratory space and apparatus, and with the new organisation of the oceanography department of the University, we may confidently look forward to further important developments in the general scientific work of the Port Erin institution.

We may tender to Prof. Herdman our cordial congratulations on his achievements in the past and our good wishes for the full success in the future of the great enterprise which is so largely due to his own personal genius and enthusiasm.

S. J. H.

APPLICATIONS OF INTERFEROMETRY.

IN a report by Prof. Carl Barus, of Brown University, recently published by the Carnegie Institution of Washington, a number of interesting applications of achromatic interferometry are described. In the first chapter a method of measuring small angles is discussed. The general theory of the subject is developed at some length, and a variety of interferometer devices, with mirror, ocular, and collimator micrometers, are instanced. As the achromatic fringes cannot (in general) be found without first finding the corresponding spectrum fringes, the second chapter is devoted to spectrum fringes. The work described in the third chapter was undertaken at the request of Prof. W. G. Cady, in the endeavour to obtain the elastic constants of small bodies. The application of the displacement method proved astonishingly easy in a case where a degree of rough handling is inevitable, but it was found that there lurked in the elastic apparatus some discrepancies, both of viscosity and hysteresis, the nature of which escaped detection after many attempts to locate its origin. The fourth chapter contains applications of the rectangular interferometer using achromatic fringes to the study of gravitation. A method for the determination of the Newtonian constant is worked out. Again, the same interferometer is associated with the horizontal pendulum for the detection of small changes in the inclination of the earth's surface. Series of observations extending between January and August are recorded. In the fifth and last chapter the author deals with the application of interferometers to the study of vibrating systems. To test the method, an examination is made of the vibration of telephonic apparatus. Interference-vibration curves have been obtained for two identical telephonic systems joined directly in series, while these forms subsided completely when the telephones were joined differentially.

[1] The Marine Biological Station at Port Erin. Thirty-third Annual Report of the Liverpool Marine Biology Committee. Drawn up by Prof. W. A. Herdman. Pp. 84. (Liverpool: C. Tingling and Co., 1919.)

RESEARCHES AT HIGH TEMPERATURES AND PRESSURES.

BY THE HON. SIR CHARLES A. PARSONS, K.C.B., F.R.S.[1]

I.

JUST ten years ago in this room Sir Richard Threlfall discussed the effects of temperature and pressure on various substances, and commenced by referring to a suggestion I made in 1904 to sink a bore-hole twelve miles deep in the earth with the object of exploring the region beneath us, about which so little is known. Last summer at Bournemouth I ventured again to direct attention to the desirability of such an exploration in the interests of science generally, and to the possibility that it might ultimately lead to some developments of practical importance and utility.

Ten years ago no experiments had been made on the behaviour of rocks under the conditions existing at great depths below the surface of the ground; but, prompted by my suggestion in 1904, and after some subsequent correspondence in regard to the possibility of the rock crushing in and closing the shaft, Prof. Frank D. Adams, of McGill University, Montreal, commenced experiments on the strength of rocks to resist the closing up of cavities under the conditions prevailing at great depths below the surface. He published the account of these experiments in the *Journal of Geology* for February, 1912.

Adams's method was to place a block of granite or limestone in a tightly fitting cylinder of nickel-steel, which was shrunk lightly around the block to ensure perfect fitting and support; hard steel rams actuated by a hydraulic press were arranged to exert a known pressure against the ends of the block. Two small holes were previously drilled in the specimen, one axial in the centre and one transverse, the diameter of the holes being 0·05 in., or one-tenth the diameter of the specimen. The temperature of the container and specimen was maintained at any desired point up to the softening point of steel. In some experiments no heat was applied, while in others the temperature

[1] Discourse delivered at the Royal Institution on Friday, January 23.

was raised to that estimated to exist at the depth below the surface of the earth corresponding to this pressure.

When no heat was applied the holes in the granite showed no alteration under a pressure equivalent to thirty miles deep, and in the case of limestone the specimen supported one-half of this pressure without alteration. Adams then raised the temperature of the container and specimen. When granite was heated to 550° C., a temperature corresponding to eleven miles below the surface, it stood a pressure equivalent to fifteen miles, and might have stood more but that the container became weakened by the heat. Limestone begins to decompose at a temperature of 450° C., but even at this temperature it withstood a pressure corresponding to ten miles.

Adams concludes that small cavities in granite will not close in under the conditions of pressure and temperature at eleven miles below the surface, however long a time is allowed to lapse, and that the cavities may persist to much greater depths, but the softening of the steel of the container precluded the carrying of his experiments to still higher temperatures and pressures.

So far as they go, these experiments are reassuring as to the permanence and safety of a pit shaft twelve miles deep sunk through granite, but it would be more satisfactory to experiment on a larger specimen than one only $\frac{1}{2}$ in. in diameter as used by Adams, and to heat the specimen electrically when submerged in graphite while keeping the container cold, the temperature being indicated by a thermo-couple in the specimen. This could be carried out in a nickel-steel container like that shown in Fig. 2.

In this connection P. W. Bridgeman in 1911 submerged a sealed glass tube containing a cavity under an external hydrostatic pressure of 24,000 atmospheres (corresponding to a depth in the earth of fifty-six miles) for three hours, and the cavity showed no change in size or form. It, however, appears that temperature will probably place a limit to the depth that could be reached before the closing in of the shaft commences to occur, for Judd, Milne, and Mallet agree in the view that the deepest origin of earthquakes is between thirty and fifty miles. This would seem to indicate that at greater depths than thirty miles the temperature and pressure are such that changes of form take place by plastic deformation, and not by sudden slips or the formation of faults, which are the chief cause of earthquakes. Again, Oldham states that beyond twenty miles deep seismic waves which are transmitted by compression and distortional vibrations change in character in this respect: that though the compressional waves are only slightly affected in velocity, on the other hand the distortional waves are reduced to one-half their velocity. This would seem to imply that the modulus of elasticity in shear has, at twenty miles depth, owing to the rise of temperature, fallen to one-half, and it seems probable that the rock also is weakening in its resistance to shear; in fact, that the rock is becoming more plastic, and that cavities would probably close up at twenty miles below the surface.

The greatest depth to which a shaft has as yet been sunk is only about $1\frac{1}{3}$ miles. The deepest single-stage shaft on the Rand is that of the Hercules East Rand Proprietary Mine. It is 4500 ft. vertically, and rectangular in section. The deepest shaft in the world is that at Morro Velho, Brazil. The bottom is 6400 ft. vertically below the surface, and it has been sunk, and is worked, in stages, two of which are about 1200 ft. vertical. The deepest shaft designed on the Rand is by the City Deep Co. It is 7000 ft. vertically, is circular of 20 ft. diameter, and is to be worked in two stages of 3500 ft. each. The most rapid sinking record was made at the Crown Mines No. 15 Shaft, where 310 ft. were sunk in a month; the shaft is circular, and of 20 ft. in diameter.

There are several interesting departures from ordinary mining practice necessary. The haulage is arranged in stages of about half a mile, principally in order to economise the weight of rope and also the power for winding. In countries where the atmosphere is dry the sides of the shaft are cooled by sprinkling water upon them, which by evaporation cools the rock. It is, however, possible to augment this effect by artificially drying and cooling the air before passing it down the mine.

When still greater depths of shaft are in contemplation further methods of cooling in addition to these would probably be found necessary; for instance, the carrying of the heat upwards by means of brine circulated in a closed ring formed of steel pipes with a rising and descending column. Though the columns might be carried the whole depth of twelve miles, the hydraulic pressure at the bottom would be about 12 tons per square inch, and entail very costly pipes of great strength to resist the pressure. A cheaper plan would be to work in stages, each ring covering a stage of from two to three miles of the shaft, the heat being transferred from the top of one brine ring to the bottom of the ring above by surface-heat exchangers and refrigerating machinery to neutralise the heat drop on transfer. These may be called heat pumps, and would be driven electrically.

As the depth of the shaft increases, the pressure of the air upon the miners will be about doubled for every three miles, but what is more serious is the increase in temperature of the air itself caused by the adiabatic compression due to gravity, by which it will be raised about 100° F. For these reasons it will be necessary to place airtight partitions across the shaft at every mile or two, and to carry on the ventilation through these by means of a pump to deliver the foul air upwards and an expander to allow the fresh air to descend. These two machines would be linked together, and the difference in their power supplied by an electric motor. (This method has been often used with water, and is equally applicable to air.)

At each partition heat exchangers and refrigerating machinery similar to those used for the brine would be placed. Another and preferable plan would be to place numerous heat exchangers between the ascending columns of air to transfer heat from one to the other. The air would, in this case, not itself act as a conveyor of heat to the surface, for which the brine columns would be depended upon, but it would enable airlocks every three miles to suffice. A further alternative and very simple method would be to convey liquid air from the surface, and allow it to escape at the part of the shaft requiring cooling. It would ensure good ventilation.

When sinking the deeper portions of the shaft, shields would probably be necessary to protect the miners from the splintering of the rock which is caused by the intense compressive stress, which splits off scales from the surface, sometimes with considerable violence.

In 1904 the estimate of the time required to sink twelve miles was eighty years, and was based on the records of that time. With improved machinery and methods the records have been so much lowered that an estimate of thirty years seems now to be reasonable.

Threlfall traced the gradual evolution of the theory of the effects of temperature and pressure on the allotropic forms of various substances. He described his apparatus and experiments designed to melt graphite under high pressure, his inference then being that under pressures up to 100 tons per square inch carbon does not follow the same law as many other substances, and does not crystallise as diamond on cooling.

An interesting discovery was made by Bridgeman in 1911 when studying the compressibility of mercury. He found that it had a remarkable power of penetrating steel containers, a power not possessed by oil or water, which caused them to burst at much lower pressures than when they were charged with oil or water. The phenomenon he attributed to the fact that mercury has the power of dissolving small percentages of iron, and will amalgamate with it when the surfaces are absolutely free from oxide.

In 1912 Bridgeman published his remarkable researches on water under pressures up to 20,000 atmospheres. He found that there are four allotropic forms of ice besides ordinary ice, which are found under various conditions of pressure and temperature with determinate regions of stability. All these forms except ordinary ice are more dense than water; one is remarkable as existing from a temperature of −18° C. under a pressure of 4500 atmospheres up to a temperature of 67° C. under a pressure of 20,000 atmospheres.

Recently a pressure of from 200 to 1000 atmospheres at a temperature between 500° and 700° C. has been applied to compel hydrogen to combine with nitrogen to form ammonia on a great commercial scale, a catalyst being necessary to promote the combination and to establish the equilibrium between the gases and their product. This action is reversible as regards temperature and pressure. On the other hand, iron just molten is an energetic catalyst in the transformation of diamond into graphite, but, contrary to expectations, as we shall see, no amount of pressure that has yet been applied appears to have caused a reversal of this action.

More than thirty years ago, having suitable apparatus at hand, I made a few experiments to try the effect of high pressures and temperatures on carbon, compounds of carbon, and some other substances.

The apparatus consisted of an 80-ton press, under which suitable containers were placed, and a turbo-generator of 24 kilowatts output at 80 volts provided the current. It had been discovered by Cheesborough that the carbon filaments for incandescent lamps became very hard and resilient when heated in a hydrocarbon atmosphere of about 4 mm. absolute pressure, and I was anxious to try what would be the result if a rod of carbon were electrically heated when submerged in a liquid hydrocarbon under high pressure. Benzine, paraffin, treacle, chloride, and bisulphide of carbon were tested under a pressure of 2200 atmospheres, or about 15 tons per square inch. The results were not successful in producing a hard coating to the rod or in increasing materially its density and hardness except in the case of tetrachloride of carbon, which slightly consolidated and hardened it; on the contrary, the carbon deposited from the liquids always appeared as soft amorphous carbon like soot. These experiments were extended by substituting, instead of the liquids mentioned, silica, alumina, and other substances and increasing the pressure to 30 tons per square inch. When the current density was sufficiently increased the rod was converted to soft graphite. Moissan in 1903 expressed the view that iron in a pasty condition was the matrix of the diamond, and that great pressure was the determining factor, which compelled a minute fraction of the carbon present to appear as diamond; he further referred to the probability of carbon being liquefied when under a pressure sufficient to prevent its volatilisation, and that from the liquid state it may pass into the crystalline form on cooling. Crookes, in his lecture delivered before the British Association at Kimberley in 1905, emphasised the same view as to the probability of the crystallisation of carbon directly from the molten state on cooling.

Though my original experiments in 1888 were not favourable to these views, it nevertheless seemed desirable to carry the investigations up to the greatest possible pressures attainable. Experiments were, consequently, resumed in 1907 with a new equipment, which consisted of a 2000-ton hydraulic press and a storage battery of 360 kilowatts output. The battery can be coupled for 2, 4, 8, 16, or 48 volts as required, and the mains and the main switch can carry currents up to 80,000 amperes to the hydraulic press, which is placed by itself in a small, strong house partly below ground, with walls of 2 ft. thickness reinforced with steel bars; the door is of steel 3 in. thick, and the roof is of light galvanised iron. The container under the press is further enclosed by 2 in. thick telescoping steel rings, raised into position by steel ropes and counter-weights. These precautions, as experience showed, were necessary, as several violent explosions occurred which cracked the steel rings and blew off the roof. A charge of iron and carbon, when confined and raised to a high temperature, may be very violent if suddenly released by the melting of the pole-pieces; also some endothermic compounds have been formed which swelled the container and allowed the contents to escape.

My experiments confirmed the conclusion at which Threlfall had independently arrived: that under pressures up to 100 tons per square inch and very intense heating by electrical current, graphite is not materially changed. But modifications in the experiments were made and other methods adopted, as will be explained, which in some respects carried the investigation to still higher pressures and temperatures; these, however, lead to the same conclusion.

I propose this evening to deal chiefly with the practical or engineering side of the subject, and to review the limits of pressure and temperature which are artificially attainable, and to make some comparison between them and the pressures and temperatures occurring in Nature.

When the blade of a knife is pressed strongly against another blade so as to make a dent in each, the pressure on the boundary surface of the metal at the notch will have averaged from 300 to 350 tons per square inch, according to the hardness of temper of the steel. The pressures on the knife-edges of a weighing machine when fully loaded are also of the same order.

When a needle is broken or a piece of piano-wire is strained to the point of breaking, the maximum tension on the metal will be at the rate of 150 tons per square inch. On the other hand, the pressures that occur in the chambers of large guns do not usually exceed 20 tons per square inch, and the tensile stress on the plates of a ship in heavy weather should not exceed 8 tons per square inch. From these simple instances some idea is gathered of the limitations imposed by materials and dimensions upon apparatus for experimenting at high pressures because of the practical difficulty of hardening and tempering steel in large masses.

When dealing with small amounts of material in each experiment the dimensions allow of the container and the ram being made of tungsten steel, which can be hardened and tempered throughout, and not only superficially, as in the case of ordinary carbon steel.

The material is hard and strong, but not brittle, and it retains these qualities up to moderate temperatures, such as 600° C., to a much greater extent than any other steel.

In one form of container or die the bore is 1½ in. in diameter, and it may be used for a limited number of times for a pressure of 200 tons per square inch. It will, however, eventually crack if this pressure is many times repeated, the cracks usually beginning near the bottom of the die.

For still higher pressures it is better to use a double re-entrant container with two rams ½ in. in diameter. Both the container and the rams are made of hardened and tempered tungsten steel, and are rendered fluid and gastight by mild steel cups on the ends of the rams.

If the charge occupies only a short length of the bore, as shown, the barrel of the container where the charge lies is supported by the shear strength of the metal above and below the zone of pressure in addition to its own strength as a tube. Under these conditions it is as strong as or stronger than the crushing strength of the rams, and pressures of 300 tons per square inch may be repeated several times without cracking.

In a container of this form seven grains of fulminate of mercury have been placed, embedded in graphite, and the pressure increased very gradually until it reached 230 tons per square inch (under this treatment fulminate does not usually detonate). The die was then heated by gas to more than 180° C., the temperature of detonation. After two failures of the experiment, owing to the leakage of the steel cups, the third was successful, and no gas escaped and the container was uninjured. The graphite was somewhat caked, but otherwise unaltered. Graphite mixed with sodium nitrate and fulminate was also exploded under the same conditions. Graphite with 15 per cent. of potassium chlorate detonated when 200 tons per square inch had been reached.

Many other reactions were tested in a similar manner in larger dies under pressures of from 40 to 200 tons. The action of concentrated sulphuric acid on sugar was accelerated by a pressure of 50 tons, but, on the whole, these experiments in dies failed to produce any interesting results.

Unfortunately, the heating of the die with its charge cannot be carried much above 500° C. without serious weakening of the steel and compelling a reduction of pressure. The electrical heating of the charge in such small dies, while keeping the die cool, presents great difficulties in electrical insulation on so small a scale to withstand intense pressure, but I think that it might be accomplished in certain instances.

It has been suggested, with the object of reaching higher pressures, that a small die might be bodily immersed in a large container. Doubtless it could be arranged, but it would be very cumbersome to work with, and would only add about 100 tons per square inch to the maximum pressure.

A better plan would be to follow the principle of the usual capped armour-piercing projectile, and to reinforce the rams and ends of the container by tightly fitting copper or bronze rings around the necks of the rams, keeping the parallel part of the noses as short as possible.

When in operation the copper rings will be flattened and squeezed against the necks and shoulders of the rams, and also against the ends of the container, and by this means the parts that ordinarily would have to bear the maximum stress will have part of this stress transferred to other parts not so heavily stressed, and, consequently, the maximum pressure in the container can by this means be raised considerably, perhaps to 450 tons per square inch.

In carrying out experiments on larger samples of material and in applying electrical heating to the charge, the container becomes too large to permit of its being made of hardened steel; therefore, nickel-

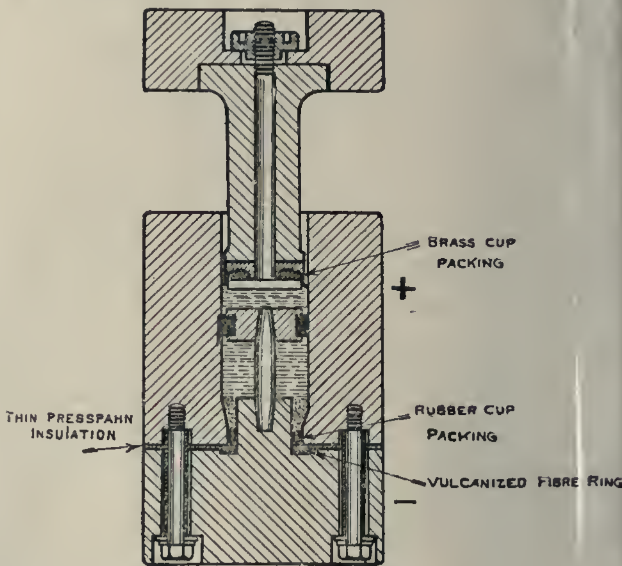


FIG. 1.—Chiefly for liquids.

steel is used, as for the barrels of guns. It is heat-treated by quenching in oil from a high temperature after rough machining. Containers (Figs. 1 and 2) with the thickness of wall equal to the diameter of the bore will stand an internal pressure of 40 tons per square inch repeated almost indefinitely without serious enlargement of the bore, but 100 tons necessitates reboring and the fitting of new packing to the ram after each experiment.

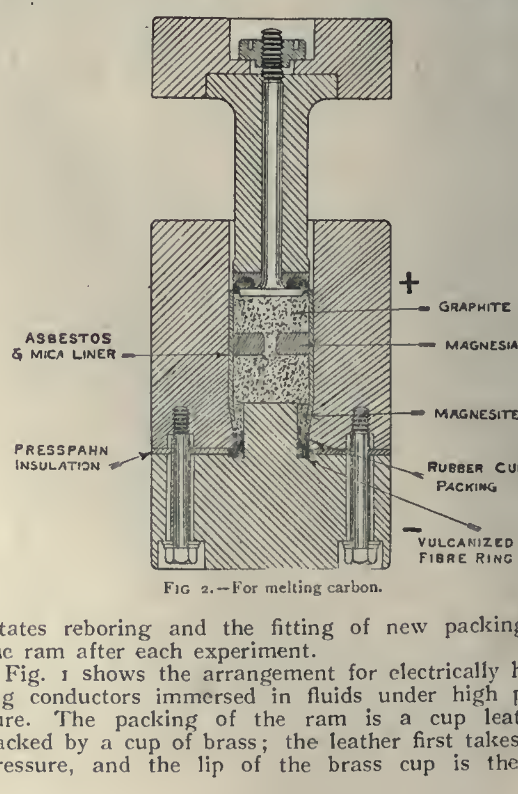


FIG 2.—For melting carbon.

Fig. 1 shows the arrangement for electrically heating conductors immersed in fluids under high pressure. The packing of the ram is a cup leather-backed by a cup of brass; the leather first takes the pressure, and the lip of the brass cup is thereby expanded tightly against the bore of the container, and remains fluid-tight even though the leather should be carbonised by the heat. The bottom pole is electrically insulated from the container by vulcanised fibre washers and a rubber cup-ring, which is protected from the heat by magnesite stemming.

The current is conveyed from the container to the top pole-piece of the conductor by pads of copper gauze, which can slide easily against the bore of the container and allow for the expansion of the conductor. Experiments on liquids with this container under 4400 atmospheres gave the same results as my former experiments under 2200 atmospheres.

Fig. 2 shows the container arranged to melt graphite under pressure by resistance heating. Here the charge is graphite, and is divided by the bridge or ring made of pressed calcined magnesia or of titanium oxide. The bore of the container is electrically insulated from the graphite by layers of asbestos, millboard, and mica.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Notice has been given that there will be an examination for the recently instituted diploma in psychological medicine: Part i. next October, part ii. next December.

OXFORD.—On Tuesday, February 17, the preamble of a statute providing that women may be matriculated and admitted to degrees in the University passed Congregation without a division.

The report recently issued of the Committee for Rural Economy shows a large increase in the number of students. The Michaelmas term began with 200 students, of whom 123 were working at agriculture and 77 at forestry. Lectures have been given on various subjects connected with agriculture, including courses on forest and agricultural botany, livestock, principles of cultivation, soils and manures, together with the history of agriculture and agricultural economics. Practical laboratory work has been provided, and classes have been held at the University farm.

A vote will be taken in Convocation on the question of Greek in Responsions on Tuesday, March 2. No further amendment being now possible, the statute will have to be passed or rejected as it now stands. Many will regret that the chance of an agreed statute was lost by the opposition of those who objected to the retention of the Greek language as a preliminary requirement even for the final literary and classical examinations. The defenders of Greek were willing to grant exemption to all students of natural science or mathematics, as well as to all passmen, but this concession failed to satisfy their opponents.

A COURSE of three free public lectures on Fermat's last theorem will be given by Mr. L. J. Mordell at the Birkbeck College on March 10, 17, and 24 at 5 o'clock. Tickets of admission are obtainable from the secretary of the college.

THE annual meeting of the Association of Technical Institutions will be held on Friday and Saturday, February 27 and 28, at the Cordwainers' Hall, London, E.C. The proceedings will commence at 10.30 on the Friday morning, when the president-elect, the Marquess of Crewe, will deliver his presidential address. Resolutions will be submitted dealing with pensions and salaries for teachers in technical institutions, and papers will be read by Mr. A. Mansbridge on Technical Schools and their Part in relation to Adult Education, Dr. R. S. Clay on Scholarships, and Mr. H. J. Taylor on Day Continuation Schools.

THE following scholarships will be offered for competition by the Institution of Naval Architects this year:—*Naval Architecture:* Vickers (150*l.* per annum), Hawthorn Leslie (150*l.* per annum), John Samuel White (100*l.* per annum), and Denny (75*l.* per annum). *Marine Engineering:* R. L. Scott (150*l.* per annum) and Denny (75*l.* per annum). These scholarships are open to British apprentices or students, and are tenable (subject to the regulations governing each scholarship) for three years at one or all of the following educational establishments:—Glasgow University, Durham University (Armstrong College), Liverpool University, Royal Naval College (Greenwich), and City and Guilds (Engineering) College (London). Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2.

AN inaugural lecture on "The Universities and the Training of Teachers," delivered at Oxford last October by Mr. F. J. R. Hendy, the Director of Training in the University, has been published by the Clarendon Press in pamphlet form. Mr. Hendy deals briefly with the conditions of the new Education Act and the qualities which will be required for those who are to carry out its provisions for senior elementary, secondary, and continuation schools. In particular, he dwells on the necessity for teachers of a wider and less specialised knowledge, men and women who can take all but the highest work in two, or even three, kindred subjects. The valuable influence of the form-master is something which has tended to disappear from secondary education in recent years, and it should be one of the duties of the training colleges to restore it, at the same time avoiding the danger of superficiality by dividing the subjects of study vertically rather than horizontally, so that, instead of going half-way in two or three honours subjects, a student should go the whole way in a section of each. Some suggestive remarks are made on the subjects of method and psychology, words frequently used, but often misused; also on the immense growth of the administrative side of educational work and the comparatively small expansion of the professional or teaching side. The University Press has done a good service in putting this lecture within the reach of all concerned with the supply of men and women for the teaching profession.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, February 4.—Mr. G. W. Lamplugh, president, in the chair.—J. A. **Douglas**: Geological sections through the Andes of Peru and Bolivia: ii., from the Port of Mollendo to the Inambari River. The paper gives a description of a geological section across the Andes of southern Peru, from the port of Mollendo to the Inambari River, a tributary of the Madre de Dios. The deflection of the Pacific coast-line of South America north of Arica towards the north-west brings to light a zone of ancient granite and gneiss comparable with the rocks of the coastal Cordillera of Chile. These rocks are shown to be of "alkaline" type, and are contrasted with the "calcic" granodiorites forming the batholitic core of the western Cordillera. It is suggested that their formation preceded the uplift of the folded chains. The Jurassic zone of northern Chile has been almost entirely stripped from the underlying plutonic core, but its continuation has been proved at more than one locality, and in the inter-Andean region strongly folded fossiliferous beds of Bajocian age are found beneath an unconformable Cretaceous series. The batholitic core is shown to comprise at least three distinct phases of plutonic intrusion, represented by granodiorites, diorites, and adamellites. The volcanic cones of the western Cordillera have given rise to an extensive series of lavas and tuffs comparable with the Mauri River series of Bolivia. Cretaceous limestones here take the place of the red gypsiferous sandstones farther south, and are transgressive on to Devonian rocks. The latter contain abundant fossils of Lower Hamilton age. The post-Cretaceous line of dioritic intrusion, formerly described as running through Coro Coro and Comanche, once more appears on the line of section. The Permo-Carboniferous fauna of Bolivia has not been discovered in the district here described.

Optical Society, February 12.—F. G. **Smith**: A ray plotter. Describes a novel instrument for the tracing of a ray through a refracting surface.—J. W. **French**: The surface layer of an optical polishing tool. Suggests a glass layer on the polishing tool as an effective cause of polishing.—Mrs. C. H. **Griffiths**: Diffraction patterns in the presence of spherical aberrations. Photographs in the various planes of the diffraction pattern for an artificial star were taken and measured, with spherical aberration of varying amounts present. These photographs were examined afterwards with the view of determining the relative intensities of light in the different zones of the ring interference and diffraction patterns both at the focus and otherwise.

DUBLIN.

Royal Irish Academy, January 12.—The Most Rev. and Right Hon. J. H. Bernard, president, in the chair.—J. A. **McClelland** and A. **Gilmour**: Further observations of the electric charge on rain. Different sections of the paper deal with the charge on non-thunderstorm rain, thunderstorm rain, snow, and hail. There is also a section dealing with the size of raindrops. The results agree with earlier observations as regards the great excess of positive charge on non-thunderstorm rain. In the case of thunderstorm rain, while the charge per cubic centimetre is greater, the excess of positive over negative is not marked. Raindrops are seldom greater in volume than 5×10^{-3} c.c.; they are usually less than 1×10^{-3} c.c. Raindrops less than a certain size ($0{\cdot}08\times10^{-3}$ c.c.) are, as previously found, always negatively charged. As a rule, drops of this size give little rainfall, but on a few occasions precipitation of this type was quite considerable.—W. B. **Wright**: Minor periodicity in glacial retreat. The terminal moraines of the Killarney and Kenmare district show a marked periodicity in their arrangement, occurring at fairly regular intervals of half a mile to a mile from one another. These moraines are themselves composite, and break up locally into smaller moraines. The smaller moraines are presumed to mark annual retreat stages, as in the neighbourhood of Stockholm—a presumption which gains support from the occurrence of an esker with seasonal mounds between two of the major stages at Kenmare. On this basis the major stages mark a 20- to 40-year periodicity, which is comparable with the climatic periodicity established by Brückner. A much longer periodicity of 500 or 600 years, in which an epoch of linear terminal moraine formation alternates with an epoch characterised by the absence of such moraine formation, is vaguely indicated by the evidence, but not proved.

January 26.—The Most Rev. and Right. Hon. J. H. Bernard, president, in the chair.—Prof. A. **Henry** and Miss M. G. **Flood**: The Douglas firs: a botanical and sylvicultural description of the various species of Pseudotsuga. Six species and one variety were investigated. The microscopical structure of the leaves was found to be distinct and constant in each species, being correlated with the special climate in which the tree lives. The Colorado and the Oregon Douglas firs exemplify this well, the leaf-anatomy of the former showing xerophytic features, which are adaptations to the dry continental climate of the Rocky Mountains. These two distinct species (*P. glauca* and *P. Douglasii*), usually regarded as of only varietal rank, are treated very fully. The remarkable difference in the odour exhaled by these two trees led to a chemical examination of the oils distilled from their foliage by Mr. C. T. Bennett. The delicious fragrance of the Oregon species was found to be due to the presence in the leaf-oil of geraniol, pinene being absent. The strong turpentine odour of the Colorado species is associated with the presence in its leaf-oil of large percentages of pinene and bornyl acetate.

Royal Dublin Society, January 27.—Dr. F. Hackett in the chair.—Prof. J. **Wilson**: The application of the food-unit method to the fattening of cattle. Thirty years ago N. J. Fjord commenced by experiments to determine what quantities of several other feeding-stuffs were equivalent to 1 lb. of barley, and his successors in Denmark and Sweden have so developed his method that there is now scarcely a feeding-stuff the feeding value of which they cannot express in terms of barley, which they have retained as the unit. Many fattening experiments have been carried out in Britain during the last eighty or ninety years, but, having no very general purpose, they have led to no very definite result. By applying Fjord's method to these experiments, however, the relative efficiencies of the various rations can be approximately determined and suggestions made for improvement in the use of feeding-stuffs for stock of all kinds.—Prof. H. H. **Dixon** and H. H. **Poole**: Photo-synthesis and the electronic theory. The modern view of the part played by sensitisers of the photographic film suggests the hypothesis that green-leaf pigment, which acts as a sensitiser to the wave-lengths it absorbs, loses electrons under the action of the absorbed light. This would suggest a photo-electric theory for photo-synthesis. Accordingly, the photo-electric properties of leaf pigment were tested qualitatively at first by several methods. These giving no indication of photo-electric activity under the action of light active in photo-synthesis, a more refined quantitative method was employed. This showed that the number of electrons ejected, even under intense illumination, from a film of leaf pigment or from a layer of leaf-powder is negligible in the photo-synthetic process. The result supports the view that the displacement of electrons, which we should expect to be the first step in photo-synthesis, must be entirely confined within the pigment-complex of the leaf, or even within the molecules of one of the pigments, and lends no support to the hypothesis that the pigment, by emitting electrons under the action of light, is able to build up carbohydrates external to itself.

PARIS.

Academy of Sciences, January 19.—M. Henri Deslandres in the chair.—M. **Hadamard**: The elementary solution of linear hyperbolic non-analytic partial differential equations.—H. **Douvillé**: The limit between the Cretaceous and the Eocene in Aquitaine, India, and the Sudan.—C. **Deperet**: An attempt at a general chronological co-ordination of Quaternary time.—P. **Boutroux**: A family of multiform functions associated with a differential equation of the first order.—G. **Valiron**: The theorem of M. Picard and the generalisations of M. Borel.—M. **d'Ocagne**: The distribution of curvatures round a point on a surface. —J. **Villey**: Explosion motors for rarefied atmospheres. Five methods are classified by means of which a normal motor may be made more effective at high altitudes.—G. **Claude**: The advantages of the synthesis of ammonia at very high pressures. At 1000 atmospheres the number of passages of the gaseous mixture over the catalyst necessary for complete combination can be reduced to three, and, as a consequence, the volume of the part of the apparatus containing the catalyst can be reduced to at least one-tenth of that currently in use in German practice. At this pressure the ammonia formed can be liquefied out by simply cooling with water.—W. A. **Noyes**, jun.: Polarisation in iron solutions. The Nernst formula does not apply to the polarisation of iron solutions, but indicates values proportional to the experimental values.—C. **Matignon** and E. **Monnet**: The reversible oxidation of sodium nitrite. Sodium nitrite heated to about 500° C. with oxygen under pressure (175 atmospheres) is almost completely oxidised to the nitrate. The reaction is slow, but possibly a suitable catalyst may make the reaction of practical interest in the synthetic nitrate and nitrite industry.—G. **Chaudron**: The reversible reaction between steam and molybdenum.—F. **Kerforne**: Some observations on the Redonian sea of Brittany.—J. **Couégnas**: Contribution to the study of the Argentat fault between Eymoutiers and Treignac.—H. **Coupin**: The causes of the elongation of the stem of etiolated plants. Plants grown in the dark in water containing the juice extracted from green plants do not have elongated stems, but resemble seedlings grown in the light.—E. **Gain** and A. **Gain**: The thermal differences of opposite sides of a lacustral valley.—A. **Guilliermond**: The evolution of the chondriome in the plant-cell.—R. **Mirande**: Alum carmine and its use, combined with iodine green in plant histology. Alum carmine should be considered as a stain for pectic materials, and not for cellulose, as usually believed.—G. **Mangenot**: The evolution of the chondriome and plasts in Fucus.—G. **Arnaud**: The family of the Parodiellinaceæ.—A. **Marie** and L. **MacAuliffe**: The anthropometric study of 136 natives of Tunis.—J. **Pellegrin**: The sub-fossil fish strata of the Tchad low country and their signification.—J. **Legendre**: The food of the Madagascan perch.

January 26.—M. Henri Deslandres in the chair.—Y. **Delage**: An integrating Pitot tube for measuring the average velocity of variable currents. The instrument, a diagram of which is given, is based on the measurement of the water flowing from the upper end of the Pitot tube at the sea-level.—F. **Widal** and P. **Vallery-Radot**: Anaphylaxy due to antipyrin after a long phase of sensibilisation. The case described had taken antipyrin monthly for nine years before any trouble arose, then each dose of antipyrin produced definite effects, localised in the lips. After seven years without this drug, antipyrin immediately reproduced the same symptoms. The treatment by which this anaphylactic state was cured, following the method of Pagniez, is described.—J. **Andrade**: The photographic measurement of rolling resistance.—L. and E. **Bloch**: A spectroscopic arrangement for the study of the extreme ultra-violet. The prism and lenses are made of fluorspar, and air absorption is prevented by maintaining the whole apparatus in a high vacuum (0·001 mm.) by means of a Gaede pump. Spark spectra of several metals have been photographed with apparatus down to a wave-length of 1550 Ångström units.—E. **Wourtzel**: The velocity of oxidation of nitric oxide. The oxidation of nitric oxide by oxygen is a reaction of the third order, and the course of the reaction undergoes no sudden modification when half the nitric oxide is oxidised. The velocity of the reaction diminishes as the temperature rises.—C. **Matignon** and Mlle. G. **Marchal**: Some properties of sodium nitrite. Determinations of the melting point (276·9° C.), heat of solution, heat of neutralisation, heat of formation, and action on colouring matters. An aqueous solution of sodium nitrite at 100° C. in oxygen at 50 to 55 atmospheres remained unoxidised during five or six hours. Platinum black is without action as a catalyst.—A. **Kling**, D. **Florentin**, and E. **Jacob**: The properties of the chlorinated methyl carbonates. All nine possible chlorine substitution products of methyl carbonate have been prepared, and their physical properties are given in a table.—G. **du Bellay** and M. **Houdard**: The chemical properties of humus and their utilisation for the protection of combatants against asphyxiating gases. Filtration of air through about 60 cm. of earth containing humus can protect against chlorine and phosgene for several hours.—P. **da Souza**: Contribution to the lithological study of the interior of Angola.—F. **La Porte**: The beaches of Gâvre and Penthièvre (Morbihan).—E. **Mesnard**: Lunations and rainy periods.—Ch. **Dufour**: Values of the magnetic elements at the Val-Joyeux Observatory on January 1, 1920.—E. **Surgis**: Contribution to the study of the Frankeniaceæ.—A. **Vandel**: The development of the copulating apparatus in the Planaria is under the control of the genital glands.—L. **Léger**: Young fresh-water stages and biology of the marine lamprey.

BOOKS RECEIVED.

Peat Industry Reference Book. By F. T. Gissing. Pp. xxiv+292. (London: C. Griffin and Co., Ltd.) 7s. 6d.

Airman's International Dictionary, including the most Important Technical Terms of Aircraft Construction. English, French, Italian, German. By M. M. Dander. Pp. vii+227. (London: C. Griffin and Co., Ltd.) 6s.

Contributions to the Genetics of *Drosophila melanogaster*. By T. H. Morgan and others. Pp. v+388+12 plates. (Washington: Carnegie Institution of Washington.)

A New Type of Hereditary Brachyphalangy in Man. By O. L. Mohr and C. Wriedt. Pp. 64+7 plates. (Washington: Carnegie Institution of Washington.)

Displacement Interferometry by the Aid of the Achromatic Fringes. By Prof. C. Barus. Part iv. Pp. 122. (Washington: Carnegie Institution of Washington.)

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Pp. iv+128+4 plates. (Washington: Carnegie Institution of Washington.)

Contributions to the Geology and Paleontology of the West Indies. Pp. 184+plates. (Washington: Carnegie Institution of Washington.)

Climatic Cycles and Tree-Growth. By A. E. Douglass. Pp. 127+12 plates. (Washington: Carnegie Institution of Washington.)

The Environment of Vertebrate Life in the Late Paleozoic in North America. By Prof. E. C. Case. Pp. vi+273. (Washington: Carnegie Institution of Washington.)

A Biochemic Basis for the Study of Problems of Taxonomy, Heredity, Evolution, etc. By Prof. E. T. Reichert. Part i. Pp. xi+376+34 plates. Part ii. Pp. vii+377–834. (Washington: Carnegie Institution of Washington.)

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.

ROYAL SOCIETY, at 4.30.—Prof. B. Moore and T. A. Webster: Studies of Photo-synthesis in Fresh-water Algæ.—Prof. W. M. Bayliss: The Properties of Colloidal Systems. IV. Reversible Gelation in Living Protoplasm.—Rev. F. J. Wyeth: The Development of the Auditory Apparatus in *Sphenodon punctatus*.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. S. R. Gloyne: The Problem of Immunity in Tuberculosis.

LINNEAN SOCIETY, at 5.—J. S. Huxley and D. F. Leney: Specimens of Sexually Mature Axolotls Metamorphosed into the Amblystoma Form by Feeding with Thyroid Gland, and of Urodele Larvæ Precociously Metamorphosed by Treatment with Iodine Solution.—Major H. C. Gunton: Entomologico-Meteorological Records of Ecological Facts in Life of British Lepidoptera.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—T. B. Stevens and C. E. Blackett: The Use of Haloid Cyanides for the Purpose of Gold Extraction.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Commr. B. T. Coote: Physical Education and its relation to National Ideals.

CHEMICAL SOCIETY, at 8.—S. B. Schryver and C. C. Wood: A New Method for the Estimation of Methyl Alcohol.—C. S. Gibson and Sir William J. Pope: $\beta\beta'$-Dichloroethyl Sulphide.—B. Flurscheim: The Relation between the Dissociation Constants of Acids and Bases and the Quantitative Distribution of Affinity in the Molecule.—S. Dhar: Direct Replacement of Negative Groups by Halogen in the Achromatic Series. Part I. Replacement of Nitro-group by Bromine.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY OF LONDON, at 3.—(Anniversary Meeting.)

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. G. Elliot Smith: The Evolution of the Cerebellum (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—E. M. Bergstrom: Recent Advances in the Utilisation of Water Power (Resumed Discussion).

CONCRETE INSTITUTE (at 296 Vauxhall Bridge Road), at 6.—H. K. Dyson: Some Points in Reinforced Concrete Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—A. Serner and Others: Discussion on State Ownership *v.* Private Enterprise.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—Prof. F. W. Burstall: Obscure Points in the Theory of the Internal-combustion Engine.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.30.—Col. W. G. King and Others: Discussion on Small-Pox.—Lt.-Col. N. H. Fairley and Capt H. R. Dew: Causes of Death from Malaria in Palestine: A Study in Cellular Pathology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. J. Russell: British Crop Production.

SATURDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

PHYSIOLOGICAL SOCIETY (at Lister Institute), at 4.

MONDAY, FEBRUARY 23.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. G. Elliot Smith: The Evolution of the Cerebellum (Arris and Gale Lecture).

ROYAL SOCIETY OF ARTS, at 8.—C. F. Cross: Recent Researches in the Cellulose Industry (Cantor Lecture).

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Charters Symonds: The Surgical Treatment of the Later Stages of Gunshot Injuries of the Chest and of Empyema.—Dr. P. M. Smith: The After-results of Certain Surgical Operations.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Jay Hambidge: Greek Design.

TUESDAY, FEBRUARY 24.

ROYAL HORTICULTURAL SOCIETY, at 3.—J. Hudson: The Cultivation of Fruits under Glass with a Minimum of Fire Heat.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. Wilson: Magnetic Susceptibility.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Sir F. J. E. Spring: Restoration of a Cyclone-Damaged Breakwater End in Madras Harbour, and Coastal Sand Travel near Madras Harbour.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the month of January, 1920.—E. G. Boulenger: On some Lizards of the Genus Chalcides.—N. S. Lucas: Report on the Deaths in the Gardens in 1919: with Notes on Rickets and Avian Enteritis.—S. Hirst: Revision of the English Species of Red Spider (Genera Tetranychus and Oligonychus).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—Dr. C. A. Swan: Wanderings in Italy.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Dr. T. L. Llewellyn and Others: Discussion on Lighting Conditions in Mines, with special reference to the Eyesight of Miners.

WEDNESDAY, FEBRUARY 25.

ROYAL SOCIETY OF ARTS, at 4.30.—J. Currie: Industrial Training.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—H. C. Sargent: The Lower Carboniferous Chert Formations of Derbyshire.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at Examination Rooms of the Royal College of Physicians, 8-11 Queen's Square, W.C.), at 6.—Dr. H. M. Vernon: The Effect of Change in Hours of Work on Output.

THURSDAY, FEBRUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, RÖNTGEN SOCIETY, and ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (at Royal Society of Medicine), at 5 and 8.15 (Joint Discussion on Electrical Apparatus in relation to X-rays).—Dr. R. Morton: The Efficiency of High-Tension Transformers as used for X-ray Purposes.—Major C. E. S. Phillips: The Problems of Interrupted and Fluctuating Currents.—R. S. Wright: High-Tension Transformers.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

CONCRETE INSTITUTE (at Vauxhall Bridge Road), at 7.30.—E. F. W. Grimshaw: Reinforced Concrete Fences and Posts.

FRIDAY, FEBRUARY 27.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Dr. Mellanby and Others: Discussion on The Influence of Accessory Food Factors in Infant Feeding.

PHYSICAL SOCIETY, at 5.—T. Smith: The Balancing of Errors.—Dr. N. W. McLachlan: The Testing of Bars of Magnet Steel.—G. D. West: The Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases.—Miss N. Hosali: Exhibit of Crystal Models.

WIRELESS SOCIETY OF LONDON (at Royal Society of Arts), at 8.—A. A. Campbell Swinton: Some Wireless Wonders (Presidential Address).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—W. B. Hardy: Problems of Lubrication.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

CONTENTS.

PAGE
The Organisation of Scientific Work in India . . . 653
Modern Physiology 654
Mendelism. By Prof. L. Doncaster, F.R.S. 655
Aeronautics in Italy. By Prof. G. H. Bryan, F.R.S. 656
The Re-mapping of the World 658
Physics for Medical Students. By Dr. H. S. Allen 658
Our Bookshelf 659
Letters to the Editor:—
Relativity and the Displacement of Fraunhofer Lines. —Prof. W. G. Duffield 659
Statistics of Valour and Service.—Major A. G. McKendrick 660
Sugar-beet Seed.—Prof. T. D. A. Cockerell . . . 661
An Electronic Theory of Isomerism.—W. E. Garner 661
The Sociological Society.—Mrs. T. J. C. Fraser Davies 662
Mirage Effects.—Robert Ross; Albert Tarn . . . 662
Unexplored Papua. (*Illustrated.*) By Sidney H. Ray 663
Alpine Plants for Rock-gardens. (*Illustrated.*) . . 664
A New Copper-refining Industry in Great Britain. By Prof. H. C. H. Carpenter, F.R.S. 666
The "Times" African Flight. By Prof. J. W. Gregory, F.R.S. 667
The National Research Council of the United States 668
The Secondary School Curriculum 669
Notes 670
Our Astronomical Column:—
Mercury as an Evening Star 674
Centenary of the Royal Astronomical Society 674
Is Venus Cloud-covered? 675
Professional Meteorology 675
Steam Boilers and Economisers 675
The Belgian Royal Observatory. By Dr. A. C. D. Crommelin 676
The Liverpool Marine Biology Committee. By S. J. H. 677
Applications of Interferometry 677
Researches at High Temperatures and Pressures. (*Illustrated.*) I. By The Hon. Sir Charles A. Parsons, K.C.B., F.R.S. 677
University and Educational Intelligence 681
Societies and Academies 681
Books Received 683
Diary of Societies 684

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THURSDAY, FEBRUARY 26, 1920.

METEOROLOGY AND THE STATE.

DURING the war, meteorology, like many other branches of science, was utilised to an unexpected extent, and its importance has thereby gained recognition in far wider circles than might otherwise have been the case. The rapid development of aviation has contributed to this, for accurate forecasts and a knowledge of the conditions prevailing in the upper air are of the greatest importance to the airman, and the subject now forms a part of his course of instruction.

With the cessation of hostilities, the Meteorological Office has had to consider the reconstruction which would be necessary in its organisation to meet the larger demands made upon it, and to maintain the expansion and development of the scientific side of the subject which such increased activity demanded. In other countries the meteorological service has always been part of one of the Departments of State, but in this country its status has varied from time to time. The Meteorological Office began in 1854 as a Department of the Board of Trade for the purpose of collecting information about the meteorology of the sea, to which was added later the study of forecasting. Later, it was placed under a committee appointed by the Royal Society, which administered the funds furnished by an annual grant-in-aid. Since 1905 the Office has been under the management of a Committee appointed by the Treasury, and consisting of representatives of the Admiralty, Board of Trade, Board of Agriculture and Fisheries, and the Royal Society. Thus the Meteorological Office has for many years been a service mainly supported by State funds, but not attached to any Department, its policy being determined by the Committee responsible for its administration.

Under these conditions much valuable scientific work has been done, and, whatever the advantages of such an independent position may have been, the greatly increased utilisation of meteorological information by various Departments of State has recently brought the status of the Meteorological Office under consideration.

In the report of the Meteorological Committee for the year ending March 31, 1919, a proposal of the Air Ministry made in the spring of 1918 to take over the Office, on account of the importance of meteorology to aviation and of the use of aviation to meteorology, is presented; but no definite action was taken at the time. Later in the year a Committee of the Cabinet was in favour of transferring the meteorological service to the Department of Scientific and Industrial Research, with a view to the co-ordination of the various meteorological services then existing. Such a scheme appeared to afford a satisfactory means of meeting the requirements of the Departments, and also of maintaining the scientific research essential to advance in meteorology.

Since then it has been announced by the Under-Secretary of State for Air that the Cabinet has decided that the Meteorological Office should be attached to the Air Ministry, and the amalgamation of the staff of the Meteorological Office with that of the Meteorological Service of the Air Ministry is understood to be in course of execution. We may therefore conclude that the importance of the State Meteorological Service to the modern needs of the fighting Services, as well as to the other Departments of State, is such as to render its closer connection with them desirable, and apparently the special needs of the Air Ministry and its exceptional facilities for obtaining information from the upper regions of the atmosphere have led to its selection as the Ministry to which the Meteorological Office should be attached.

Such recognition of the importance of meteorological science, and the co-ordination of different services dealing with the subject, are to be welcomed, but men of science will wish to see the freedom for investigation and research which has been a special feature of the Office under its former committees of management fully maintained under the new conditions arising from its re-incorporation in a State Department. Some misgivings on this point seem to exist, for the council of the Royal Meteorological Society, in a resolution published elsewhere in this issue, while recognising the advantages which the Meteorological Office may gain from a closer association with the Air Ministry, suggests that there may be a tendency for certain branches of meteorology to be relegated to a subordinate position of importance if the management of the Service rests with a single Department having special interests of its own.

Here we meet the difficulty of reconciling the advantages gained from the support and resources of an influential Ministry with such restrictions as are inseparable from the administration of a large Service. The special interests and requirements of a controlling Department will naturally appeal more strongly to its administrators, and proposals for expenditure on schemes will gain more sympathy and support than others with which they are less familiar. Such considerations probably influenced the Meteorological Committee in concurring in the proposal for transference to the Department of Scientific and Industrial Research.

But, since the incorporation of the Meteorological Office in a State Department is necessary, as seems to be generally agreed, the important matter is how advance in all branches of the subject may be assured. Besides forecasts of the weather and information concerning conditions in the upper air which especially affect the Air Ministry, there are the needs of the Navy, the mercantile marine, and the shipping community in general; the interests of farmers, foresters, and fruit-growers; the requirements of water engineers, river conservancies, and many other branches of the community. The War Office has special demands of its own in connection with gunnery, sound-ranging, etc., and there are many questions coming within the scope of the Ministry of Health and other Government Departments which utilise meteorological information. For all these lines of work, scientific investigation must be carried on continuously in order to obtain fuller knowledge of the atmospheric processes which can be utilised to the advantage of the various interests which have been mentioned. To this end observatories are maintained for investigation apart from their utility as reporting stations, and it is of the utmost importance that such scientific research should be continued and afforded full freedom ot action.

With its transfer to the Air Ministry, the Meteorological Office has gained a large addition to its staff, and with its extended network of reporting stations its budgetary provision in the coming financial year will doubtless be greatly increased. The State Service is still almost the only one offering a career to a man who is attracted to the subject of meteorology, and if those of the best ability are to be obtained, it is essential that scientific research in it should be encouraged in which their powers may be utilised. No announcement has so far been made of the constitution of the Committee which continues the work of the Meteorological Committee, or of its powers and responsibilities, but it is to be hoped that science will be strongly represented on such a Committee which can advise the Air Ministry on the best policy to be pursued for the advancement of meteorological science, and will be empowered to direct the execution of such policy. By this means the Ministry will be assured that research will be carried on most efficiently and to the advantage of all branches of the subject.

THE BIRTH OF OCEANOGRAPHY.

Accounts Rendered of Work Done and Things Seen. By J. Y. Buchanan. Pp. lvii + 435 + 3 plates. (Cambridge: At the University Press, 1919.) Price 21*s.* net.

MR. J. Y. BUCHANAN has passed the allotted span of years, but we who are no longer young cannot call him old. Yet he was hard at work in a generation which has all but passed away, and his recollection reaches back to things which are but a tradition to the most of us. He is the last of that happy band who set sail from Portsmouth in the *Challenger* under Wyville Thomson just seven-and-forty years ago; he was born in another world than ours, when (as he tells us) the only railways on the Continent ran, as kings' playthings, from Paris to Versailles, from Berlin to Potsdam, from Hanover to Herrenshausen. Now in this volume, as in one before, he has "rendered his accounts" (but only partially) of the abundant work he has done and the countless things he has seen. The book contains essays both great and small, from letters to NATURE to addresses delivered to universities and learned societies, and the things of which these papers treat are both big and little, for Mr. Buchanan has kept a sharp look-out, conning everything—from the rats in a Bordighera garden (which left the oranges alone, ate the rind of lemons and left the fruit, ate the fruit of mandarins and left the rind) to the great panoramas of earth and sea which for so many years have passed before him.

Most of the papers deal (as we should expect) with matters oceanographical, such as the temperature of the sea, its colour, its saltness, or the manganese and other nodules lying in its bed. The treatment is in great measure new, or was so when the papers were written; but the themes are old—and are made all the more attractive thereby. One is reminded of Robert Boyle's "Observationes de salsedine maris," or, again, of the "Histoire Physique de la Mer"—based upon so little, because it was all there was—of that exquisite writer and gallant soldier of fortune, Louis Ferdinand, Comte de Marsilli. Even one or two names like these (and we do not forget Captain Maury, another great captain and soldier of fortune) make us hesitate a little to accept Mr. Buchanan's account of "The Birthday of Oceanography." And yet perhaps he is not very far wrong to persuade us that that science was born, a little to the westward of Teneriffe, on February 15, 1873. For this was the day when the *Challenger* made her first oceanic sounding; and, immediately after, the dredge came up full of new and strange things, great corals, huge siliceous sponges, and what not more—first-fruits of the noble harvest to be gathered from the "Depths of the Sea."

In some things, and again it is no wonder, Mr. Buchanan prefers the old times to the new. He tells us of the cool comfort of an old wooden ship, its perfect fitness for the work of exploration, and how we have no ships nowadays like the *Challenger*. We are half-tempted to agree with him. He commends, even with enthusiasm, the old-fashioned hempen dredge-rope and sounding-line, and assures us that "wire is the very emblem of treachery." In later years, when wire had come into use, he says: "I never attached a thermometer to the wire without feeling that I was guilty of a form of cruelty—cruelty to instruments." This is a much harder saying—to those of us who have used nothing else; let us hope that it is the wire which has altered, and not the men.

It need scarcely be said that this book is well worth reading. It has many pages to interest even the man in the street, and has both an historical interest and something more besides for the present-day student of oceanography. In these seven-and-forty years methods have been refined, new theories and concepts formed; but we do not forget that birthday party on board the *Challenger*, nor Mr. J. Y. Buchanan, who is the last of the godfathers.

D'Arcy W. Thompson.

INDUSTRIAL PSYCHOLOGY.

Lectures on Industrial Psychology. By Bernard Muscio. Second edition, revised. (Efficiency Books.) Pp. iv+300. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1920.) Price 6*s*. 6*d*. net.

This book is founded on a course of five lectures which were delivered before a general audience at Sydney University, but they must have been considerably expanded when put into book form. The author does not lay claim to have made any first-hand investigations on the problems with which he deals, but the book is very far from being a mere compilation. It shows throughout a deep insight into the principles of industrial psychology, and is especially lucid on the much-debated question of scientific management.

Mr. Muscio takes in turn the various objections to this system raised by the workers themselves, and with great ingenuity tracks down the true inwardness of these objections, and discusses the manner in which they may be overcome. He maintains that the main fact to be insisted on is that the new methods prevent waste of human energy, and render it possible to obtain a given output from a much smaller expenditure of human energy than that hitherto found necessary. Labour's objection that the general introduction of scientific management would cause widespread unemployment applies equally to every improvement introduced into industry in the past. The difficulty can be largely overcome by installing the improvements gradually and absorbing the surplus workers by the simultaneous introduction of other forms of labour.

Again, Labour maintains that scientific management leads to undue speeding up. There is much truth in this assertion, but the difficulty can be overcome by the introduction of longer intervals of rest and by shortening the working day. Other objections to the system could be avoided by arranging for an adequate system of industrial education. The employer and employee must co-operate in the introduction of a scheme whereby no time study of an operation shall be made, and no bonus system adopted, without the consent of the worker.

A very interesting and important field of industrial psychology centres around vocational selection. This subject is discussed at length by the author, and concrete instances of the methods as applied to the selection of telephone girls and electric-street-car drivers are described in detail. Industrial fatigue is treated rather briefly, and is the least satisfactory part of the book, as the information adduced is largely out of date. That concerning industrial accidents is fragmentary and misleading, and no reference is made to the "safety first" campaign, and to the effects of suggestion on the avoidance of accidents. The lectures were apparently written in 1916, and the author has endeavoured to bring them up to date in this revised edition by the somewhat irritating and unsatisfactory method of appending footnotes.

H. M. V.

CRIMINOLOGY AND NERVOUSNESS.

(1) *Criminology.* By Dr. Maurice Parmelee. Pp. xiii+522. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 10*s*. 6*d*. net.

(2) *The Mastery of Nervousness based upon Self-Re-education.* By Dr. Robert S. Carroll. Third revised edition. Pp. 348. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 10*s*. 6*d*. net.

(1) Dr. Parmelee has written a very readable book on the various aspects of crime and criminals. He has disclosed nothing that is

altogether new, but he has brought together and discussed the varied factors of a large subject in a lucid and interesting way. He begins with a consideration of the evolution of crime, and then discusses in some detail the part played by environment. In part iii. the subject of the organic and the mental basis of criminality is taken up, together with the classification of criminals and the problems of juvenile and female criminality. Part iv. deals with criminal jurisprudence, and part v. with a discussion of penology. The final section comprises a study of the problems of political crime and the crimes arising from opposition to the fixity of social custom, with a chapter on prevention.

Two appendices are added, one dealing with the relation between the price of cereals and crimes against property, and the other—of revived interest at the present time—a criticism of the late Dr. Charles Goring's book, "The English Criminal," which appeared in 1913.

Dr. Goring is taken very pointedly to task for misrepresenting Lombroso "grossly and inexcusably," for his "gross misrepresentation" of the author of "Criminology," and for his ignorance of psychology—although we must confess we think several of Dr. Parmelee's beliefs, such as the physiological theory of instinct, the James-Lange theory of emotion, and his belief in the efficacy of ideomotor action, are not the most fruitful that could be applied to the elucidation of his subject. Finally, he condemns Dr. Goring's researches as carrying the statistical method too far, and concludes that, in spite of his initial disagreement with Lombroso, Dr. Goring has proved himself "more Lombrosian than Lombroso himself."

The author's aim, as he states, has been to make a more or less comprehensive survey of criminology, and that he has succeeded admirably no one who reads his book will doubt.

(2) "The Mastery of Nervousness" is a zealous book, a volume not only of medical, but also of ethical, instruction, a guide, philosopher, and friend to the nervous, but chiefly the last. The aim has not been the exposition of any narrow or restricted doctrine; there are, consequently, a freedom of style and treatment and a command of metaphorical expression which are certainly stimulating and doubtless of benefit to many.

The author points out the growing prevalence of nervousness—that is, overactive or misdirected nervous activity—and describes the influence of various factors—heredity, diet, inactivity, work, play, and others. On "Mastery through Work" he writes: "It is a profound misfortune for any young person to enter the serious years of life without having been earnestly impressed with the dignity of work, or taught to feel that ever within reach are divinely appointed duties."

Dr. Carroll lays emphasis on the importance of the early years of life. "Loss," he writes in the chapter on "Surrender," "begins in childhood. The babe is king of us all. The grim visage of the warrior softens in the presence of its cooing innocence; nobility stops and turns, and does homage; rich and poor, high and low, young and old, kneel at the cradle to welcome the bright, new, young soul."

In the same chapter is a picturesque example of sublimation or "side-tracking," which describes how a patient worked her "jim-jams" off in the garden by "vicious jabs into the soil with hoe and spade"—a species of horticultural profanity that brought back memories of France and the impressive language of the trenches, which, we know, performed an equally estimable function.

The theme of treatment is efficiency through harmony. "If we are to win the battle of personal mastery we must lay hold on a force higher than reason alone, for force of mind not governed by force of spirit does not make man good." The great necessity, the author says, is for "ultimate control of the moral idea, as the only force resolving the dissonance of jangling nerves into harmony."

PRACTICAL CHEMISTRY.

(1) *Elementary Practical Chemistry.* Part i. *General Chemistry.* By Prof. Frank Clowes and J. Bernard Coleman. Seventh edition. Pp. xvi+241. (London: J. and A. Churchill, 1920.) Price 6s.

(2) *A Treatise on Qualitative Analysis: Adapted for Use in the Laboratories of Colleges and Technical Institutes.* By Prof. Frank Clowes and J. Bernard Coleman. Ninth edition. Pp. xvi+400. (London: J. and A. Churchill, 1920.) Price 12s. 6d.

THERE are two distinct aims that may actuate the writer of a text-book on practical chemistry, whether analytical or otherwise, namely, (1) the setting forth of principles, and (2) the enumeration of facts. To a certain extent they are inseparable, for principles without facts are useless, and facts without principles are not ordered knowledge. But it is impossible to make the best of both at the same time. If the principles are burdened with too great a multiplicity of facts, they are fairly certain to be smothered by them, and facts cannot be set forth in the clearest possible way if the method of arranging them is to serve some other end as well.

(1) "Elementary Practical Chemistry" is now, for

the convenience of students, divided into two volumes, of which the "General Chemistry" is the first, leaving "Analytical Chemistry" to the second. The volume before us deals with the principles of chemistry, and gives a series of more than 300 experiments in illustration of them. The text is sufficient to show the bearing of the experiments, in addition to the instructions for the performance of them, but it is presumed that a course of lectures dealing more fully with the subject will be given concurrently with the practical work.

(2) The "Treatise on Qualitative Analysis" has, in the present edition, been "rewritten, recast, and enlarged in order to adapt it to modern methods of teaching." It is essentially a book of facts, for it treats of the detection of the rarer as well as the more common metals and acids, a considerable number of organic acids both aliphatic and aromatic, a few hydrocarbons, halogen, nitro- and other derivatives, alcohols, ethers, aldehydes, ketones, carbohydrates, glucosides, organic bases, eighteen alkaloids, and finally nineteen different gases. In addition to all this there are instructions for making stirring rods, boring corks, etc., for performing various operations, such as precipitation, filtration, washing, and drying, and as to the use of the spectroscope, a description of laboratory fittings, recovery of residues, lists of reagents, and various tables. There is also a small section which gives lists of simple salts, mixtures, and minerals suitable for practice, though these do not include organic substances, the rarer elements, or gases. Thus teachers, as well as students in all stages of their work, will find assistance in this volume.

It is curious how long a time it takes for some facts of first importance to work their way into text-books that are written for students. It has been known for more than fifty years that manganous chloride, when introduced into a flame in the ordinary manner, colours it brightly green, but scarcely any text-books note the fact. We have known students to be led astray by this omission. The authors here state definitely that the compounds of the metals Zn, Mn, Ni, and Co show no characteristic flame colorations, and in the tables a green flame is followed by the inference —Ba, Cu, B_2O_3, exactly as in almost every text-book on the subject. There is a tendency to be more "theoretical" than practical in the statement that ammonium carbonate and nitrate are decomposed by heat into gases, and "they are therefore volatilised without producing white fumes or a sublimate."

The full instructions in the tables, and the very large number of notes appended to them, are evidence of the care taken by the authors, and the many editions that have been issued show that this care is appreciated, and it is deservedly so, by those for whose use the book is intended.

C. J.

A MATHEMATICIAN'S MISCELLANY.

Pensées sur la Science, la Guerre et sur des Sujets très Variés. By Dr. Maurice Lecat. Pp. vii + 478. (Bruxelles: Maurice Lamertin, 1919.)

M. LECAT is a great reader with catholic tastes. For twenty years he has been in the habit of copying out all the passages that have struck him in the reading which occupies his leisure. He has now, at the instance of a friend, collected and arranged them in a volume of 480 pages of double columns. There are about 11,000 extracts from some 1500 authors grouped under subject headings. The first 1200 refer to various branches of science and its most distinguished exponents. The remainder, dealing with every possible subject, grave and gay, of topical or perennial interest, come under titles arranged alphabetically; we proceed in due order from Abstraction, Abus, . . . Allemagne (the longest section), to Voltaire, Voyage, Yeux, Zola. The quotations, whatever the language of their origin, are usually, but not always, translated into French. The whole is furnished with two elaborate indexes and the dignity of an appendix.

The industry that has produced the book is amazing—so amazing that it is surprising that obvious slips should have been allowed to pass in the information concerning authors. A reviewer who should take the opportunity it affords for ridicule would lack even that small portion of humanity usually allotted to his kind. But we fear that M. Lecat is too optimistic in his hope that his collection will serve as an instrument of intellectual research by providing a compendium of the best thought of mankind. In both selection and arrangement such a work inevitably bears the impress of the editor. No one man, even with the voracity of M. Lecat, can consume all literature; the portion that he can digest is infinitesimal. Though writers of at least eight languages are included, ranging from David (the son of Jesse) to Max Harden, and from Homer to the *Morning Post*, it is only natural that those who have used the French language should have the preponderance. Nor do our author's wide interests and his passionate plea for impartiality enable him to conceal from his readers that he is a Belgian, a good son of the Church, and a mathematician. Even if he had been able to avoid the exclamatory "sic!", his best efforts would still have left those whom he addresses with the impression that they are studying, not the sifted wisdom of the ages, but the opinions of M. Maurice Lecat.

However, the subsidiary claim that he makes may be heartily supported. It is a most entertaining volume to dip into for a few moments to pass the time. If it were only rather handier, and the type a little larger, it would be ideal for the bedside. As it is, perhaps the dentist's waiting-room provides for it the proper sphere of usefulness.

N. R. C.

OUR BOOKSHELF.

Penrose's Annual. Vol. xxii. of "The Process Year Book." Edited by William Gamble. Pp. x+112+plates. (London: Percy Lund, Humphries, and Co., Ltd., 1920.) Price 10*s.* 6*d.* net.

OUR special congratulations are due to the editor and publishers of this ever-welcome annual that, after an interval of three years, they have been able to resume its issue. The editor, as usual, in his "Foreword" reviews the recent advances and the present condition of the reproductive graphic arts. In the circumstances one could scarcely expect anything strikingly new, but we are told that one bright and hopeful feature of the present is that work is now being adequately paid for, and that as a consequence employers are able to give satisfying wages as well as to improve their plants. Photo-lithography is coming more and more into use. Collotype is "coming into its own again, thanks to the absence of German competition." The collotype work now being done in this country is of excellent quality, and probably greater in quantity than ever before. Half-tone and three-colour work stand pretty much where they were before the war, while rotary photogravure is coming increasingly to the front for newspaper and periodical work. It is now quite practicable to print both text and illustrations together by this last process, and there are signs that before very long type-setting may be rendered unnecessary. Two American journals have already been produced without the aid of the compositor. The volume contains articles from the pens of many contributors, and is very rich in illustrations of all kinds.

C. J.

The Occlusion of Gases by Metals: A General Discussion held by the Faraday Society, November, 1918. (Reprinted from the Transactions of the Faraday Society, vol. xiv., parts 2 and 3, 1919.) Pp. 93. (London: The Faraday Society, n.d.) Price 8*s.* 6*d.*

THIS volume contains a record of another of the valuable symposia held by the Faraday Society. The subject of the gases retained by solid metals bears on a number of technical processes, so that the papers contributed cover a wide range. Sir Robert Hadfield's introduction gives a useful summary of the knowledge of the gases in iron and steel, with a bibliography. The theoretical aspects are dealt with by Profs. Porter and McBain, the well-known case of the absorption of hydrogen by palladium receiving attention, whilst Dr. McCance's paper on balanced reactions in steel manufacture discusses the question of the equilibria in the steel furnace which determine the proportions of the various gases which will be in contact with the metal at the time of tapping. The view that the amorphous phase in solid metals is responsible for much of the dissolved gas is maintained by several of the contributors, but no evidence is adduced to prove that gases are insoluble in crystals of pure metals. The fact that the solubility of gases in molten metals increases with the temperature has often seemed remarkable, but Prof. Wilsmore points out that this is probably the normal behaviour, water being exceptional in its diminished solvent power for gases with increasing temperature. The discussion contains much that is of interest both to metallurgists and to physical chemists.

C. H. D.

Examples in Heat and Heat Engines. By T. Peel. Pp. iii+104. (Cambridge: At the University Press, 1919.) Price 5*s.* net.

THE working of exercises forms a very important part of the course work of an engineering student. Many of the exercises required for the purpose of elucidating the subject of heat and heat engines can easily be made up; on the other hand, there are many important facts which can be illustrated only by exercises containing as data observations made during experiments. Teachers and students will welcome the book before us, because, among numerous other exercises, there is a large number giving experimental data on steam, gas, and oil engines, steam boilers and turbines, refrigerators, and calorimetric work. It is true that the best data for exercise working are those obtained by the student in experiments carried out by himself. Since most heat and heat-engine tests take a rather long time to carry out, the amount of information thus accumulated in the case of any one student can have only a limited scope, and the excellent exercises contained in the book will make a very useful supplement.

The Hill of Vision: A Forecast of the Great War and of Social Revolution with the Coming of the New Race. Gathered from Automatic Writings obtained between 1909 *and* 1912, *and also, in* 1918, *through the Hand of John Alleyne under the Supervision of the Author.* By Frederick Bligh Bond. Pp. xxv+134. (London: Constable and Co., 1919.) Price 7*s.* 6*d.* net.

THIS book is a sequel to "The Gate of Remembrance," which contained an account of the automatic script giving instructions for excavations in Glastonbury. The further script now published deals with the war and after, but it cannot be said that the correspondences and verifications of predictions pointed out are particularly striking or convincing.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Organisation of Scientific Work.

I TRUST the rank and file of scientific investigators throughout the Empire will wake up to the urgent need of combined energetic action. The proposals to centralise under the control of a few official departmental heads the body of actual scientific investigators in India, thus creating a few highly paid administrative posts for senior men and effectually killing all initiative, enthusiasm, and liberty of action on the part of those actually carrying on the investigations, is perfectly in accord with what has happened in this country since, in an evil day, the Government assumed the control of scientific and industrial research. It is a proposal that appeals, naturally, to the official without knowledge of the way in which scientific discoveries originate, and anxious to secure a body of cheap and docile labour, even though it be mediocre in calibre, and to those few who hope to secure for themselves these senior lucrative administrative posts. To genuine investigators such posts, however highly paid, would be unattractive, and under such a system there seems every inducement for men of originality and scientific ability to give the service a wide berth. Whereas the crying need in India, as everywhere, is for men of high calibre and honest, independent mental outlook, anxious only to secure favourable conditions under which they may be left free to pursue their creative work, and, this being secured, careless of wealth, rank, and power save as the necessary antecedents to the essential condition.

Two assertions, which can be made without the slightest fear of contradiction, may be put into juxtaposition in order to contrast the remedy proposed with the state of things it is desired to cure. First, that of all great nations the British Empire has most signally failed in its application of scientific knowledge and methods to its national problems; and, secondly, that in the British Empire there exists a body of skilled and hard-working scientific investigators second to none, and, even under the most disheartening conditions, actually enlarging the boundaries of natural knowledge in no mean degree. As the great schemes for rectifying matters crystallise into action, with the formation of a Department of Scientific and Industrial Research at home and concrete proposals for action, as in the Indian reorganisation suggested, more and more they seem to amount to this: The men who do the work, and against whom no fault is alleged, are to be deprived even of what little satisfaction and independence genuine scientific work for its own sake affords, and are to be put under the men against whose incompetence and lack of knowledge the whole uproar originally arose. In research, where, as the leading article in NATURE of February 19 so truly says, the man is everything, that man is to be put under men who brought an Empire, as rich in scientific talent and genius as any, perilously low. The remedy, surely, is to put the incompetent machine under the charge of competent men, not *vice versa*.

Our *soi-disant* scientific representatives seem still in the stage once lived through in our ancient universities, where it was at one time deemed politic that any scientific demand, if it were to pass, should be put up and seconded by well-known opponents of science, thus, on the chance of securing a temporary advance, permanently sacrificing the whole future. That we did not in 1914–19 repeat the medical horrors of the Boer War, when more died of pestilence than at the hands of the foe, is surely due to the emancipation in the interval of the Army medical services from non-qualified misdirection. That our food control during war-time was successful, even by comparison with that of more favourably situated belligerents, was because scientific men were from the first in charge of its scientific aspects—a rare condition, due probably to so many of them belonging to the profession that exacts due and proper respect for its members. Can one imagine young medical graduates, after a prolonged and serious university training, being sent up, as our scientific graduates were sent, hauling about gas cylinders with the rank of corporal? Can one imagine a director of a medical research association a foreign business man or manufacturer unknown to the research world? Can one imagine a proposal for State aid for medical research being dismissed by an unqualified person so ignorant of the history of scientific discovery as to deem it sufficient to dub the proposal as a "floating research" in order in his own eyes to condemn it? Neither can I imagine such happening in the scientific world if its leaders were equally alive.

Ordinary people, benevolent to science and unfamiliar with affairs, often wonder why scientific men are so powerless and peculiarly unable to protect themselves and to advance their subjects to a position commensurate with their national importance. The answer is to be found, I think, in the obsolete character of their so-called representative societies. Year after year in the chief of these the councils nominate and elect themselves without any reference to their members except for formal ratification. Through sheer lack of backbone and being out of contact with the body of their members, time and again they sacrifice interests vital to the continued existence of genuine scientific research. I do not wish to advocate for scientific investigators a close corporation keeping lynx-eyed vigil over their professional interests and seeking every opportunity to enlarge and consolidate them, identical with other learned professions; for the paramount interest of a scientific investigator should be his work, and his privileges, emoluments, and status are to be regarded merely as means necessary to secure opportunity and power *to do it*. That should be the test of these schemes, and not the further subordination of the men who do the work to the organisation attempting to get the work done. But unless they band together and take action, the rank and file of research workers throughout the Empire will not even be able to retain the miserable position they occupied before the war in the national life, and their interests will continue to be sacrificed to the ambitions and love of power of the few. FREDERICK SODDY.

THE "Notes" columns of NATURE for February 19 contained a reference to a suggested conference between British botanists at home and overseas at which matters of common interest would be discussed. From some preliminary correspondence which had taken place in order to ascertain the feeling of our colleagues overseas as to the prospects of success of such a conference some interesting communications were received, especially from India, which bear on the subject of the organisation of scientific work. It was urged that this should form a subject for discussion in the event of a conference taking place, and it was evident that the writers were strongly opposed to a policy of centralisation. On the contrary, they were seeking greater freedom in their scientific work, and their communications hinted at irritating restrictions and disastrous results due to official interference—effects which would be much enhanced by such a scheme of centralisation as was indicated in the leading article in the same issue of NATURE. There may have been some waste of effort in the past, both at home and overseas, owing to insufficient co-operation between men of science working independently, but this is a matter for workers to set right among themselves, and will not be mended by an organisation conceived on the lines of a German military system. Further, it is unlikely that the best men will be attracted to work under such deadening conditions.

Care must be taken that public money is not wasted in scientific development, but the kind of official control suggested by a scheme of centralisation does not commend itself as an efficient waste-preventer. Grants of money to scientific societies or institutions might be administered by carefully selected boards of trustees, the scientific work being left to the unhampered initiative of the scientific staff under a head specially suited to the character of the work. The management of our Natural History Museum, a Government institution, is invested in trustees, who leave to the scientific staff the carrying out of the scientific work as effectively as funds and opportunity allow. Research work of the highest value to agriculture is being carried out at the Rothamsted Experimental Station, the original endowment of which has been generously supplemented by private munificence and by Government grants. Here also the management is vested in a small committee the members of which represent the various scientific sides of the work carried on. A. B. RENDLE.

British Museum (Natural History).

Gravitational Deflection of High-speed Particles.

THE investigation of the consequences of Einstein's law as regards the motion of a material particle moving through a gravitational field with a velocity comparable to that of light brings out some interesting and rather surprising effects. As Einstein's law is entirely kinematical, involving accelerations instead of forces, no account need be taken of variation of mass with velocity other than that contained in the law itself. Let m denote the mass of the attracting body (*i.e.* the sun) in astronomical units divided by the square of the velocity of light. Then the motion of a particle in the field produced by this body is determined by

$$\delta\int\sqrt{\left(1+2\frac{m}{r}\right)\left(dr^2+r^2d\theta^2\right)-\left(1-2\frac{m}{r}\right)c^2dt^2}=0,$$

the $r\theta$ plane being that of the orbit. From the Lagrangian equations corresponding to this Hamiltonian statement of the law, the energy relation

$$\frac{1}{2}\frac{d}{dt}(v^2)=-\frac{mc^2}{r^2}\left(1-4\frac{m}{r}\right)\dot{r}=3\frac{m}{r^2}v^2\dot{r}$$

is obtained. If the velocity of the moving particle is comparable to the velocity c of light, the second term in the parenthesis on the right-hand side may be omitted as negligible compared to the last term. The resulting approximate equation is easily integrated, leading to the expression

$$v^2=c^2\left\{a^2\left(1-6\frac{m}{r}\right)+2\frac{m}{r}\right\},$$

where a is the ratio of the velocity of the particle at infinity to that of light.

Consider a particle the velocity of which at infinity is negligibly small compared to that of light. Then the factor a is small, and the second term in the parenthesis which it multiplies may be omitted. This gives the energy equation of the Newtonian theory.

If, however, the particle has a high velocity, the omitted term becomes of importance. In fact, when the velocity is $1/\sqrt{3}c$, this term has the same value as the third term, but the opposite sign. Therefore, these two terms annul each other, and the velocity of the moving particle is unaffected *in magnitude* by the gravitational field. In other words, the *tangential* acceleration of the particle is zero throughout the course of its motion through the field. If it were headed directly for the attracting centre, it would move along in a straight line with constant speed just as if no field were present.

Next, consider a particle having a velocity at infinity greater than $1/\sqrt{3}c$. The velocity of this particle is actually decreased by the gravitational field. If it were aimed straight at the attracting mass, it would be slowed down just as if it were *repelled* with a force varying inversely with the square of the distance. If the velocity of the particle at infinity is equal to that of light, its velocity decreases as it approaches the centre of attraction in the same amount as that of a light-wave, for Einstein's theory makes no distinction between material particles and electromagnetic disturbances.

Consider a particle moving along the X axis with a high velocity v. Let the attracting mass m be on the Y axis, a distance R below the origin. Then the components of the particle's acceleration are

$$f_x=-\frac{mx}{r^3}\left(c^2-3v^2\right),$$

$$f_y=-\frac{mR}{r^3}\left(c^2-v^2\right).$$

If the particle's velocity is greater than $1/\sqrt{3}c$, the tangential component f_x is positive, and the particle is slowed down as it approaches the centre of the field. The normal component f_y, however, causes the particle to be deflected towards the gravitating mass for all velocities less than c. This deflecting acceleration becomes less, however, as the velocity increases, and a particle moving with the velocity of light would travel through a gravitational field in a straight line. Its velocity, however, decreases as it approaches the gravitating centre, and then increases as it recedes from this point. For velocities close to that of light the deflection is given by

$$2\frac{m}{R}\left(\frac{c^2-v^2}{v^2}\right).$$

The deflection suffered by a light-wave is of a nature quite different from that experienced by a material particle. A ray of light is not bent towards the sun by the latter's gravitational attraction, but the velocity of that portion of the wave-front closest to the sun is decreased more than that of the more remote portion. Therefore, the wave-front is swung round in exactly the same way as when light passes obliquely from a rarer to a denser refracting medium.

In conclusion, it may be noted that the two consequences of Einstein's law which are of great enough magnitude to be tested experimentally have been most conspicuously verified. The predicted shift of the Fraunhofer lines towards the red does not seem to be a necessary consequence either of Einstein's law or of the part of the theory on which this law is based, but rests on the very doubtful assumption that the system of a freely moving atom near the sun's surface is identical with that of a freely moving atom 93,000,000 miles away. If space-time had the same properties in the two regions this identity would be required by symmetry, but as the warping of space-time is quite different near the sun from what it is at the distance of the earth, does it follow that these two systems are necessarily equivalent? It does not seem to the writer that the failure to find this shift invalidates the part of Einstein's theory from which his law of gravitation is deduced, and it certainly does not contradict this law itself.

Leigh Page.

Sloane Laboratory, Yale University, New Haven, Connecticut, January 22.

Biological Science in Secondary Schools.

I should like to direct attention to a very important paragraph in the Report of the Investigators of the Secondary School Examinations Council which is not referred to in the article which appeared in Nature of February 19 (p. 669). It is the paragraph which deals with natural history and zoology.

It is quite clear from this paragraph that the Investigators wish to discourage the teaching of the animal side of biology in secondary schools—a very serious matter in itself. But when the Investigators proceed to state that "the principles of biological science can be [better] illustrated by means of botany," they are expounding a doctrine as to the teaching of a science which is bound to have most serious and harmful results.

The principles of biological science can be taught or illustrated only by persons with a competent knowledge of both botany and zoology, and a suggestion such as this, issued as the considered judgment of a body of educationists, that a knowledge of botany alone is sufficient for this purpose, will only exaggerate the present-day incompetence of the teaching of biology in many of our secondary schools, in which the teachers have had no training in zoology. This matter has already been considered by a representative meeting of zoologists in London, and steps are being taken to represent the views of zoologists to the President of the Board of Education at an early date.

Sydney J. Hickson.

The Victoria University of Manchester, February 23.

Change of Colour in Captive Birds.

Mr. Harold Millar invites notes on this subject (Nature, February 5, p. 600). The case of the crossbill (*Loxia curvirostra*, Linn.) seems in point. My attention was directed to it some years ago, when I saw a number of crossbills—six or eight, if I remember aright—confined in a large cage or small aviary at Glenferness, Nairnshire. The brilliant scarlet plumage which distinguishes the adult male in a state of freedom had changed on these captives to yellowish-olive, and I was informed that this was the invariable effect of captivity. The late Lord Lilford kept a number of crossbills in his famous aviary, and has the following note in his *coloured* "Figures of Birds of the British Isles":—

"On the vexed question of the plumage of the crossbill, I can only say that every *red* bird that I ever possessed lost that brilliant colour at the first moult, and never regained it" (vol. iv., p. 76).

In all the stuffed specimens that I remember to have seen the scarlet hue had faded to the same dingy olive.

Herbert Maxwell.

Monreith.

Volcanic Rocks in Northern Kordofan, Sudan.

In view of the discovery of the Bayuda volcanic field observed by Dr. Chalmers Mitchell during the *Times* African flight, and referred to by Prof. J. W. Gregory in Nature of February 19, some interest attaches to a specimen of a volcanic rock sent to the Mineral Department of the British Museum for identification in July, 1912, by Dr. C. G. Seligmann. The specimen was collected by Dr. Seligmann at the base of Jebel Katul, Northern Kordofan, where he found many stone implements made of the same rock.

Jebel Katul is 350 miles south-west of the volcanic field seen by Dr. Chalmers Mitchell, and is on the trend of the north-east to south-west depression indicated by Prof. Gregory as running from the coast of the Red Sea south of Adal Qaqa, and following the course of the Nile from Abu Hamed to Korti.

The rock is very fine-grained and slate-blue in colour, weathering to pale green. Examination shows it to be a riebeckite-rhyolite showing "flow structure," but too fine in grain to enable the nature of the felspar or the relative amount of quartz present to be determined. The rock is nearly allied to the riebeckite-rhyolites of Gilgil, north of Lake Naivasha, and to the riebeckite-bearing trachytes of Senafé and Fakoda, North Abyssinia, described by Dr. G. T. Prior in 1903, both of which occurrences are on the line of the Great Rift Valley.

W. Campbell Smith.

Mineral Department, British Museum (Natural History), Cromwell Road, S.W., February 23.

Scientific Workers and a National Federation.

Considerable misapprehension seems to have arisen with regard to the action taken by the National Union of Scientific Workers in connection with the inaugural Conference of Professional Associations on February 7, convened for the purpose of forming a National Federation of Professional, Technical, Administrative, and Supervisory Workers. I shall be glad if you will give publicity to the following statement of fact:

This union was invited to send delegates to the inaugural conference and accepted the invitation, as there were many other technical and scientific associations invited with which it was felt this union had almost identical interests. As the result of the preliminary discussion, it was found that such bodies as this would be out-voted and out-influenced in any such federation by unions with which it has little in common. With the help of other associations we moved an amendment in an attempt to prevent the new federation from taking a definite bias at its inception. This amendment was lost, whereupon we abstained from taking further part in the proceedings.

The report as it appeared in the Press stated that the resolution to form a federation was carried unanimously, the inference being that this union, which was represented at the meeting, had decided to join the federation, and many of our members, seeing this misleading statement, have assumed that this is the case. I trust that this disclaimer will reassure them and other such persons who are interested in the union.

A. G. Church,
Secretary.

National Union of Scientific Workers, 10 Tothill Street, Westminster, S.W.1, February 19.

COTTON GROWING IN THE BRITISH EMPIRE.

THE report to the Board of Trade of the Empire Cotton Growing Committee has just been issued (Cmd. 523, price 1*s.* 6*d.* net). Briefly, the story there told may be summed up as follows: The British cotton mills have been directly adapted to utilise the American long-staple cottons, and they produce, in consequence, the high-class goods for which they are famed. The mills may, in fact, be described as unable to use up the abundant, though much shorter, staples of India and certain other countries of the British Empire. For some years past the mills of the States have begun to work up more and still more of their home supply (of superior cottons), so that the position has thus come about that Britain must be prepared, in the near future, to dispense with a large amount of the American raw cottons hitherto regarded as essential. In what way and how soon can this feat be accomplished? Delay may mean famine to the immense community (something like 5,000,000 people) more or less dependent on the cotton mills of Lancashire.

The answer is presumed to have been given by the report before us. But the perusal of the volume leaves a somewhat confused impression, in which we seem to have been studying something closely resembling the meanderings of a great river which flows through the tropical and sub-tropical regions of the world. It engulfs many great tributaries, and is finally discharged into the ocean of British cotton manufacturing interests by six mouths or sub-committees. All this may be fine, and certainly is ingeniously elaborated, but when we read that it is intended to flow on for ever, we begin to wonder if a complex organisation of impersonal and mutable committees is likely to prove the most satisfactory course for obtaining the very-much-to-be-desired results.

The raising of funds (Imperial and Colonial, etc.); the organisation of existing resources; the institution of greater specialisation in the working up of available supplies; the establishment of improvements in handling, transporting, and marketing the raw staple; the prevention of the practices of adulteration and damping; and many other such subjects, are all dealt with in the report, but they do not seem to resolve themselves into the promulgation of a concrete scheme of increased and improved production. Nevertheless, we are assured that the British Empire can be made self-supporting in this matter, though we are not told where or how this is to be accomplished. It must be confessed that the whole history of cotton improvement is most disheartening. We read, for example, of a great scheme having been floated, some seventy years ago, to raise in Manchester a sum of 20,000,000*l.* to be expended in India, during five years, in measures calculated to forward India as a cotton-producing country. Nothing came of that great conception, though spasmodically, after intervals of neglect (due to increased American supply), Associations, Committees, and Commissions were formed, and each in its day aroused considerable interest, but all proved more or less futile. Meanwhile, two great new manufacturing centres gradually progressed into importance—namely, the United States of America and India—and now these have to be reckoned with in the future.

There are, however, in the present report two important schemes—the training of men, and the establishment of research. In both we think the contemplated methods of accomplishment are likely to prove unsatisfactory.

But let the Central Research Institution, proposed in the Committee's report, become a permanent department of expert officials (not a committee of voluntary workers), and have handed over to it a desired programme of work, then we think a definite step would be taken in the right direction. The members of that institute could be held responsible and judged by results. Their programme should be: Research, Education, and Cotton Production. House them, therefore, in a building large enough to have fully equipped laboratories for research, give them as complete a library as possible, and build them a museum and herbarium. But let there be no hair-splitting separations into research as distinct from information—no divided responsibilities. Who can be better qualified to make public the results or materials obtained than the experts concerned? Information cannot, and should not, be separated from research in the way proposed by the report.

One-half at least of all the subjects of research that have to be investigated can be undertaken better in Manchester than in Egypt—the report suggests Egypt. Establish in Manchester a College of Cotton—a Central Research Institution, as it has been called—where both experts and planters can be trained, in close and personal relationship with the great manufacturing interests. One such centre is quite sufficient, and far better than the proposed lectureships and readerships in half-a-dozen colleges or universities, where plant physiology, plant genetics, mycology, entomology, and the like might be taught. In the one, expert and practical men would be directly and immediately trained for cotton planting; in the other, general instructions would be given that might never mature into cotton planting at all. No risks of this kind should be run; general principles of education must never be allowed to take the place of specific training and definite results.

> The Indian Committee insist on the need for more detailed botanical investigation of the existing kinds of cotton in most of the cotton-growing tracts. . . . They consider selection as the first step in evolving better types, to be followed by plant-breeding, which, however, should be entrusted to selected officers who can devote personal attention and considerable time to it.

These passages we single out of the report because they denote acceptance of a most important issue. It has far too long been the habit of cotton experts to hold systematic studies up to ridicule. They have imagined that they were operating on certain species, or they have coined quasi-scientific names for equally illusory forms known to themselves but to no one else. There can be no manner of doubt that not only critical, but also even hypercritical, studies of all the species of Gossypium are imperatively necessary. The work accomplished in one country must be capable of immediate adoption in all others. This involves acceptance of definite specific standards throughout the Empire. No plot of land should, therefore, be cultivated with cotton, in the research experimental farms, without carefully prepared botanical samples being kept of the plant, of its seeds, and of its lint. These should be registered and preserved in both the herbarium and the museum, and, when found necessary, duplicates sent to all research stations, as also to the Central Research Institution. All further experiments could then contrast result after result, until definite progress had been established or the plant rejected as worthless. We require the history of each species to be worked out in the herbarium, and its habitat thereby fully established, before it can be accepted as a unit for investigation.

Then, in collaboration with a fully equipped home institution, there should be opened out branch institutions in each of the more important centres of cotton cultivation within the British Empire. Results worked out in Egypt might be quite unsuited to India, to Africa, or to the West Indies. Each important centre must discover and establish its own stocks. After the students had passed through the home college, they would be sent out to the branch college of the locality for which they were being trained, and made to study there practical cotton planting, as well as learn the local aspects of the industry. They might with advantage be also sent, for a few months, to an American college.

So much for Research and Instruction; but it is next to useless to talk of "investigation" and "education" if no rational scheme can be submitted, side by side, of immediate and direct application. In India, for example, cotton is grown exclusively by natives, each of whom owns but a very few acres. It is believed that the Government is averse to granting land (at present cultivated by the people) to be handed over to Europeans. Tea planting became a European industry because it was organised in uncultivated waste lands. It might, therefore, be recommended to the Government of India to make every effort to organise cotton plantations on such conditions as were found possible. The planter, for example, might be guaranteed against loss while given all profits, but subject after, say, twenty or thirty years to being bought out. If some such scheme could be carried through, it is highly likely that in a very few years cotton planting would be established on a sound commercial basis, and then for a certainty be greedily taken over by the people themselves. Moreover, were it made known in India that a large cotton-growing scheme had been organised by the Government, landed proprietors might be expected to send their sons to England to be trained for running home-farms. Since India is the largest cotton-growing country within the Empire, success there would give the most immediate results; but what may be said of India is doubtless more or less true of most other cotton-growing centres.

It has, however, to be demonstrated that high-class cultivation will pay in order to overcome the peasant cultivation of to-day, with its impecuniosity that precludes advancement. The planters would all be trained pupils of the college, and given the advantages arranged for on condition of carrying out the principles enjoined on them and also of using the stock supplied from the local research station; but their plantations should on no account become experimental farms. The planters should, so far as possible, be free agents. The local research stations would no doubt require experimental farms on which to raise and develop seed, and these should be provided, but every effort should at the same time be put forth to organise a European cotton-planting industry, or at all events an industry on European lines. Indian experience (see the report of the Indian Cotton Committee[1]) would seem to establish at least one great practical conclusion—namely, that there are certain very restricted areas within which the so-called long staples of India can be produced immediately. Assuming that to be correct, cotton planting on a large scale should be at once organised within these tracts as the initial step.

In America success may be described as having been due to three main causes: (*a*) There were no vested interests of native cultivators to contend against; (*b*) the cultivation was undertaken by Europeans who were mostly intelligent farmers; and (*c*) the planters finally rejected the imported stocks, brought from India and the Levant, and evolved purely American stocks. It was these American stocks that gave the world most of the prized fine long staples. The lesson to be learnt is that the three directions indicated should be kept clearly in mind through all future endeavours. We may not be able at once to disregard local vested interests, but we can take the most promising course of ultimately overcoming them—for many years to come, planting must be on European lines if success is to be attained; and finally we must evolve in each centre its own stocks from purely indigenous, or at least long-acclimatised, plants.

Disregard of the vested interests of the people is more dangerous than ignorance of the requirements of the plant. As the Indian Committee says (and very properly), the cultivator's interests are paramount. It is on that account sailing very much too near the wind to speak, as in the report, of "control of seed" and "compulsory measures against cotton pests." No one, of course, could doubt the value of the arguments set forth in these paragraphs, but in certain countries they are highly impracticable. They

[1] Report of the Indian Cotton Committee. (Published by Superintendent of Government of India Printing, 1919.) Price 2s.

could be applied in all Government farms and plantations, but what of the many millions of acres outside? No doubt it would be the most obvious solution of many pests to have a season, like the frost of winter in the United States and in the northern tracts of India, that would kill the cotton plant and the pests as well, so that next year's sowings would stand a chance of being clean. But in many parts of the cotton area of India two cotton crops are taken off the fields every year—the *uppam* and *nadam* of Madras, for example. Cotton may, in fact, be seen growing throughout the year in almost any province of India, one crop coming immediately after the other. The soil is often such that a good staple may be raised on one plot of land, and an inferior on another closely adjacent, and the seasons of their production often overlap. Obviously, while there could not be any compulsory orders that would deprive the individual of his rights, the persuasion of personal advantage, once established by the success of neighbouring large plantations, would in a few years secure all that could be desired.

The salvation of the position is thus the establishment of independent large cotton plantations, but the most serious difficulty is the discovery of the alternative crop or crops most convenient and profitable. It is not cotton growing only (like tea planting) that has to be faced, but systematic tropical agriculture with a full rotation of crops. This aspect of the problem the report has, of course, not dealt with, and has only general principles to offer.

The extension into new areas—more especially lands with rich soils that need only enhanced schemes of water supply to bring them into bearing—is most fascinating, but, as the Indian Committee points out, better results may be looked for from an increase in the average annual yield than from new areas. That view is certainly correct, and should be faced by some practical scheme, and not by a panorama of committees.

GEORGE WATT.

INDUSTRIAL AND MEDICAL RADIOLOGY.

THE extent to which radiology has widened its scope during recent years was strikingly brought out by the exhibition of radiographs held very opportunely by the Röntgen Society at the Royal Photographic Society's galleries during January and February.

Radiology has usually been regarded as a special province of the physician and surgeon, which provides them with a routine means of quick and exact diagnosis. But radiology is spreading its wings into branches of activity far removed from medical endeavour, and the widening of its physical scope cannot fail to react beneficially on the older branch of the subject.

Simultaneously comes the awakening of the medical faculty generally to the importance and promise of physical methods and physical agencies as a means of progress in medical research. There is little doubt that within a short time every large and progressive hospital will have a physicist of standing on its staff; and in this connection we would congratulate the Middlesex Hospital on the good fortune which enables it to establish what we believe is the first medical chair of physics in this country.

In particular, as regards radiology, the physicist will find work to hand in nearly every branch with which he comes in contact. Again, nearly all the problems of equipment and design are physical in character, and need physicists to tackle them, as America has already discovered to her profit. If the physicist can further obtain the co-operation of the electrical engineer, all-round improvements should speedily follow.

(a) (b)

FIG. 1.—(a) Radiograph of hand; exposure 20 mins; January, 1896. (Campbell Swinton.) (b) Radiograph of hand; exposure 1/100 sec.; December, 1919. (Knox.)

What of progress to date? The exhibition referred to here, although confined to radiographic prints, could very fairly be regarded as representative of present-day radiography, and as such it received generous approval from both the public and the Press. Some 200 prints were hung representing work by about thirty of the leading workers.

As a radiographer rarely takes his work beyond the negative stage, for the good reason that a print shows him no more, but usually rather less, than the negative, it was gratifying to find so high a pitch of photographic technique in the majority of the exhibits. On the other hand, few exhibitors had devoted much care or thought to the mounting of their work, a feature which a photographer would never be guilty of neglecting.

About half the exhibition was devoted to medical radiography, and the extraordinary progress that has been made since the discovery of the X-rays twenty-five years ago was strikingly brought out by the juxtaposition of two prints of the human hand (Fig. 1), one taken in January, 1896, by Campbell Swinton, with an exposure of twenty minutes, and the other in December, 1919, by Knox, with a single-impulse flash occupying about 1/100 sec. In the former the bones can be seen, though only blurred; in the latter (with 1/120,000 of the exposure) every detail is brilliantly portrayed. Knox further showed a fine series of flash radiographs of the chest (Fig. 2). Detection of stones in the kidney and bladder is now relatively straightforward work, as the constituent oxalates and phosphates are dense enough to cast good shadows. Until recently gall-stones (consisting chiefly of cholesterin) were deemed impossible of detection, but the radiographer acquires astounding skill in the interpretation of faint shadows, and both Thurstan Holland and Knox showed fine examples of success in diagnosing this troublesome complaint. Fig. 3 is an example of Thurstan Holland's work in barium-meal radiography.

FIG. 2.—Flash radiograph of chest. (Knox.)

FIG. 3.—Right iliac fossa after a barium meal, showing appendix, cæcum ascending colon (with "filling defect" due to malignant growth), an transverse colon. (Thurstan Holland.)

A number of war radiographs were shown; one calling for comment was by Finzi of a bullet in the heart of a man who, it may be added, is still alive. Of interest also was the radiograph of the hand of an Egyptian mummy—a princess of the Second Dynasty (1500 B.C.)—with a scarab ring on the third finger. (Evidently an X-ray equipment will have to be added to the Egyptologist's outfit!)

Some of the most attractive prints were those of shells and rare fossils taken by Rodman; the results reminded one irresistibly of the designs which the harmonograph traces out. Henri Beclere showed a new application of the rays in the radiographing of finger-prints. The skin is first rubbed over with red lead, and the radiograph shows the surface markings and openings of the cutaneous glands in so vivid a fashion as to suggest that the method would have advantages over that normally employed by the Criminal Investigation Department.

Several examples of negative prints on radiobromide paper were exhibited, the most remarkable being that of the skeleton of a man. This radiograph, which was contained on a single sheet, 8 ft. by 4 ft., was taken by Forder with a Coolidge bulb working 8 ft. away.

The use of the X-rays for revealing the interior of plant life is comparatively recent. Considerable differences exist in the mineral content and density, and hence in the transparency, of the different parts of a plant—root, stem, leaf, flower, fruit, seed, etc. It thus happens that even the most delicate structures of plants can be laid bare without tearing the plant to pieces in order to study it. Microscopic detail is, of course, not revealed. Long-waved X-rays are required for such work, of which Knox showed some good flower illustrations.

In the case of timber the different varieties absorb X-rays to different degrees. Peculiarities in the structure and course of the fibres (such as the contortions which produce "figure") are easily discerned. The denser heart-wood is differentiated from the sap wood, the summer and spring growths of the annual rings are readily identified, and defects such as knots or grub-holes show up with astonishing clearness. Kaye and Knox showed some radiographs of aircraft timber and timber-structures taken during the war on behalf

FIG. 4.—Radiograph of aeroplane hollow "box" strut, showing badly fitting internal end-block split by screws. (Kaye and Knox.)

of the Aeronautical Inspection Department (Fig. 4). The method is particularly useful in the case of hollow or laminated components, which cannot otherwise be thoroughly inspected except by destructive tests. Bad gluing, shoddy workmanship, and a variety of timber blemishes are detectable with ease, even on the fluorescent screen.

FIG. 5.—Golf balls, showing absence of core in "floaters" and irregular core in others. (Sunic Research Laboratories.)

There appears to be considerable scope for this branch of radiography.

The radiographing of minerals is an easy means of detecting the presence of very dense elements such as uranium or tungsten. Pilon showed a good example of the method. The structure of golf balls is a somewhat unexpected subject (Batten). The "non-floaters" are wound on a core of heavier rubber; some of the cores were spherical, but others were not—to the probable detriment of accuracy in long putting or driving. Undoubtedly the standardised championship balls of the future will have to satisfy an X-ray test!

A neat method of testing the electrically heated clothing of aeroplane pilots was shown by the Sunic Research Laboratories. The heating strip is sewn within the lining of the leather garment, and any break or kink in the element can easily be "spotted" on the fluorescent screen. The same laboratories showed radiographs of outer covers of motor and aeroplane tyres, and a variety of welds in metal tubes and plates, one of these of a steel plate $\frac{1}{2}$ in. thick being of particular excellence (Fig. 6). The Cox-Cavendish Co. showed a somewhat similar collection, and Chambers and Rankine displayed examples of their curious "diffraction" and multiple image X-ray photography.

Among the most novel exhibits were those by Heilbron illustrating the X-ray examination of old paintings with the object of detecting alterations or additions made since the original work. Success in discovering any such falsifications would be

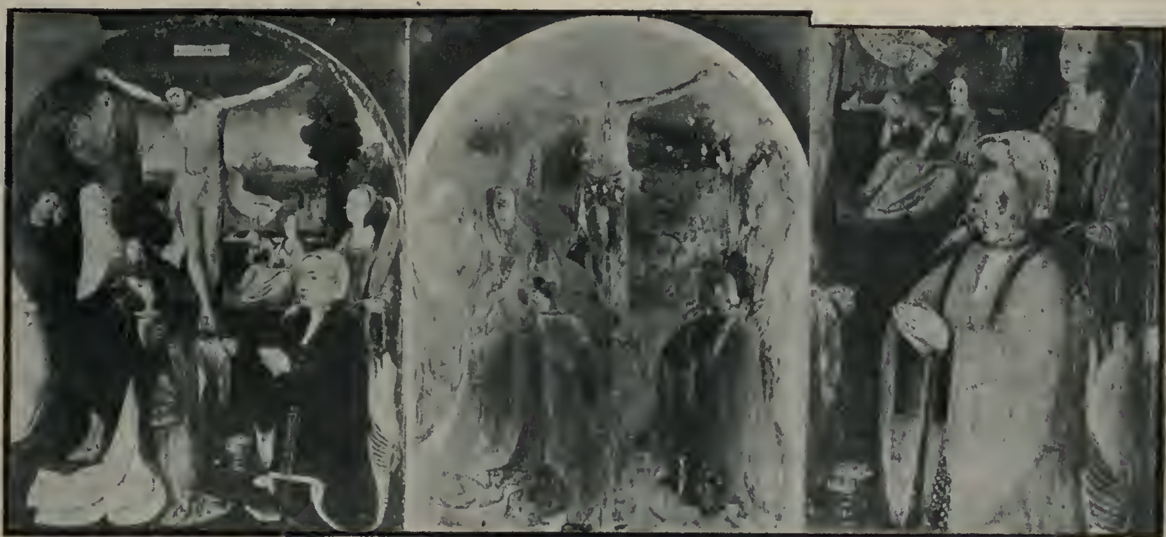
FIG. 6.—Bad weld in steel plates $\frac{1}{2}$ in. thick. (Sunic Research Laboratories.)

possible only if the paint used in the original work were denser than that used in the additions. Some of the ancient pigments used by the masters are obscure in composition, but the blacks, for example, of a more modern day are largely carbon, and very transparent. Two examples of the method were shown, both by Dutch masters of the early sixteenth century. In one, a panel of the Madonna by St. Jans, the X-rays showed that the arms (which appear in a stiff and unnatural attitude) formerly held the Child, and in the other, the "Crucifixion" by Engelbrechtsz (Fig. 7), the radiograph revealed a number of "restorations," including the painting of the portrait of a former "donatrice" over the picture of a monk. As the *Times* remarked in a recent leader, this method of detecting the presence of later additions imposed on the work of the original artists suggests a great field for the re-investigation of palimpsests and ancient manuscripts hitherto regarded as carrying only their face value. Under the trivial inscriptions of medieval monks there may be revealed older matter of priceless worth. We commend the notion to the directors of the various art galleries and museums.

Space considerations have compelled a somewhat invidious selection of exhibits for comment, and we have had to leave much interesting and clever work unnoticed. But, granting the scope and versatility of the attack, we venture to predict that the exhibition will be as nothing to a similar one held, say, in five or ten years' time. Great improvements are imperative, and will doubtless be forthcoming, in the means of registering X-rays. Photographic plates and fluorescent screens need to be improved out of recognition. A good explorer for use in radio-metallography could doubtless be evolved by means of the thermionic valve, as in wireless telegraphy.

With improved equipment radiology will acquire powers which will give it acknowledged status among the sciences, and medical radiology will find an unquestioned place in every medical curriculum. The diploma of medical radiology established last term by the University of Cambridge is a first step. An even bigger one would be the setting up of an X-ray institute in London, which, properly staffed and equipped, would lead to incalculable progress. We understand that such an institute forms part of a forthcoming memorial scheme to the late Sir James Mackenzie Davidson, which we trust will command generous support.

G. W. C. KAYE.



(a) (b) (c)

FIG. 7.—The "Crucifixion" by Cornelis Engelbrechtsz (c. 1500). (a) Natural photograph. (b) Radiograph showing monk in surplice and stole underlying portrait of "donatrice" on right (Heilbron). (c) Natural photograph taken during process of restoration, revealing monk.

REAR-ADMIRAL R. E. PEARY, U.S.N.

THE death of Rear-Admiral Peary at Washington on February 19, at the age of sixty-four, removes one of the most remarkable of modern explorers. It is not so much to the crowning achievement of his life in reaching the North Pole that Peary's claim to the respect of the geographical world is due as to the manner in which he persevered, in the face of almost overpowering difficulties, with very slender resources in a cumulative effort to succeed. The really remarkable thing about Peary is that the method by which he achieved success was practically independent of modern developments in the art of travel. Before very long the North Pole will be accessible by aircraft; it is possible that it might have been attainable years ago by a steamer in an exceptionally open season, but Peary reached the Pole without mechanical help, by the exercise of the powers of human mind and body alone; and had he been a contemporary of Hudson or of Davis there seems to be no reason why his genius could not have won success in the sixteenth or seventeenth century as well as in the twentieth.

Peary's professional training was that of a land-surveyor and civil engineer, and from early youth he was accustomed to find his way through unmapped solitudes and to survey routes hitherto untrodden. He was engaged, amongst other things, on the survey of the abortive Nicaragua Canal after he had joined the civil engineering branch of the United States Navy, and his naval rank must not be taken to imply that he was in any sense a sailor. His official work lay in the construction of harbours and dockyards, and the world owes a debt to the enlightened chiefs of the United States Navy, who recognised that they were making a wise use of their powers in granting this born explorer unlimited leave for Arctic work.

Peary was led to visit Greenland for the first time in 1886 on account of his interest in Baron Nordenskiöld's journey on the inland ice, and he returned from the trip determined to continue the exploration of the ice-cap in its least-known parts. In 1891–92 he spent thirteen months in northern Greenland, establishing himself amongst the Etah Eskimo on Whale Sound, and making a 1200-mile journey with dog-sledges to the north-eastern extremity of Greenland. In 1893–95 he spent twenty-five months in travelling from the same headquarters and proved the insularity of Greenland. The result of his three years' life with the Eskimo was not only to make a thorough anthropological study of the tribe, but also to secure the personal friendship of every member of it, and to become intimately acquainted with the character of every individual, so that, in selecting travelling companions from amongst them, he knew in advance what their powers were and how far they could be trusted. He found that it was possible to live with the Eskimo as one of themselves, and so to make himself independent of the luxuries, and even of many of the supposed necessities, of civilised life without diminishing his power of travelling or of scientific study.

In 1896 and 1897 Peary made summer trips to the north-west coast of Greenland, and brought back from Cape York the famous mass of meteoric iron weighing 90 tons the existence of which had been reported by Sir John Ross nearly a century earlier. The description of the shipping of this mass of metal on a small vessel with no appliances save those which could be improvised on the spot showed how Peary, in becoming an explorer, had not ceased to be a very able civil engineer.

By this time Peary's plan for reaching the North Pole had been fully matured. He resolved to transport a picked contingent of the best of the young men of the Eskimo tribe he knew so well to the farthest north point accessible by sea, and to leave them there with their wives, families, and full equipment in an absolutely normal settlement where they would be happy and contented. From this base he was to travel north as far as the land extended by easy stages, and make a second settlement of the best natives at that point. Thence he proposed to make a continuous march over the sea ice to the Pole and back, waiting for a favourable opportunity, and spending the waiting time, whether it should be weeks or years, in studying the effects of wind and tides on the ice-movements. Lord Northcliffe presented to him the steamer *Windward*, which had done good service in the Jackson-Harmsworth expedition to Franz Josef Land, and, under the auspices of the Peary Arctic Club of Philadelphia, Peary set out on his great task in 1898. It was 1902 before he returned, having reached only 84° 17′, but, in spite of the severest hardships, he was more convinced than ever of the soundness of his method of exploration. In 1904, while recovering from his privations, Peary presided over the Eighth International Geographical Congress in Washington and New York, impressing all who attended that brilliant meeting with the confident, yet modest, assurance of his ultimate success by the methods he had worked out.

In 1905 Peary started in the new exploring ship *Roosevelt*, but had to return in 1906 with no greater success than the attainment of latitude 87° 6′, the farthest north that had been reached so far. Finally, in 1908, he went north for the seventh time, again in the *Roosevelt*, and at last, by the perfected working of his original plan, he hit the fortunate trend of ice and weather and reached the North Pole on April 6, 1909. It will be remembered how the pleasure of this triumph was marred by the pretension of Dr. F. A. Cook to have attained the Pole a year earlier; but the unfortunate controversy held at least this crumb of comfort, that Cook's claim, unfounded as it was, was to have attained success by Peary's method of travelling with trusted Eskimo.

Peary had a fine presence and a forceful diction in speech and writing, his books are amongst the most stimulating for the reading of young explorers, and his careful inductions and thoroughly reasoned plans are a model to all who have to do with the promotion of exploration. He was supported in all his efforts by his wife, who accompanied him on two of his expeditions.

H. R. M.

ROBERT ETHERIDGE.

MR. ROBERT ETHERIDGE, director of the Australian Museum, Sydney, died on January 4 last at the age of seventy-three years. He was active almost until the end, still occupied with research, and his decease is a serious loss to Australasian science. The only son of the late Mr. Robert Etheridge, palæontologist to the Geological Survey of Great Britain, and afterwards assistant-keeper of the geological department of the British Museum, Etheridge adopted the profession of his father, and made many important contributions to our knowledge of the fossils of both Australasia and Britain. Beginning his career on the first geological survey of Victoria, Australia, he returned in the early 'seventies to become palæontologist to the Geological Survey of Scotland, where he not only did important official work, but also co-operated with the late Prof. H. A. Nicholson in describing the Silurian fossils of Girvan, Ayrshire. From 1878 until 1887 he was assistant in the geological department of the British Museum, where he joined the late P. Herbert Carpenter in the authorship of the "Catalogue of the Blastoidea," which still remains the standard work on these fossils.

Colonial life, however, had special attractions for Etheridge, and in 1887 he returned finally to Australia as palæontologist to the Geological Survey of New South Wales and to the Australian Museum. He started two new serials, the Records of the Geological Survey and the Records of the Australian Museum, and published many memoirs and papers on Australian fossils. He also joined R. Logan Jack in preparing two handsome volumes on "The Geology and Palæontology of Queensland and New Guinea," which were published in 1892. In 1895 he succeeded E. P. Ramsay as director of the Australian Museum, but his new administrative duties did not damp his ardour for research, merely extending its scope. He added a deep interest in the aborigines to his earlier pursuits, and wrote, among other works, valuable memoirs on the dingo and on the sculpturing of sacred trees.

Etheridge was always absorbed in his science, and shunned ordinary social life, so that his real good nature could be appreciated only by a very small circle of intimate friends. His scientific worth, however, was widely acknowledged, and he received the Wollaston Fund from the Geological Society of London in 1877, the Clarke medal from the Royal Society of New South Wales in 1895, and the Mueller medal from the Australasian Association in 1911. His name is also associated with the Etheridge goldfield in North Queensland, a high peak on the Kosciusko tableland, and a glacier in Antarctica.

A. S. W.

NOTES.

THE report of observations of a gigantic dinosaurian reptile in the Congo region of Africa, which was made the subject of sensational articles in December last, proves, as we surmised (NATURE, December 18, p. 396), to be without foundation. Mr. Wentworth D. Gray, Acting Representative of the Smithsonian African Expedition in the Katanga, writing from Elisabethville on January 21 to the *Times* of February 23, says:—"I am authorised to contradict the statement that the members of the Smithsonian African Expedition who proceeded to this territory came here to hunt the Brontosaurus. There is no foundation for this statement. I may also state that the report of the Brontosaurus arose from a piece of practical joking in the first instance, and, as regards the prospector 'Gapelle,' this gentleman does not exist except in the imagination of a second practical joker, who ingeniously coined the name from that of Mr. L. Le Page."

THE first meeting since 1914 of the International Council for the Exploration of the Sea will be held in London on March 2. Delegates will be present from Belgium, Denmark, France, Finland, Holland, Norway, and Sweden. Russia and Germany are not represented, and France sends delegates for the first time. The German investigations, it is now known, have been resumed, and the steamer *Poseidon* has been working at sea since last September. The council, it is expected, will consider arrangements for the resumption of the pre-war investigations, and will devote special attention to tracing the effects of the restrictions on fishing during the war period on the abundance of fish in the North Sea. Proposals for the closing of certain North Sea areas against steam-trawling are, it is understood, to be considered. Arrangements are being made by the British Fishery Departments for an early beginning of an extended programme of research. The question of the inclusion of Germany has not yet been considered, but it is believed that there is a growing feeling in this country that she should be invited to participate.

THE Home Secretary, Mr. Shortt, announced in the House of Commons on February 24 that it is proposed that summer time shall begin on March 28 and end on September 27.

WE regret to announce the death, at seventy-five years of age, of Prof. J. Emerson Reynolds, F.R.S., professor of chemistry and chemical philosophy in Dublin University from 1875 to 1903.

MR. J. S. DUNKERLEY, of the University of Glasgow, and Mrs. E. W. Sexton, of Plymouth, have been appointed Ray Lankester investigators at the Marine Biological Laboratory, Plymouth.

THE lecture entitled "Some War-time Efforts in Chemical Industry at Gretna," arranged to be given by Mr. J. C. Burnham before the fellows of the Chemical Society on March 4, has been unavoidably postponed. The usual ordinary scientific meeting for the reading and discussion of papers will be held on that day.

AT the meeting of the Chemical Society held on Thursday, February 19, it was stated that the following changes in officers and council had been proposed by the council:—As secretary, Dr. H. R. Le Sueur *vice* Prof. S. Smiles. As vice-presidents, Prof. J. B. Cohen and Prof. S. Smiles *vice* Prof. A. Smithells and Prof. S. Young. As new ordinary members of council, Prof. A. J. Allmand, Dr. E. F. Armstrong, Mr. F. H. Carr, and Dr. J. T. Hewitt.

A DEPARTMENTAL Committee has been appointed by Dr. Addison to consider the present state of the law with regard to the pollution of the air by smoke and other noxious vapours, and to advise what steps are desirable and practicable to diminish the evils still arising from such pollution. The members of the Committee are:—Lord Newton (chairman), Capt. Hamilton Benn, Prof. J. B. Cohen, Mr. S. Curphey, Sir John Lithiby, Mr. J. F. MacCabe, Mrs. Gilbert Samuel, Mr. E. D. Simon, Bailie W. B. Smith, and Mr. F. J. Willis. Mr. E. C. H. Salmon, of the Ministry of Health, will be secretary, and any communication should be addressed to him at the Ministry, Whitehall, S.W.1.

THE officers and council of the Physical Society elected at the annual meeting on February 13 are as follows:—*President:* Prof. W. H. Bragg. *Vice-Presidents:* Dr. H. S. Allen, Prof. W. Eccles, Prof. A. S. Eddington, and Dr. R. S. Willows. *Secretaries:* Dr. D. Owen (Birkbeck College, Bream's Buildings, London, E.C.4) and Mr. F. E. Smith (National Physical Laboratory, Teddington). *Foreign Secretary:* Sir Arthur Schuster. *Treasurer:* Mr. W. R. Cooper (82 Victoria Street, S.W.1). *Librarian:* Dr. A. O. Rankine (Imperial College of Science and Technology). *Other Members of Council:* Mr. C. R. Darling, Prof. C. L. Fortescue, Dr. E. Griffiths, Dr. E. H. Rayner, Dr. A. Russell, Sir Ernest Rutherford, Dr. G. F. C. Searle, Mr. T. Smith, Dr. J. H. Vincent, and Mr. F. J. W. Whipple.

THE *Morning Post* of February 17 contained an article from its correspondent in Paris stating that three days previously he had witnessed five experiments at a works in the northern suburbs of the city, each of which involved the production of a ton and a half of "high-class steel." At the present time such steel is made either in crucibles or in an electric or an open-hearth furnace. The novelty of the experiments referred to consists in the fact that the steels are made in some form of "converter" of the Bessemer type. Usually this process does not give a sufficiently scientific control of the product to enable high-class steels to be made. It appears from the account given that certain "secret substances" are added which have the effect of controlling the quality of the metal produced, so that it can be used as a basis for the manufacture of high-grade alloy steels. The process is said to have been worked out by four inventors, two of whom are Belgians. The demonstration was witnessed by about a dozen metallurgical experts, who were engaged in taking samples for tests. If the claims of the inventors are substantiated the process will be one of considerable practical importance, and further details will be awaited with interest. It is stated that they have decided not to patent their method, but to operate it as a secret process.

NEWS has just been received of the death at Cairo of Mr. Henry Gribble Turner at the age of seventy-seven years. Mr. Turner joined the Madras Civil Service in 1864, and soon gained a reputation by his successful management of the wild tribes of Vizagapatam district on the east coat, a region where the practice of human sacrifice in honour of the Earth goddess had recently been discontinued. After holding for a time the office of Postmaster-General, he returned to his old district, Vizagapatam, which he administered with much credit until his retirement in 1889. It was due to Mr. Turner that, in the face of great opposition, the standard-gauge railway linking Calcutta with Madras was constructed. He was a skilled mineralogist, and discovered the Vizagapatam manganese deposits, the trade in which has so rapidly developed that the total export is now 600,000 tons annually. He also started the export of Indian magnesite, which proved most useful during the war. Another of Mr. Turner's projects was a harbour at Vizagapatam to serve the rich uplands of the interior, a scheme which is now at last to be undertaken. He failed to secure election as Member for South Somerset in 1895, and he thus escaped the fate of more than one distinguished Indian administrator who did not succeed in making his mark in the House of Commons.

THE committee of the Sheffield Museums and Mappin Art Gallery has issued a consolidated report for the last five years. Special attention is directed to an exhibition relating to infant welfare which was held in 1916. The exhibits were of a comprehensive character, and a series of descriptions was prepared by Dr. Scurfield, Medical Officer, and Dr. Lucy Naish, which is now republished. The instructions in all questions relating to the care of children are elaborate and arranged with full knowledge and much common sense. The authorities of other provincial museums might consider the advisability of reprinting the pamphlet, which is likely to be of much utility.

IN the February issue of *Man* Mr. A. C. Breton describes a remarkable picture-map from Mexico in the manuscript department of the British Museum. The museum authorities acquired the map from Mr. H. Stevens, who, in his turn, purchased it from the original finder, Col. Campos. It was found on the site of the ancient Indian city of Metlaltoynca, in a stone chest which appears to have formed the pedestal of an idol. Several remarkable statues have been found on this site, and the building depicted in the centre of the map is somewhat like the existing Castillo, a pyramid on a base with six high steps and a platform, on the summit of which are buildings. The interpretation of the figure-groups in the map is still to some degree uncertain, but its publication will doubtless lead to an elucidation of its meaning.

THE identification of two statues in the Indian Museum, Calcutta, found at Patna about a century ago, has aroused much interest among Indian archæologists. The question of the date of these statues and of the inscriptions engraved upon them is discussed in vol. v., part 4, of the Journal of the Bihar and Orissa Research Society. Dr. Vincent Smith, in one of the last articles that came from his pen, was disposed to believe that they are portraits of two kings who reigned in the fifth century B.C. This conclusion, if it be correct, revolutionises the current view of the development of Indian art, because hitherto it has been supposed that stone sculpture began in the time of Asoka, who reigned some two centuries later than the assumed date of the Patna statues. Moreover, the execution of these presupposes a long prior development of plastic art. But it must be remembered that the dates of the statues are not yet quite certain, and the question is still under discussion by archæologists.

IN *Sudan Notes and Records* (vol. ii., No. 4, October, 1919) Prof. G. A. Reisner announces the discovery for the first time in the Nile Valley of a horse cemetery. The graves were in four rows, and four complete skeletons were discovered, the horses being of a short, small breed, not unlike the Arab. Each horse was buried with its chariot trappings—they were not ridden at that period—and placed upright with the head towards the south. The regular spacing of the graves, the division into rows, the chronological order of the rows, and the uniformity of the graves in each row justify the conclusion that these horses were sacrificed at the funerals of the kings in order that the spirits of the horses might accompany the spirits of the kings into the other world. The idea is widespread, but in this special form it was hitherto unknown in Egypt. But excavations recently made at Kerma show that the sacrifice of men and animals at funerals was a well-established ancient Ethiopian custom. In fact, there seems reason to believe that horse-sacrifice was due to King Piankhy, who was a great connoisseur of horses, as is proved from his inscriptions.

PROF. C. E. A. WINSLOW, in an address to the American Association for the Advancement of Science entitled "The Untilled Fields of Public Health," expressed the opinion that the public health campaign of the future would need the collaboration of at least the seven following types of highly qualified experts: the physician, the nurse, the bacteriologist, the epidemiologist, the engineer, the statistician, and the social worker. In addition, there must be inspectors to supervise sanitary and housing conditions, and, finally, the administrator who organises and develops the work of all the rest. The latter ought to be medically trained, with subsequent specialisation in public health (*Science*, January 9, p. 23).

THE February number (vol. i., No. 5) of *Medical Science: Abstracts and Reviews*, published for the Medical Research Committee, has reached us. Reviews of current work on medical subjects appear monthly, diseases of the respiratory system and cardiovascular diseases, among others, being dealt with in this issue. In the article on the former, reference is made to the question of the production of emphysema of the lungs (a condition of permanent distension with other changes) by the playing of wind-instruments, as is stated in many text-books. Of forty-six professional players examined, in only three was there slight evidence of emphysema, so that the commonly accepted view seems to be without foundation.

WE have received the quarterly report of the Research Defence Society, dated January, 1920, when the society completed its twelfth year of active work. The society was founded to make known the value and the necessity of experiments on animals, the restrictions imposed on them in this country under the Act of 1876, the nature and the purposes of the experiments which are being made, and the discoveries which have come by the help of the experimental method; also to bring about a better understanding between the few who make these experiments and the many who profit by them. The campaign has been carried out by the circulation of pamphlets, by articles in the Press, and by public lectures. The president of the society is Lord Lamington, and the hon. secretary Mr. Stephen Paget.

MAJOR-GEN. SIR W. LEISHMAN publishes in the *Lancet* of February 14 (p. 366) the results of protective inoculation against influenza in the Army at home during 1918–19. The vaccine consisted of a mixture of three micro-organisms, the influenza bacillus, streptococci, and pneumococci. Among the inoculated, numbering 15,624, the incidence per thousand was:—Of attack, 14·1; of pulmonary complications, 1·6; and of deaths, 0·12. Among the uninoculated, numbering 45,520, the figures were 47·3, 15·3, and 2·5 respectively. At least half of the vaccinated received one dose only, and not two doses as recommended, and the vaccine used at first was considerably "weaker" than that used later. Nevertheless, the figures are decidedly favourable to the value of vaccination, particularly as a preventive of mortality from influenza.

MR. E. E. LOWE, in the *Museums Journal* (vol. xix., No. 7), utters a timely word of warning to the curators and governing bodies of local museums in regard to the haste they are displaying to be taken over by the Board of Education, as recommended by the Adult Education Committee of the Ministry of Reconstruction. If this fate ever overtakes them they will have ample time for unavailing repentance. Mr. Lowe's arguments are stated with considerable ability and force, and his views on the functions of museums are eminently sound. The modern museum, he urges, should, among other things, be educational, but he points out that it would constitute a grave error of judgment, as well as a breach of trust, to hand over museums to the local education authorities.

FROM *California Fish and Game* (vol. vi., No. 1) we learn that extensive plant is being set up at Tropico, California, for the preparation of agar-agar on a commercial scale. Experiments have been carried out which seem to show that agar-agar of a quality much superior to the imported article can be produced from the seaweeds native to the coast of southern California. If this venture is successful, it will create a new industry for the United States. In the same issue a series of figures illustrating the growth of the young of the black sea-bass or jew-fish (*Stereolepis gigas*) is given. These furnish a very striking illustration of the "recapitulation" theory, and explain how it is that the fishermen were unaware of the connection between the gaily coloured fish of a few inches long, with enormous dorsal and ventral fins, and the unicoloured giant in which these fins are relatively extremely small.

THE very handsome volumes issued in 1916–18 by the Maryland Geological Survey have now become available in Europe. They are largely a memorial to the energy of the director, William Bullock Clark, who held office for twenty-five years, dying at too early an age in 1917, and whose obituary, with a portrait, appears in vol. x., which includes his latest educational work, "The Geography of Maryland." This is now published as an amplification of the treatise already used in the State schools. Part 2 of this volume deals with water-supply, and the somewhat massive style of publication—a heritage from the traditions of the United States Geological Survey—makes one wish that the geographical part could have been issued separately bound. Mr. Clark and his staff also contribute two fully illustrated volumes on "The Upper Cretaceous Deposits of Maryland." These occur mainly on the left bank of the Chesapeake Inlet, opposite Baltimore, and are specially noted for their dicotyledonous flora. The Maryland Geological Survey, in continuation of its series of county descriptions, which recall the ambitious scheme of the Ordnance Survey of Ireland in 1837, published in 1917 its memoir on Anne Arundel County; this is written by a number of specialists, so as to present the area south of Baltimore from a geographic point of view. The co-operation of the United States Geological Survey enables this finely illustrated work to be accompanied by four large folding maps on the scale of 1/62,500 (four times that of the 1/250,000 sheets), showing the topography and political divisions, the geology, the soils, and the forestry and commercial areas.

The scientific portion of the *Central Zeitung für Optik und Meckanik* for January 1 contains the first of a series of articles by Prof. von Rohr on the principal points of optical systems and the graphical methods of determining images. The constructions given are those suitable for convex and concave systems of which the principal planes and foci are given. The industrial portion includes a reproduction of the new regulations under which optical workers of eight years' standing may attend shortened courses of instruction at the Government optical school at Jena and, after a qualifying examination, obtain the optician's diploma. A list of the optical and other instruments for which there is at present a demand in foreign countries is given. The wages paid to the various grades of workers in metal in the principal countries of the world form the subject of a further article. A list of the publications of the German Committee on Standards for Industry is provided, and the importance of the rapid adoption of the new standards throughout the country is emphasised. Coloured wall-charts have been prepared, so that the information may readily be placed before the eyes of designers, foremen, and workmen.

In a paper in the *Chemical Age* of February 14 Dr. Stephen Miall plots the atomic weights of the elements against their atomic numbers, and shows that all the elements lie upon a series of parallel lines of three different slopes. The atomic weights may be represented as $bx+a$, where x is the atomic number, a a small integer ranging from 0 to 5, and b has the value 2 for the elements from helium to nickel, 2·5 from copper to tungsten, and 3 from osmium to uranium. The first term, which contributes to the chemical character, he terms "live-weight," and the second term, which is of no influence on the chemical character, "dead-weight." Similar regularities have been previously pointed out, and, indeed, since the atomic weights for the most part conform to integral values, some such relation as the above is necessarily true. But the diagrams have a value apart from their interpretation. They suggest a novel basis for classification, and arrange the elements on parallel lines for which a and b have the same values. They may be useful to those seeking for regularities in the nuclear structure rather than in the atomic shell. Hitherto chemists have been too exclusively obsessed with the study of chemical character to the neglect of the atomic weight—an independent variable, as the study of radio-active change has made quite clear. The atomic weights, however, as the author remarks, mean something. They furnish the only present clue to the structure of the nucleus.

The Carnegie Institution of Washington has issued another section of its monumental "Index of Economic Material in Documents of the States of the United States." The section, prepared by Adelaide R. Hasse, is the first instalment of the index relating to the State of Pennsylvania. Part i. contains the titles of collected documents, mainly printed by authority of the Senate and of the House of Representatives. Part ii. is a topical analysis arranged alphabetically from A to E. Among the longer sections we find Agriculture, Canals, Climate, Coals, Coal-mining, and Education. The period covered is from 1790 to 1904. The new volume has been preceded by twelve similar quarto volumes, and will be followed by others, each devoted to a single State. The index undertakes to deal only with the printed reports of administrative officers, legislative committees, and special commissions of the States, and also with Governors' messages. References are given by volume and page to all material of economic importance contained in the reports and messages indexed. Under each sub-heading the arrangement is chronological. In the alphabetical part the compiler has introduced, in addition to subject entries, the names of persons who have exercised an important influence on the development of the economic life of the State. After each name there is reference to work done. The amount of material which had to be examined for the preparation of this volume must have been very great.

A short but useful list of books on ornithology and oology (No. 398) has just been circulated by Mr. F. Edwards, 83 High Street, Marylebone, W.1. It contains some two hundred and fifty items, including several long runs of serials such as the *Ibis*, Transactions and Journals of the Royal Microscopical Society of London, Proceedings of the Zoological Society of London, etc. The list is sent free on application.

OUR ASTRONOMICAL COLUMN.

Holmes's Comet.—Dr. Schorr reports that the cometary object 1919*f*, found on two plates taken at Bergedorf by Dr. Baade on December 10, is definitely not identical with Holmes's comet, as it failed to appear on two plates taken on December 26, on which it would have been registered if it were moving in accord with the ephemeris calculated for that comet.

Minor Planet GM.—This is the object discovered by Señor Comas Sola on January 13, and considered for a time to be a comet. As it is the brightest minor planet discovered in recent years, it is of interest to give the elements which have been deduced at the Berkeley Observatory, California.

$$T = 1920 \text{ March } 16{\cdot}36 \text{ G.M.T.}$$

$$\left.\begin{aligned} \omega &= 194^\circ\ 28' \\ \Omega &= 300^\circ\ \ 0' \\ i &= 17^\circ\ 59' \end{aligned}\right\} 1920{\cdot}0$$

$$q = 2{\cdot}326$$

$$e = 0{\cdot}1109$$

$$\text{Period} = 4{\cdot}2315 \text{ years}$$

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Mag.
February 28 ...	7 25 26	17 33	11
March 7 ...	7 24 54	16 44	

Nova in Lyra.—Harvard Bulletin No. 705 reports the finding of another nova on the Harvard photographs by Miss Mackie. Position for 1900·0, R.A. 18h. 49m. 3cs., N. decl. 29° 6·3′. Between December 4 and 6 it rose suddenly from mag. 16 or fainter to mag 6·5; on January 6 it had sunk to 8·5. Messrs. Adams and Joy report from Mount Wilson that its spectrum shows the striking nova characteristics.

The same message reports that these observers find remarkable changes in the spectrum of Mira Ceti, the bright helium and hydrogen lines being strengthened and widened towards the red.

TIDES IN PIPES.—In 1914 Messrs. A. A. Michelson and H. G. Gale made a preliminary investigation of the tidal changes in water-level in two pipes, each 502 ft. long, placed respectively along a meridian and a parallel, in the grounds of the Yerkes Observatory. They have now made a more refined series of observations (described in the *Astrophysical Journal* for December). The small changes of water-level are registered by photographing interference fringes produced by placing a mirror about ½ mm. below the surface of the water, and passing a beam of light from an electric lamp vertically down through the water-film, then reflecting it on emergence into a camera in which a sensitive film is moved by clockwork at the rate of 2 cm./hour. Some of the photographed curves are reproduced, and show a beautiful accord with the theoretical curves, which were carefully calculated by Prof. F. R. Moulton. The transition from spring to neap tides, and even the difference in height of alternate semi-diurnal tides, are obvious at a glance. The result shows that the pipe tides are 0·690 of what they would be on a rigid earth, so that the bodily tides in the earth's crust are 0·310 of what they would be if the earth were fluid. The earth tides appear to lag behind the impressed forces by 4°. This method avoids many of the complications that are present in the observation of ocean tides; it also appears to be capable of greater relative precision, in spite of the smallness of the quantities involved.

There appears to be a slip in the value of the rotational velocity ω (p. 350); it is printed as 2π sidl. day/solar day, but surely it should be 2π solar day/sidl. day, the mean solar day being the unit of time employed.

LUMINOSITY IN CENTIPEDES.[1]

AS Chilopoda have been traced back to the Carboniferous age by the palæontologists, these centipedes may be presumed to have understood their own interests pretty well in the struggle for existence. *Geophilus electricus* (Linn.) had already won the attention of Aldrovandi in the sixteenth century, and the specific name adopted for it by Linnæus was obviously based on its observed luminosity. The notes now under review state that among the centipedes only one great group, the Geophilimorpha, is known to exhibit the phenomenon.

With so long a history for the group in the modern period, it seems strange that biologists should still need to ask in regard to some of its species, which are by no means uncommon: Why are they luminous? Even those keen observers, Mr. and Mrs. Brade-Birks, after minute examination, with the aid of friends, and critical comparison of recent authorities, leave the subject inconclusively concluded. Microscopists will read with pleasure details of the contrivances by which they persuaded their many-legged, wriggling subjects, under just the friendliest squeeze, to sit for their portraits. As definite result of their careful study of *Geophilus carpophagus*, they "conclude that in the excretion which accompanies luminosity there are generally present: (i) the contents of the white glands, for [which they] propose the name of *protoluciferin*, (ii) mucin, (iii) acid." The expression "white glands" seems to be used rather vaguely, as applying to certain white, rounded masses on the ventral parts of the specimen, these masses being "groups of pyriform, and probably unicellular, glands intimately associated with the production of light." But it is not made clear whether whiteness is a property of individual glands or only an effect of their grouping into opaque masses.

For an understanding of the debate on the value of lighting up as displayed in this very limited section of the animal world, Dr. Shipley's brief notice may usefully be quoted. He says:—"Some members of the family Geophilidæ are phosphorescent, and secrete from certain glands on the ventral surface a luminous slime; since this is produced by both male and female, and neither of them has eyes, the secretion is regarded as a means of frightening or warding off enemies. The male Geophilus spins a web, and drops a spermatophore in the middle of it, and the female comes and fertilises herself" ("Zoology of the Invertebrata," p. 315). The present collaborators suggest that, without specialised organs of sight, the Geophilids "may be able to appreciate light by a general absorption of its waves through the surface of the body." Though this inchoate power of vision might be otherwise of service, it could scarcely help in bringing the two sexes together, and the riddle is complicated by the fact that allied species without luminosity seem to arrange their affairs very well in its absence.

In general, experience has shown that animals, other than beasts of prey, are not frightened, but attracted, from a dark environment by illumination, so that among the alternative services of *protoluciferin* suggested by the authors any scaring property may be set aside as very improbable.

The systematist is now warned by our authors that *Stigmatogaster subterraneus* should be attributed to Shaw. So lately as last December, in Nevin Foster's list of fifty-three Irish Myriapods, they sanctioned the long-standing error of assigning the species to Leach. They acknowledge themselves baffled by the specific name of *Geophilus convolvens*, on which Fabre founded his researches. This is said to be not a phosphorescent species. Otherwise one might have supposed the name evolved from the strange account which Lucas cites out of the *C.R. Acad. médicale des sciences de Metz* in 1830. This records the frightful tortures in the head of a young Frenchwoman, which after a year were suddenly terminated "par l'expulsion d'un insecte qui, jeté sur le plancher, s'agitoit avec rapidité et se rouloit en spirale." It, however, was determined to be a specimen of *Geophilus carpophagus*, Leach. Gistel in 1850, writing of the Feuerwurm *Geophilus electricus*, alludes to the story, but does not, in fact, discredit it by remarking that such a species could not penetrate the frontal cavities of a human head unless the owner of the head were asleep.

T. R. R. S.

[1] Dartford Naturalists' Field Club Occasional Papers. Notes on Myriapoda. XX. "Luminous Chilopoda, with Special Reference to *Geophilus carpophagus*, Leach." By Hilda K. Brade-Birks and the Rev. S. Graham-Birks.

THE POSITION OF THE METEOROLOGICAL OFFICE.

AT the monthly meeting of the Royal Meteorological Society, held on February 18, Capt. C. J. P. Cave brought forward a paper on "The Status of a Meteorological Office and its Relation to the State and to the Public." It was pointed out that a Meteorological Office is a practical necessity, and, since to be at all efficient it must be subsidised from public funds, it has to be under some Government Department. The work of a Meteorological Office is, however, very wide, and concerns, not one, but almost every Government Department; and if it is to be under one without adequate safeguards, there is a great danger that many important sides of meteorology will be neglected. Safeguards are that the Director of the Meteorological Office should be directly under the Minister of the Department concerned, and on no account under other permanent officials, and that the Meteorological Office should have its separate vote and account in the Estimates. Hitherto the expenses have been controlled by the Meteorological Committee, a body on which several Government Departments as well as the Royal Society are represented; there seems to be no reason why this arrangement should not be continued. The work of the Meteorological Office concerns not only Government Departments, but also such bodies as county councils, municipal bodies, organisers of engineering undertakings, and the general public; and probably none of these know how great a use may be made of meteorological information.

The public is chiefly concerned with forecasts, and probably the mistrust of forecasts which undoubtedly exists in the public mind is due to the delay that occurs before the forecasts are available. Those that appear in the daily papers are based on observations at 6 p.m. of the previous day, but if forecasts based on the 1 a.m. or 7 a.m. observations were sent to every telegraph office in the country and posted up, and could be obtained by telephone subscribers, it would probably prove a great boon, especially to agriculturists, and do much to dispel the present mistrust of weather forecasts.

During the past year the Meteorological Office forecasts have been issued from the Air Ministry, and in the Air Estimate there appears a sum for the Meteorological Office. From this it appears as though the Office is to pass under the Air Ministry. In former times when any change was made in the status of the Office an official inquiry was held, but no such inquiry has apparently taken place as a prelude to the present change, and no public announcement of any kind has been made. There seems no reason for the change. The Meteorological Office had done work on the upper air long before the war, and it was its work which proved that long-distance night flying was a practical possibility. Meteorology must be a national Service, but the policy of handing it over to one Ministry without a separate vote and account would be disastrous, not only to meteorology as a science, but also to the State at large.

The following resolution was adopted at the meeting:—"The Royal Meteorological Society observes that in the Air Estimates for 1919–20 published last December there appears a sum of 12,000*l.* as a supplement to the grant in aid of the Meteorological Office. It would appear from this that it is intended that the finances of the Meteorological Office shall pass under the control of the Air Ministry.

"The Meteorological Office deals with a variety of problems of high scientific and practical importance, some of which have no bearings on the work of the Air Ministry, but are closely connected with the work of other Government Departments. While recognising to the full the great benefits to the meteorology of the upper air likely to accrue from a close association with the Service to which a knowledge of the upper air is so essential, and which possesses such facilities for its investigation, this society cannot but feel misgiving that there may be a tendency for other branches of meteorology to receive less than their due attention if one Government Department has the sole control of the finances and management. The society, therefore, is of opinion that the Meteorological Committee should continue to have full control of the expenditure.

"It has been the practice in the past, before any change was made in the body administering the Meteorological Office, for an inquiry to be held by a Departmental Committee. Reports of three such inquiries have been published, the last being that issued in 1904 of a Treasury Committee presided over by Sir Herbert Maxwell, Bart. The Treasury did not adopt the whole of the recommendations of this Committee, but on May 20, 1905, it issued a minute constituting the Meteorological Committee as it has since existed. The society is of the opinion that before the future constitution of the Meteorological Committee and the status of the Meteorological Office are finally settled, it is desirable that an inquiry by a representative committee should be held."

PRE-HISTORY OF MAN IN BRITAIN.

Flint Implements from the Chalky Boulder Clay of Suffolk.

MR. J. REID MOIR described to the Royal Anthropological Institute on February 17 some interesting flint implements and flakes found in two pits situated to the north of Ipswich, and in a pit at Claydon, to the north-west of that town. In each of these pits Boulder Clay of considerable thickness is exposed, and this deposit, in the opinion of Prof. J. E. Marr, who has visited the sections, is *in situ*, and represents part of the large sheet of Boulder Clay of the Ipswich district. Mr. Reid Moir found many of the specimens described *in situ* in the Boulder Clay, and the others, handed to him by workmen employed in the pits, are of such an order as to make it certain that these implements were also derived from the Boulder Clay. The specimens are in nearly every case made from flakes, and exhibit very little change of surface or signs of abrasion. The two principal types are *râcloirs* and *pointes*; primitive flake-implements and large scrapers are also represented in the series. The technique of these artefacts is in many ways comparable with that of Early Mousterian times, and it is probable that these Boulder Clay specimens are referable to this cultural phase. The implements appear to have been lying in or upon a land surface before being incorporated with the morainic material in which they are now found. One well-made and deeply ochreous flake found in the Boulder Clay appears to be of Chellean age. It exhibits reflaking along its edges, and this flaking is patinated in the peculiar manner of some of the Boulder Clay artefacts.

In the discussion which followed the reading of the paper all the speakers united in dwelling upon the importance of the contribution made by Mr. Reid Moir to the study of the pre-history of man in Britain. Prof. Arthur Keith pointed out that the conclusions which followed from the results of Mr. Reid Moir's investigations could only be described as revolutionary, and would involve a reconsideration of the evidence relating to the antiquity of Stone-age implements. Mr. Reginald Smith said that the *pointe* was considered to be the typical implement of the Mousterian stage of culture. Archæologists would have to consider the possibility of its occurrence in other periods. The peculiar patination which occurred on certain of the specimens found by Mr. Reid Moir in the Ipswich Boulder Clay occurred at Northfleet, and was usually considered to be typical of the Le Moustier period. Mr. Smith also pointed out that some thirty-five years ago Dr. Skertchley had raised the question of the occurrence of palæolithic implements below the Boulder Clay. Dr. Barnes remarked that a considerable number of flakes must be examined before it can be concluded with certainty that a particular type of implement was present. Mr. Reid Moir's collection appeared to him to present all the characteristics which one would expect to find in a group of implements belonging to the Le Moustier culture.

Mr. Kennard said that palæontologists were firmly convinced that the Boulder Clay was of late occurrence. An examination of a continuous series of examples of the fauna exhibited no traces of the variation between warm and cold types, which would have been expected to occur if the theory of alternating warm and cold periods were correct. Fauna of the cold period were always last in the series. Mr. H. Bury said that the evidence brought forward by Mr. Reid Moir made it necessary to raise the question whether Chalky Boulder Clay was always, and wherever it occurred, of the same age. The evidence from Hoxne was diametrically opposed to Mr. Reid Moir's results, and this, together with the doubts which had been expressed as to the character of the evidence obtained from Hoxne, made it desirable that the borings on that site should be repeated.

RECENT ENGLISH MARINE BIOLOGY.

Recent English papers on marine biological research include one by Dr. E. C. Jee on the hydrography of the English Channel during the years 1904–17. This forms part i. of the Fisheries Investigation Series III., the publication of which is now resumed by the Board of Agriculture and Fisheries. Periodicities in the physical properties of the Channel water are discussed, and correlations between these and the pilchard fisheries are apparently established. A most interesting "Contribution to the Quantitative Study of Plankton" is published by Dr. E. J. Allen in part i., vol. xii., of the Journal of the Marine Biological Association.

Plankton investigations, in so far as they have been quantitative, have been a series of approximations to a complete determination of the number of organisms of all kinds contained in a unit volume of sea-water. Hensen's original method consisted in the use of a net made of fine-meshed silk cloth which was lowered in the sea and hauled to the surface. Experiment and calculation gave a coefficient for each net, from which the area of cross-section of the column of water filtered could be approximately determined. It has been found latterly that the greater number of microscopic organisms in the water escaped through the meshes of the cloth, and more refined filtering methods were introduced by Lohmann.

Finally, it was thought that by centrifuging small quantities of water a complete enumeration of the organisms present might become possible, and this method did, indeed, largely increase the numbers inhabiting unit volume of sea-water. Why it should not enable the investigator to determine *all* is not easy to see, but it certainly under-estimates them, as Dr. Allen's results show. In his experiments small quantities of water (10 c.c.) were centrifuged and the contained organisms counted. From four such trials a mean of 14·45 per c.c. (or 14,450 organisms per litre) was obtained. The same water sample was then examined by inoculating ½ c.c. in a sterilised sea-water containing the culture solutions used by Allen and Nelson for the study of marine diatoms. The inoculated medium so prepared was then distributed into seventy small flasks, each containing about 20 c.c. of the liquid, and the latter were allowed to stand for several weeks. The colonies (mainly Diatoms and Flagellates) growing in the flasks were then identified and counted, giving an estimated number of at least 464 organisms per c.c. (or 464,000 per litre). Even then it is evident that the result is an under-estimate of the actual population of the water sample, for the medium is apparently selective, and organisms that appeared in the centrifuged samples did not grow (and were therefore unrecorded) in the cultures. Bacteria did grow, but were not identified and estimated. The result is therefore another, and closer, approximation to a biological value which is of extraordinary interest.

J. J.

THE RED COLOURING MATTER OF PLANT GALLS.

During recent years our knowledge concerning plant colouring matters has rapidly increased, and quite a large number of pigments have been subjected to careful and full investigation. A further interesting contribution to our knowledge in this field of research is contained in a recent paper by Dr. M. Nierenstein, in which he deals with the colouring matter of the "red-pea gall" (Trans. Chem. Soc., 1919, cxv., pp. 1328–32). The galls that were examined occur on the leaves of various British oak-trees when galled by *Dryophanta divisa*, Adler.

It has been generally assumed that the red colouring matters of these and similar galls belonged to the anthocyan class, and one of the objects of the investigation was to ascertain whether the anthocyan assumed to be present was related to quercetin. By this means it was hoped to obtain some light upon the relationship between the products present in the normal plant and those pathologically produced as the result of the formation of the galls.

The investigation resulted in the isolation of a red pigment, to which the name "dryophantin" has been given. Dr. Nierenstein concludes that this colouring matter is not an anthocyan, but a diglucoside of purpurogallin (the first derivative of purpurogallin to be found in Nature), and that, like gallotannin, it is of pathologic origin. He is of the opinion that the other so-called anthocyans obtained from plant-galls are in all probability not anthocyan colours at all, but related to "dryophantin." In view of this he proposes to classify these red pigments under the class-name "gallorubrones."

This paper is of considerable interest, particularly if further investigation confirms the presence of purpurogallin derivatives as regular constituents of these and other red galls. In respect of the conclusion implied as to the absence of pigments of the anthocyan group, the present paper is not sufficient evidence of such absence, for the process whereby the colouring matter has been isolated is such that there is a very considerable doubt whether many anthocyan pigments would survive the treatment.

IONS AND IONISATION.

The Faraday Society, though a small body, is very active. One of the most useful features of its activity is the holding of general discussions on matters of scientific and technical interest, and the publication of these discussions in its Transactions. "The Present Position of the Theory of Ionisation in Solution" was the subject of a discussion held on January 21, 1919, and the report is now issued in the form of a separate reprint (pp. 178, Faraday Society, 10 Essex Street, Strand, W.C.2, price 12*s.* 6*d.*), thus making it available to a larger public than the members of the society.

The discussion was opened by Dr. Senter, who briefly reviewed the position with regard to such outstanding problems as the hydration of ions, the deviation of strong electrolytes from the mass-action law, and the chemical activity of ions and non-ionised molecules respectively. Communications on these and other topics were afterwards read and discussed, amongst the contributors or those taking part in the discussion being Arrhenius (the originator of the theory), Acree, McBain, Bousfield, Sand, Partington, Porter, Newbery, Lindemann, Philip, and J. C. Ghosh.

Fundamental differences of opinion with regard to the main problems discussed were very marked. The evidence for the hydration of ions is by some held as final, by others as having only a limited application, and by yet others as quite inconclusive. Most attention was given to the problem of the abnormality of strong electrolytes. At extreme dilutions these electrolytes are regarded by many as behaving normally, the dissociation constant for uni-univalent electrolytes being about 0·02, but owing to the magnitude of the water-correction, and the difficulty of exactly fixing the molar conductivity for infinite dilution, this result must still be looked upon as uncertain. At ordinary dilutions the law has no application, and the most promising explanation is that elaborated by Dr. J. C. Ghosh, who proceeds on the assumption that the strong electrolytes are practically completely ionised in all dilute solutions, but that there is an electrostatic equilibrium between mobile ions, which contribute to the conductivity, etc., and inert ions, which do not. An electrical dilution law is therefore substituted for the chemical mass-action law in the case of strong electrolytes. For weak electrolytes this electrical action would only enter as a negligible disturbing factor of the mass-action law. The further development of this idea may be awaited with interest.

THE SPECIES CONCEPT AMONG FUNGI.

IN the Transactions of the British Mycological Society (vol. vi., part ii., September, 1919) Mr. W. B. Brierley protests against the practice of mycologists in describing as species the forms which are presented to them in Nature or as pathological growths, especially on cultivated plants. The description of new fungal species is based on the assumptions that the distinguishing characters are of a morphological nature, and that the essential specific characters are constant and hereditary and may be determined in one specimen of one generation. But the laboratory and field experience of the experimentalist shows that under changes in the environment the whole structure and facies of the organism may be transformed, while under identical conditions there is considerable evidence that the morphological variation of a particular fungus is definite and constant. The so-called species of the mycologist is comparable with the "ecad" of the ecologist, and is the resultant of the organism and its environment. "Ecads" indistinguishable from each other may be produced from two distinct organisms interacting with one and the same environment, or with two different environments. Two precisely similar fungi growing on a potato and a decaying tree-stump respectively may really be different species, though the systematic mycologist would consider them identical. The true organism is a physiological equilibration, a metabolic entity, the interaction of which with the environment results in the growth-form or "ecad." It follows that the morphological species concept must be given up in favour of the physiological species concept. The only exact method of determining species is by means of quantitative data derived from cultural treatment under standardised physico-chemical conditions, for this method alone reveals the physiological condition of the organism. The author suggests that even the apparently stable forms of the higher fungi, Agarics, Polypores, etc., are merely "ecads," and that two precisely similar morphological entities of, for instance, *Agaricus melleus* may conceal totally different physiological constitutions which under other conditions of growth would diverge characteristically.

Mr. Brierley also attacks another concept of mycology, namely, the "educability" of fungi, or the induction by suitable treatment of permanent modifications in their biochemical, morphological, or other properties. This concept is widely held by microbiologists, but if it implies a possibility of a change in the physiological constitution of an organism, it follows that with fuller knowledge and improved technique a rapid change of one species into another is possible. The author affirms that the condition of knowledge and the available evidence are not such as to warrant an hypothesis so subversive of the foundations of biological science. The presumed mutations may be due to the presence of mixed populations in supposed pure cultures, or merely the expression of a developmental stage previously unrecognised; further, no organism in which sexuality exists or is conceivable must be used unless its gametic constitution and genetic behaviour under all the conditions of the experiment are known.

THE UPPER LIMIT OF UNPLEASANT BEATS.

IT is well known that Helmholtz traced all discordant effects of two or more musical notes when sounded together to the presence of beats occurring between the prime tones, between the prime of one and an upper partial of the other, between the upper partials of each, or to beats occurring in some other way. Further, to produce the unpleasantness in question the beats must lie between certain limits of frequency, which limits vary with the pitch in use.

In this connection it is of interest to note that Mr. Narendranath Chatterjee, of Chittagong, India, has recently given a formula expressing the upper limiting frequency for beats for which the roughness vanishes. This formula he writes as follows:

$$B = \frac{N}{0{\cdot}7 + n + i}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where B is the number of beats per second for which the roughness vanishes, N is the frequency of the lower of the two tones sounded simultaneously, n is the number of the musical scale containing N and beginning with 32 per second as the fundamental of the first scale (the octave of this being the fundamental of the next scale, and so on), and, finally, i is the interval between N and the fundamental of the scale in which it is contained.

Thus N, n, and i are connected by the equation

$$N = 32 \times 2^{n-1} \times i \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The results of the law compared well with Mayer's experimental values, as shown in the following table:

Frequency N of lower tone	Frequency B of beats when roughness vanishes	
	Mayer's values	Results of law
64	16	17
128	26	27
256	47	45
512	78	76
1024	135	133

RESEARCHES AT HIGH TEMPERATURES AND PRESSURES.

By the Hon. Sir Charles A. Parsons, K.C.B., F.R.S.[1]

II.

THE calories evolved in the combination of graphite and oxygen are about 0·5 per cent. less than those evolved in the combination of diamond and oxygen, indicating that graphite at ordinary temperature is, to this extent, a stable state. The bulk-pressure which has operated in some of the experiments would, however, seem to have been amply sufficient to turn the balance in favour of diamond instead of graphite. The uncertainty, on the other hand, as to the compressibilities and specific heats of the allotropic forms of carbon under high pressures and at high temperatures renders speculation of little value as to what may occur at the melting point of carbon. All we know is that, up to the pressures and temperatures reached in our experiments, no indication of a change from graphite to diamond has been produced. In one experiment very intense heating was applied for five seconds, but sufficient in amount to melt the graphite core six times over, the only result being a slight alteration in the structure of the graphite. The barrier in this experiment was calcined magnesia, and the hole in it was superficially converted to magnesium carbide. It appeared, however, desirable further to investigate the possibility of carbon losing its electrical conductivity when approaching its melting point, as alleged by Ludwig and others, and of shunting the current from itself on to the contiguous molten layers of the insulating barrier surrounding it. There had been no indication of such a change having occurred even momentarily; it rather seemed that the graphite core had been partially vaporised and condensed in the cooler parts of the charge. The experiment was repeated with rods of iron and tungsten embedded in the core, so that should the temperature of volatilisation of the metals under a pressure of 15,000 atmospheres exceed that necessary to liquefy carbon under the same pressure, the presence of these metals might produce a different result. No change, however, occurred.

Note.—The temperatures at which carbon, iron, and tungsten volatilise under a pressure of 15,000 atmospheres are unknown, but they are probably much higher than at atmospheric pressure.

This experiment also tested iron as a solvent of carbon and as a catalyst from diamond to graphite under a pressure of 100 tons, and showed that under this pressure that action was not reversed.

Fig. 3 shows the container arranged for treating powders by resistance heating with or without the addition of liquids or gases. The electric current is conveyed from the container to the upper end of the conductor by a layer of graphite which rests on the charge under treatment. The bottom end of the conductor rests on or is spigoted into a cast-iron block which rests on the bottom pole; this block is sometimes partially melted, but can be easily renewed.

The container is charged by first stemming magnesite powder by hand around the bottom pole-piece and block; then the charge is placed on the top and pressed to 5 tons per square inch; the top ram is then removed, a hole drilled through the charge, and the conductor inserted. Liquids, if used, or carbon dioxide snow may then be introduced; lastly, a layer of graphite is placed on the top, and the whole pressed to the desired pressure for the experiment.

[1] Discourse delivered at the Royal Institution on Friday, January 23. Continued from p. 681.

In one experiment several pounds of carbon dioxide snow were added to the charge, which consisted of magnesia, and was so arranged that evaporation of the heating carbon rod took place in an atmosphere of carbon dioxide and carbon monoxide under a gaseous pressure of 4400 atmospheres, the condensate resulting being soft graphite. Upwards of two hundred chemical reactions arranged to deposit carbon were tested under high pressure and central heating. After each experiment samples were taken from various parts of the charge and carefully analysed for diamond, the methods of the analyses generally following those of Moissan and Crookes. On the whole, there was no evidence that diamond had been produced by any of the chemical reactions, some of which were endothermic, such as carborundum and sodium carbonate, which produced a grey solid which detonated when struck with a hammer, and nearly caused a serious accident. In one experiment the charge was olivine and water; when molten under 10 tons per square inch the pressure was suddenly removed, and artificial pumice was formed by the expansion of water-vapour absorbed by the olivine when molten.

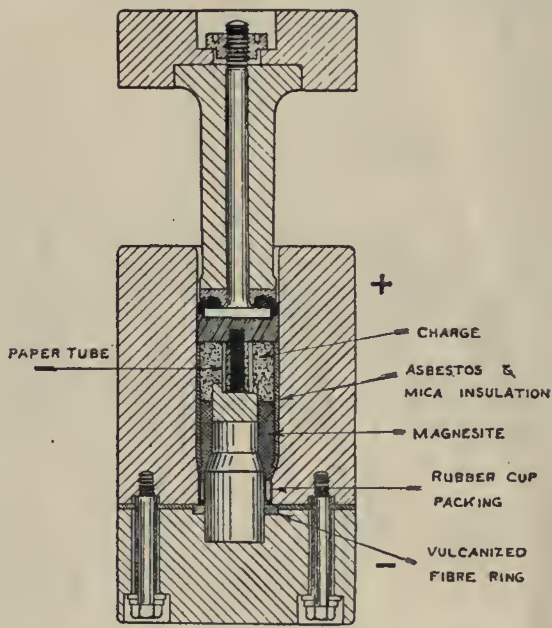


FIG. 3.—For powders with or without liquids and gases.

Having nearly reached the limits of steady pressure obtainable in steel containers under a press, experiments with impact pressures produced by steel bullets were tried, which produced much higher instantaneous pressures than are obtainable in any die.

A rifle, 0·303-in. bore, was arranged for withstanding a charge of cordite 90 per cent. in excess of the Service charge. The gun (Fig. 4) was fixed with its muzzle 6 in. from a massive block of steel, in which a hole 0·303 in. in diameter had been drilled to a depth somewhat greater than the length of the bullet, and in alignment with the bore of the gun; cylindrical bullets of steel with a copper driving band were chiefly used, shorter than the Service bullet and about one-half the weight. The substance to be compressed was placed either at the bottom of the hole, when a conical-nosed bullet of mild steel was used, or over the mouth of the hole, when a cupped-nosed bullet of tool-steel was employed. About a hundred experiments were made.

The substances tested included graphite, sugar-carbon, bisulphide of carbon, oils, etc., graphite and sodium nitrate, graphite and fulminate of mercury, finely divided iron and fine carborundum, olivine and graphite, etc. After each shot the bullet and surrounding steel were drilled out, and the chips and entrained matter analysed. Fig. 5 shows the bullet in the hole after firing.

Several experiments were also made with a bridge of arc-light carbon placed over the hole and raised

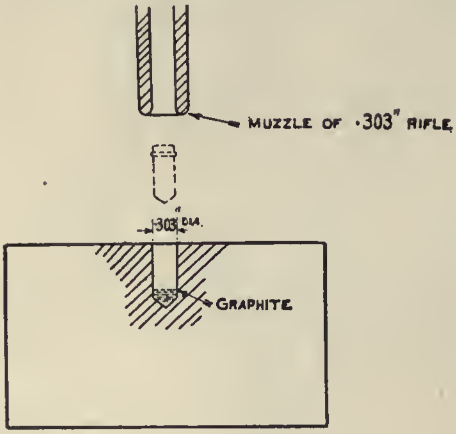


FIG. 4.

to the limit of incandescence by an electric current, and the shot fired through it into the hole at the moment the carbon commenced to vaporise, as observed in a mirror from without. Also, an arc between two carbons was arranged to play just over the hole and the shot fired through it (Fig. 6). The residues were in all cases exceedingly small, and there was no evidence of any incipient transformation of carbon in bulk into diamond that could be detected by analysis.

The pressure on impact of a steel bullet fired into

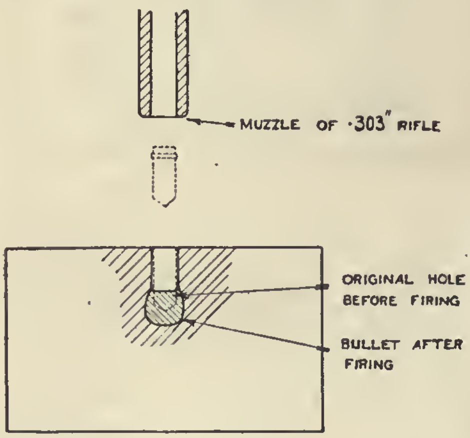


FIG. 5.

a hole in a steel block which it fits is limited by the coefficient of compressibility of steel; with a velocity of 5000 foot-seconds it is about 2000 tons per square inch. Measurements made from a section through the block and bullet (Fig. 5) showed that the mean retardation on the frontal face after the impact until it had come to rest was about 600 tons per square inch. Several experiments were made by substituting a tungsten steel block hardened and tempered, and a hole tapering gently from 0·303 in. at the mouth to 0·125 in. at the bottom. The mild steel bullet was deformed by the tapered hole, which greatly increased the velocity imparted to the nose. Progressively increased charges were used. With the 90 per cent. excess charge the block always split on the first shot, but this probably occurred after impact, and not until the full instantaneous pressure had been exerted, which was probably about 5000 tons per square inch, or about equal to that at the centre of the earth.

It would be interesting to repeat some of these experiments on a larger scale. With a projectile of 6 in. or 9 in. in diameter and a velocity of 5000 foot-seconds, the instantaneous pressure would be the same, but its duration (which is proportional to the linear dimensions) would be increased from twenty-to thirty-fold. It has been estimated that the rise in temperature due to adiabatic compression of incandescent carbon when subjected to 2000 tons per

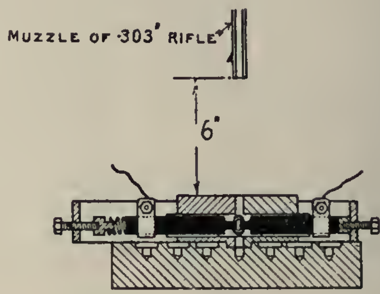


FIG. 6.

square inch is of the order of about 1000° C., so that actual melting of the carbon would probably have occurred when the shot was fired through the incandescent carbon bridge.

Another experiment was arranged which would ensure that carbon should be subjected to an extremely high temperature concurrently with a high pressure obtained by the rapid compression of the hottest possible flame, that of acetylene and oxygen, with a slight excess of the former to provide the carbon. The arrangement was as follows (Figs. 7 and 8):—A very light piston made of tool-steel was carefully fitted to the barrel of a gun of 0·9 in. bore; the piston was flat in front, lightened out behind, and fitted with a cupped copper gas-check ring, the cup facing forward; the total travel of the piston was 36 in. To the

FIG. 7.

muzzle of the gun was fitted a prolongation of the barrel formed out of a massive steel block, the joint being gastight; the end of the bore in the block was closed by a screwed-in plug made of tempered tool-steel, also with a gastight collar. A small copper pin projected from the centre of the plug to give a record of the limit of travel of the piston. The gun was loaded with 2 drams of black sporting powder, which amount had been calculated from preliminary trials. The barrel in front of the piston was filled with a mixture of acetylene and oxygen. It was estimated that this mixture would explode when the piston had travelled about half-way along the bore. When fired, the piston travelled to within $\frac{1}{8}$ in. of the end, as had been estimated, giving a total compression ratio of 288 to 1. As a result, it was found that the surfaces of the end plug, the fore end of the piston, and the circumference of the bore up to ⅜ in. from the end of the plug had been fused to a depth of about 0·01 in., and were glass-hard; the surface of the copper pin had been vaporised, and the copper sprayed over the face of the end plug and piston. The end plug, which had been hardened and tempered to a straw colour, showed signs of compression, and the bore of the block for ⅜ in. from the plug was enlarged by 0·023 in. in diameter, both indicating that a pressure above 100 tons per square inch had been reached. A little brown amorphous carbon was found in the chamber, which was easily destroyed by boiling sulphuric acid and nitre. There was no diamond residue from this. Considering the light weight of the piston and the very short duration of the exposure to heat, the effects would indicate that a very abnormal temperature had been reached, many times greater than exists in the chambers of large guns. A calculation made by Mr. Stanley Cook, based upon the ratio of compression and a final pressure of 15,000 atmospheres, indicates that a temperature of between 15,250° and 17,700° C. was reached, the exact temperature depending upon the amount of dissociation or combination existing between the elements at the time.

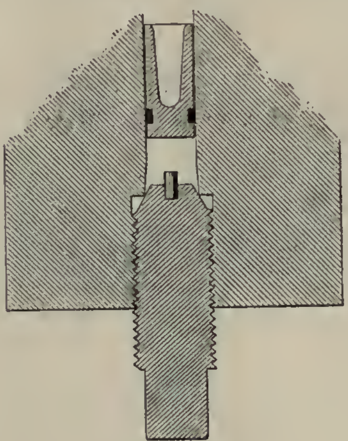


FIG. 8.

Calculation of the Temperature Reached on the Compression of Acetylene and Oxygen Experiment.
BY STANLEY S. COOK.

The temperature reached may be estimated from the final pressure, which the observed deformation of the block and plug indicates to have been in the neighbourhood of 100 tons per square inch. But it must be remembered that there is a change of molecular volume as a result of combustion. Thus the mixture, which as C_2H_2 and 5(O) has 3½ molecular volumes, would on combustion to $2CO_2$ and H_2O have only 3 molecular volumes. The final temperature deduced from the pressure will therefore depend upon the extent to which chemical combination has taken place.

The original mixture being at atmospheric pressure and at a temperature of 290° C. absolute, a pressure of 100 tons per square inch, after compression to 1/288th of its original volume, would indicate a temperature of 15,250° C. If, however, complete combustion has taken place, this pressure would correspond to a temperature greater in ratio of 3½ to 3, viz. to 17,700° C. The actual temperature must therefore have been something between these two values.

Let us for a moment consider the pressures and temperatures possible in Nature (in this I am indebted to kind assistance from Prof. Jeans). The pressure at the centre of the earth is between 4000 and 10,000 tons per square inch, according to the variation in density of the concentric layers.

Emden has estimated the probable pressure at the centre of the more massive component of the binary star S Hercules to be 360,000,000 tons per square inch.

Again, the densities of the brighter components of certain binary stars are estimated by Öpik to be about that of iron, and if we assume that their diameter is the same as that of the sun, that each has an initial velocity in space not greater than 30 miles per second, and that they directly collide, then, owing to their mutual attraction, Jeans calculates that their velocity will have increased to 450 miles per second, and that the pressures in the centre as they strike and flatten would be of the order of 1,000,000,000 tons per square inch. He also estimates that the heat equivalent of the energy would be sufficient to vaporise the whole mass 100,000 times over. This immense pressure would be maintained for many minutes, perhaps for half an hour.

Let us consider what is the greatest pressure that can be produced artificially. If the German gun which bombarded Paris were loaded with a solid steel projectile somewhat shorter and lighter than the one actually used, a muzzle velocity of about 6000 foot-seconds might be reached (many years ago Sir Andrew Noble had reached 5000 foot-seconds); and if it was fired into a tapered hole, as I have described, in a large block of steel, this would give the greatest instantaneous pressure that can be produced artificially so far as we at present know, viz. about 7000 tons per square inch: it is only about 1/150,000th part of that possible by the collision of the largest stars.

As to the temperature and conditions of matter under these intense pressures, extrapolation from known data is valueless. We have no knowledge of the coefficients of compressibility of matter under these conditions or of its specific heat. What may be the effect on the atom? And will elements under such conditions be transformed into others of higher atomic weight?

Some of us may recall that in 1888 a lecturer, after describing in this room the experiment in which oxygen at atmospheric pressure was passed in close contact with a platinum surface heated by the oxy-hydrogen burner to nearly its melting point, and then immediately cooled by contact in water, said:

"In this experiment ozone is formed by the action of a high temperature, owing to the dissociation of the oxygen molecules and their partial recombination into the more complex molecules of ozone. We may conceive it not improbable that some of the elementary bodies might be formed somewhat like the ozone in the above experiment, but at very high temperatures, by the collocation of certain dissociated constituents and with the simultaneous absorption of heat."

It seems indeed probable that the centres of the great stars and stars in collision may be the laboratories where the elements as they gradually degenerate are being continually regenerated into others of higher intrinsic energy, and where endothermic processes, such as the recombination of lead and helium into radium, may be taking place, absorbing in this process an energy 2,500,000 times that developed by the explosion of an equal weight of T.N.T.

The transformation of only a minute fraction of the mass of two colliding stars would therefore be amply sufficient to absorb the whole energy of their collision.

Emerson said many years ago, "None but the elements can themselves destroy."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ABERDEEN.—The honorary degree of LL.D. is to be conferred on Sir J. C. Bose, founder of the Bose Research Institute, Calcutta; Prof. W. Bulloch, professor of bacteriology, London Hospital; Prof. J. Wight Duff, Armstrong College, Newcastle-upon-Tyne; Sir Daniel Hall, Permanent Secretary to the Board of Agriculture; Mr. J. H. Jeans, secretary of the Royal Society; and Sir Robert Jones, lecturer on orthopædic surgery, Liverpool University.

CAPT. JAMES W. LOW has been appointed assistant in the natural history department, University College, Dundee (University of St. Andrews).

APPLICATIONS are invited for the Radcliffe Crocker travelling scholarship in dermatology at University College Hospital Medical School. The scholarship is of the approximate value of 280*l.*, and tenable for one year. Particulars are obtainable from the Dean, University College Hospital Medical School, Gower Street, W.C.1.

THE next election—the seventh—to Beit fellowships for scientific research will take place on or about July 15 next. The latest time for receiving applications is April 19. Forms of application and information respecting the fellowships are obtainable, by letter, from the Rector, Imperial College of Science and Technology, South Kensington.

A MOVEMENT has been started to form a properly constituted Old Students' Association at King's College, London. A committee has drawn up a provisional constitution, and a general meeting has been called for March 4, at 6 p.m., at the college. It has been possible to send notices of this meeting only to those old students whose names are on the register, but it is hoped that the meeting will be made widely known, and that as many old students as possible will be present.

THE first meeting of the International Federation of University Women, which will include delegates from the women's colleges throughout the world, will meet in London in July next. The chairmen of the International Federation are Dean Virginia Gildersleeve, of Barnard College, Columbia University, U.S.A., and Prof. Winifred Cullis, of the London (Royal Free Hospital) School of Medicine for Women, University of London.

THE Chadwick Trustees announce three public lectures on "Military Hygiene in Peace and War," by Gen. Sir John Goodwin, K.C.B., in the lecture-room, Royal Society of Arts, John Street, Adelphi, W.C.2, on Mondays, March 8, 15, and 22, at 5.15 p.m. The titles of the lectures are:—Army Hygiene prior to the Recent War, Army Hygiene during the Recent War (Application of its Principles to Active Service Conditions), and The Future of Army Hygiene (Its Relation to the Hygiene of the Civil Community). All information about Chadwick public lectures may be obtained from the secretary, Mrs. Aubrey Richardson, at the offices of the Trust, 40 (6th) Queen Anne's Chambers, Westminster, S.W.1.

THE opening of the British Bureau of the Office National des Universités et Ecoles Françaises at 50 Russell Square by M. Lucien Poincaré took place on Monday, February 23, in the presence of many distinguished university men of both countries. The bureau is intended to serve as a university *liaison* office between the two countries, giving advice to British students who may wish to study abroad or French students seeking to pursue their studies in England, and so bringing British and French universities into closer touch with one another. M. Poincaré, in declaring the bureau open, said the work which would be done in Russell Square would be of the greatest use, particularly to England and France. He hoped the day would come when all Englishmen would speak French and all Frenchmen would speak English. It was too early, he thought, to say we were internationalists, using the word in its better meaning. We were rather inter-Allies. It was still necessary to struggle for civilisation. He trusted that the Office National would be a powerful factor in uniting England and France in closer bonds and for working for the good of humanity. In the evening, M. Millerand, the Prime Minister of France, in the chair, a dinner given by the Groupe Inter-Universitaire Franco-Britannique was held at the Connaught Rooms in honour of M. Poincaré and to celebrate the formal opening of the bureau. Many public men were present, and the general trend of the speeches during the evening was to emphasise the possibility of this alliance of the universities helping to cement the already established union between France and England.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 12.—Sir J. J. Thomson, president, in the chair.—J. W. **McBain** and C. S. **Salmon**: Colloidal electrolytes. Soap solutions and their constitution. For the first time a comprehensive theory of soap solutions has been set up. This has led to a definition of colloidal electrolytes, a class the members of which will probably prove more numerous than acids and bases put together. They are salts in which one of the ions has been replaced by an ionic micelle. The ionic micelle in the case of soap exhibits an equivalent conductivity equal to that of potassium ion, and double that of the palmitate ion which it has replaced. Its formula may correspond to $(P')_n . m(H_2O)$, but more probably it is $(NaP)_x(P')_n . (H_2O)_m$, where P′ is the anion of the fatty acid in question. In concentrated solutions soaps exist chiefly in colloidal form, together with sodium or potassium ion, equivalent to the ionic micelle present, whereas in dilute solution both undissociated and dissociated soaps are crystalloids of simple molecular weight. In mixtures of soaps the tendency is to form more micellæ. Addition of electrolytes, however, exerts opposing influences, dehydrating and driving back dissociation. The conception of the ionic micelle serves to explain the behaviour of solutions of dyestuffs, indicators, and proteins. A modification of the dew-point method is described, which has enabled measurements of osmotic activity and "molecular weight" to be carried out, free from the uncertainties of interpretation of the results obtained for colloids by the osmometer method, and superseding the well-known but erroneous data of Krafft.—C. C. **Farr** and D. B. **Macleod**: The viscosity of sulphur. The results are discussed of a number of experiments, under a great variety of conditions, on the viscosity of sulphur with temperatures rising and falling between 123° C. and 278° C. The method employed was that of rotating cylinders, usually with a bifilar suspension. A unifilar suspension was, however, employed in the neighbourhood of the point of minimum viscosity. Great care was taken to secure that the sulphur had actually attained the temperature indicated by the thermometer used. The effects were observed of prolonged heating, also the effects of the absorption of gases, especially NH_3 and SO_2. The relation of the viscosity to the amount of "insoluble sulphur" present is considered.—C. V.

Raman and B. **Banerji**: Kaufmann's theory of the impact of the pianoforte hammer.—Comdr. T. Y. **Baker** and Prof. L. N. G. **Filon**: A theory of the second order longitudinal spherical aberration for a symmetrical optical system. The authors obtain a formula for the longitudinal spherical aberration in a symmetrical optical system of the type

$$\Delta x = (\mathrm{A}t^3 + \mathrm{E}t^5)/(1 + \mathrm{B}t^2),$$

where Δx is the longitudinal spherical aberration on the axis, t is the slope to the axis of the emergent ray calculated by Gauss's method, and A, B, E are polynomials in the magnification of degrees 4, 3, and 6 respectively. It is shown (1) that a formula of this kind is, on the average, superior in numerical accuracy to the first two terms of the usual series of aberrations of successive order; and (2) that it removes a number of difficulties connected with convergency which occur in the methods at present in use. In particular, developments in powers of trigonometrical functions of the true inclination of the emergent ray are shown to be unsatisfactory. Certain invariant relations are obtained, connecting A, B, and E in general, and facilitating their computation. Formulæ are found enabling the functions A, B, and E to be calculated for a combination of lenses when the corresponding functions for the individual lenses are given, and a method is indicated whereby the contribution of each lens to the final image defects can be rapidly traced.—Prof. J. W. **Nicholson**: The lateral vibrations of sharply pointed bars. The paper is a sequel to one already published, which arose from a suggestion as to the formation of siliceous deposits on sponge-spicules of a certain type. The present paper deals with an exceptional case, for which the necessary analysis presents unusual features. It is that of a double rod each half of which is generated by rotation of the parabola $y = \mathrm{A}x^2$ about the axis of x. The influence of sharpness on the frequencies and nodal positions of the notes is traced numerically after the general analysis. It is shown that a limiting frequency and nodal position exist, so that the frequency is a lower limit to those producible under any conditions of support. As the rod becomes sharper all its frequencies tend to this value, while of the nodes one for each frequency tends to a definite position, and all the others to the extreme ends of the rod. The same conclusions apply to a single rod.—R. E. **Slade** and F. C. **Toy**: A new method of spectrophotometry in the visible and ultra-violet and the absorption of light by silver bromide. A new method of measuring the absorption of light by a substance has been devised. This method is independent of the relation between density and exposure of the photographic plate. The following values of the extinction coefficient of silver bromide at various wave-lengths have been determined:

λ		k	λ		k
450 $\mu\mu$	...	270	400 $\mu\mu$	...	2000
440 ,,	...	410	390 ,,	...	2790
430 ,,	...	600	380 ,,	...	3800
420 ,,	...	900	370 ,,	...	5100
410 ,,	...	1380	360 ,,	...	6700

This extinction coefficient is defined by the formula

$$\mathrm{I}_2 = \mathrm{I}_1 e^{-kd_1},$$

where I_1 and I_2 are the intensities of the light at points d centimetres apart in the absorbing medium. It is estimated that the average error of any of these values is less than 3 per cent.—Dr. S. **Chapman**: A note on Dr. Chree's discussion of two magnetic storms.—Dr. C. **Chree**: An explanation of the criticisms on Dr. Chapman's recent paper, "An Outline of a Theory of Magnetic Storms."

Linnean Society, February 5.—Dr. A. Smith Woodward, president, in the chair.—Dr. R. Ruggles **Gates**: The existence of two fundamentally different types of characters in organisms. The experimentalist point of view regarding evolution, resulting from the work in mutation and Mendelism, is frankly antagonistic to the views of palæontologists, anatomists, and others who deal with orthogenesis and the inheritance of acquired characters. While these two factors bear entirely different relations to evolutionary changes, both are necessary to account for evolution as it has taken place. The conclusion is reached that higher organisms exhibit two contrasted types of characters, which differ fundamentally (1) in their manner of origin, (2) in their relation to the structure of the organism, (3) in their relation to such phenomena as recapitulation, adaptation, and inheritance, and (4) in their relation to geographic distribution. To the first category belong cell-characters, which arise as mutations, are represented in every cell of the individual, and are usually inherited as distinct entities. To the second category belong organismal characters, which arise gradually through impact of the environment or through orthogenetic changes, may modify only localised portions of the life-cycle, and may not be incorporated in the germ-plasm from the first.

Zoological Society, February 10.—Prof. E. W. MacBride, vice-president, in the chair.—H. R. **Hogg**: Some Australian Opiliones. The genera and species described belonged to the sub-orders Palpatores and Laniatores, the Palpatores being represented by the genera Pantopsalis and Macropsalis of the family Phalangiidæ, and the Laniatores by genera of Triænobunidæ and Triænonychidæ. In the case of the Phalangiidæ the author had been able to establish that long mandibles were a male and short mandibles a female character.—Dr. C. F. **Sonntag**: Larynx and œsophagus of a common macaque, exhibiting several unusual features.—R. E. **Turner** and J. **Waterston**: A revision of the Ichneumonid genera Labium and Pœcilocryptus.

Physical Society, February 13.—Prof. C. H. Lees, president, in the chair.—Prof. C. H. **Lees**: Presidential address: The temperature of the earth's interior. In an average cubic centimetre of matter within the earth's substance the energy generated by radio-active matter is equivalent to the sum of the following quantities: (1) Heat utilised in rise of temperature, (2) loss of heat by conduction, etc., (3) change in gravitational energy, and (4) thermal stress. The only factor known with certainty is the loss by conduction, which works out to an average of 10 ergs per annum per c.c. The approximate water equivalent of the material of the earth is 0·8; therefore a rise of temperature of 1° C. requires 33,000,000 ergs. Hence, if there was nothing to take into account but the conduction loss, the temperature would fall by 1° in 3·3 million years. The discovery of radio-activity, however, showed that near the earth's surface the average amount of energy radio-actively generated is 1000 ergs per c.c. The quantity falls off rapidly as deeper rocks are reached. The present Lord Rayleigh suggests that the average may be about 10 ergs—just sufficient to balance the heat lost from the surface. If we accept this theory, we have to deal with a steady state, in which the temperature neither rises nor falls, and the calculation of the temperature at points inside the mass is simple. The equilibrium theory has been much criticised, however, and it is necessary to consider other alternatives. There are two possibilities: Either the temperature may be rising, due to the radio-energy exceeding the surface loss, or it may be falling if the balance is the other way. The geological evidence renders the first contingency highly improbable. For a rate of change of temperature of 1° per million years the change in thermal energy involved is 33 ergs per annum per c.c., while the change in gravitational energy is 20 ergs per annum per c.c. These quantities can be lumped together and regarded as one by assuming the water equivalent of the earth's substance to be 1·6 times its actual value. Thus, neglecting radio-active effects, the time taken to cool 1° would be 5·4 million years instead of 3·3 million, as calculated without taking gravitational energy into account. From the relative amounts of lead and uranium found in rocks it has been calculated that the time which must have elapsed since the formation of the crust is of the order of 1,000,000,000 years. The temperature of solidification was probably about 1300° C., so we have the data necessary to give the present rate of cooling. From this, for any assumption regarding the actual distribution of radio-active material, the temperature at points within the earth can be determined.—Sir Arthur **Schuster**: The influence of small changes of temperature on atmospheric refraction. The paper is an investigation of the possible deviation of the light from a star near the sun due to the temperature changes in the atmosphere produced by the passage of the moon's shadow across the earth during an eclipse. It is shown that while the actual displacements from this cause vary widely for slight differences in the assumed conditions, they are always negligibly small compared with the effects observed at the last solar eclipse.

Royal Meteorological Society, February 18.—Mr. R. H. Hooker, president, in the chair.—Capt. C. J. P. **Cave**: The status of a Meteorological Office and its relation to the State and to the public (see p. 705).—W. H. **Dines**: Atmospheric and terrestrial radiation. The author endeavours to follow the flow of radiant energy, other than solar, both upward and downward across any horizontal plane in the atmosphere. Certain theoretical assumptions are made to render the calculation possible, and it is shown that the curves that represent the net loss or gain of heat from strata at different heights are all more or less of the same character, whatever possible values are ascribed to the emissivity of the various strata. It is found that over Europe the air from the earth's surface up to about 8 km. is losing heat by radiation, and that from 8 km. to 12 km. it is gaining heat, losing it again at more than 12 km. The validity of the assumptions made is then discussed, and it is pointed out that the numerical values agree well with those obtained by entirely different means.—D. **Brunt**: Internal friction in the atmosphere. When a steady state of motion is assumed, any portion of the atmosphere is in equilibrium under the action of three forces: the gradient of pressure, the deflecting force at right angles to its motion, and the frictional force. The first two of these are measurable, and so the third can be evaluated. The paper gives a comparison of the frictional force calculated in this manner, with the values derived from a theoretical discussion of turbulent motion. A new derivation of the solution of the equations of motion is given. Use is made of observations at the top and base of the Eiffel Tower to derive the value of the coefficient of eddy viscosity. An additional note shows that a solution of the equation of motion is possible in cases where the coefficient of eddy conductivity varies with height.

CAMBRIDGE.

Philosophical Society, February 9.—Mr. C. T. R. Wilson, president, in the chair.—F. W. **Aston**: The mass spectra of the chemical elements. By means of a special arrangement of electric and magnetic fields it is found possible to bring positive rays of definite mass to a focus, independent to some extent of their velocity, so that the dispersion can be made much greater than hitherto without loss of intensity. In this way a mass spectrum is formed on which the values of mass can be compared, in favourable cases, to an accuracy of about one part in a thousand by comparison with known reference lines such as O (16), C (12), etc. In this way atmospheric neon is definitely proved to consist of two isotopes of mass 20 and 22. Argon gives a line exactly at 40, and if it is a mixed element the other constituents must be present in very small proportion. Chlorine gives a group of four lines exactly at 35, 36, 37, and 38, and others from which good evidence can be adduced that this element consists of at least two isotopes, Cl^{α} (35) and Cl^{β} (37), (36) and (38) being the two corresponding hydrochloric acids. Mercury is also found to be a mixture of isotopes, probably three in number, their masses not yet being accurately determined. Very interesting results are yielded by helium and hydrogen; the former appears to be a "pure" element of mass 4·00, but hydrogen is very definitely heavier than unity (O=16. H_1, H_2, and H_3 all give consistent values in approximate agreement with that accepted by chemists: 1·008 for hydrogen. When due allowance has been made for multiple charges, it is found that of more than fifty atomic and molecular masses so far determined, every one, with the exception of the three hydrogen lines, falls on a whole number within the error of experiment.—K. **Molin**: An examination of Searle's method for determining the viscosity of very viscous liquids.—H. W. **Richmond**: Note on the Diophantine equation $t^3+x^3+y^3+z^3=0$.—Prof. H. F. **Baker**: Mathematical notes: (1) The stability of rotating liquid ellipsoids; (2) the general theory of the stability of rotating masses of liquid; (3) the stability of periodic motions in general dynamics; (4) the invariance of the equations of electrodynamics in the Maxwell and in the Einstein forms; (5) a property of focal conics and of bicircular quartics; (6) the Hart circle of a spherical triangle; (7) a proof of the theorem of a double six of lines by projection from four dimensions; (8) a group of transformations of rectangular axes; (9) transformations with an absolute quadric; and (10) the reduction of homography to movement in three dimensions.

EDINBURGH.

Royal Society of Edinburgh, January 12.—Prof. F. O. Bower, president, in the chair.—Prof. W. **Peddie**: The atomic space lattice in magnetite. The question of the uniqueness of the determination by the X-ray method was discussed. It appears that the solution is probably not unique within the limits of accuracy in observation.—J. **Marshall**: An unnoticed point in the theory of Newton's rings. By consideration of the passage of light-waves through three media the author discussed the considerations under which the centre of the rings was a black spot or a bright spot. These depend upon the relative refractive indices of the three materials. It was shown that the reason why Brewster obtained a bright spot at the centre with an appearance of interference rings was because the refractive indices of his materials were approximately in geometrical progression.—A. T. **Doodson**, R. M. **Carey**, and R. **Baldwin**: Theoretical determination of the longitudinal seiches of Lake Geneva. The essential feature of this paper was the development of a mathematical method (due to J. Proudman) of successive approximations by which the nodes of seiches in irregular-shaped basins can be calculated. The method was applied to the seiches of Lake Geneva with satisfactory results.

February 2.—Sir George A. Berry, vice-president, in the chair.—Dr. C. G. **Knott** and Miss **Dallas**: Magnetic strains in nickel-steel tubes. The material was the usual commercial nickel-steel with 2·63 per cent. of nickel. The four tubes were cut down from the same bar, being all of equal length and equal width, and the bores were $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 in. in diameter. The changes in the length of each tube in various fields were measured, as were also the corresponding changes in volume of the bore of the material and in the external form when the bores were plugged so that the tubes were in appearance solid cylinders; and from these measurements the values of the several linear dilatations in these fields were calculated. The longitudinal dilatation was always positive, attaining a value of from $3{\cdot}5\times10^{-6}$ to nearly 5×10^{-6} in field 500. The corresponding radial and tangential dilatations were negative, and ranged from $-1{\cdot}3\times10^{-6}$ to $-2{\cdot}4\times10^{-6}$. The results indicate that a spherical element becomes ellipsoidal or spheroidal, with the longest axis along the axis of the tube. If the effect is to be explained in terms of the orientation of magnetic molecules, then these molecules tend to set with their longer axes along the lines of magnetisation. In former experiments with iron and steel the longitudinal dilatation changed sign from positive to negative in fields of about 300 to 400. In nickel, again, the longitudinal dilatation was always negative and about eight or ten times larger than in the case of either iron or steel. In nickel-steel the dilatation remained positive up to the highest fields used (about 900), although in three of the tubes it passed its maximum in field 400 or 500. So far as magnetic strains are concerned, the small admixture of nickel does not impart to the alloy any nickel characteristic whatever.—Prof. W. **Peddie**: The adequacy of the Young-Helmholtz theory of colour-vision and colour-blindness. Trichromasy in normal eyes is not now theoretical, but a proved fact. Hering's theory, which is favoured by some investigators, is, as Helmholtz showed, also a trichromatic theory; and while both can account for the observed facts, the Young-Helmholtz theory is the simplest that can be formulated. Lack of recognition of its accuracy has been due to non-recognition of the fact of normal trichromasy; or to the erroneous supposition that it is tied down to any one definite view of the nature of the physical and physiological actions concerned in vision; or to the equally erroneous supposition that it can account for only one particular type of colour-blindness with merely individual variations. It can account for any type that is known, or for any at present unknown which may afterwards be found to exist, provided only that it arises from limitation of the at present known normal conditions.—Prof. W. **Peddie**: Note on the quaternionic system as the algebra of the relations of physics and relativity. The author showed that in all cases in which our observations are upon directed phenomena occurring in tridimensional space, but which are actually or merely descriptively to be regarded as influenced by the existence of that space in space of a higher order, the appropriate algebra to be used in their investigation is that of quaternions with the addition of the symbol of the space involved.

PARIS.

Academy of Sciences, February 2.—M. Henri Deslandres in the chair.—The president announced the death of Jules Boulvin, correspondant of the Academy.—C. **Moureu** and G. **Mignonac**: The dehydrogenation of the primary and secondary alcohols by catalytic oxidation. A general method of preparation of aldehydes and ketones. Finely divided silver deposited on asbestos was found to be the best catalyst, and the oxidation is carried out in stages, only about half the amount of air theoretically required for the full reaction being employed in the first stage. The results for nine alcohols are given; the yields are high—62 per cent. for formaldehyde and 70 to 95 per cent. for the higher aldehydes.—A. **Gautier**: The normal arsenic in living tissues and the traces of iodine found in air and waters. Some necessary corrections.—G. A. **Boulenger**: An extraordinary tortoise, *Testudo Loveridgii*. This tortoise is the first example of a reptile in the adult state without ribs, and is a unique case of normal osteolysis.—M. Chodat was elected a correspondant for the section of botany in succession to M. Flauhault, elected non-resident member, and M. Ch. Nicolle a correspondant in the section of medicine and surgery in succession to the late M. Lépine.—L. **de Peslouan**: A congruence between Bernoulli's numbers.—P. **Idrac**: Study of hovering flight in Upper Guinea.—M. **Romieux**: Alluvial strata of the Lot in the neighbourhood of Fumel.—L. **Brillouin**: The continuous spectrum of X-rays.—F. **Canac**: The determination of the axes of symmetry of a cubic crystal.—R. **Abrard**: A Mesoliassic fauna of Sidi Mouley Yakoub (Western Morocco).—F. **La Porte**: Atmospheric observations at Gâvre by means of free rubber balloons. The experimental results can be fairly well represented by Dines's formula with a modified numerical constant, $V=\frac{90\sqrt{F}}{(F+P)}$, where V is the ascensional velocity per minute, F the ascensional force, and P the weight of the envelope in grams.—L. **Emberger**: The evolution of the chondriome in the vascular Cryptogams.—L. **Daniel**: Antagonistic reactions and *rôle* of the pad in grafted plants.—M. **Bezssonoff**: Experimental sexuality in fungi, situated on the typical structure of the sexual plasma.—F. **Gard**: Division in *Euglena limosa*.—G. **André**: The inversion of saccharose in the juice of the orange.—E. **Hérouard**: Double monsters of the scyphistome.—C. **Gessard**: Pyocyanoid bacilli.

BOOKS RECEIVED.

The Topographical Anatomy of the Limbs of the Horse. By Dr. O. C. Bradley. Pp. xi+172. (Edinburgh: W. Green and Son, Ltd.)

Harmsworth's Universal Encyclopedia. No. i. Pp. xix+128. (London: The Amalgamated Press, Ltd.) 1s. 3d.

Index of Economic Material in Documents of the States of the United States. Pennsylvania, 1790–1904. Part i. By A. R. Hasse. Pp. 810. (Washington: Carnegie Institution of Washington.)

Index to U.S. Documents relating to Foreign Affairs. 1828–1861. In three parts. Part ii. By A. R. Hasse. Pp. 795–1331. (Washington: Carnegie Institution of Washington.)

British Journal Photographic Almanac and Photographer's Daily Companion, 1920. Edited by G. E. Brown. Pp. 912. (London: H. Greenwood and Co., Ltd.) 1s. 6d. net.

A Field and Laboratory Guide in Physical Nature-Study. By Prof. E. R. Downing. Pp. 109. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1 dollar net.

Practical Pharmacology: For the Use of Students of Medicine. By Prof. W. E. Dixon. Pp. viii+88. (Cambridge: At the University Press.) 7s. 6d. net.

Chemistry for Textile Students. By B. North. Assisted by N. Bland. Pp. viii+379. (Cambridge: At the University Press.) 30s. net.

An Introduction to the Study of Cytology. By Prof. L. Doncaster. Pp. xiv+280+xxiv. (Cambridge: At the University Press.) 21s. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* L. F. Richardson: Some Measurements of Atmospheric Turbulence.—W. G. Duffield, T. H. Burnham, and A. A. Davis: The Pressure upon the Poles of Metallic Arcs, including Alloys and Composite Arcs.—J. H. Hyde: The Viscosities and Compressibilities of Liquids at High Pressure.—A. Russell: The Capacity Coefficients of Spherical Conductors.—C. Cuthbertson and Maude Cuthbertson: The Refraction and Dispersion of Carbon Dioxide, Carbon Monoxide, and Methane.—A. A. Griffith: The Phenomena of Rupture and Flow in Solids.

INSTITUTION OF ELECTRICAL ENGINEERS, RÖNTGEN SOCIETY, and ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (at Royal Society of Medicine), at 5 and 8.15 (Joint Discussion on Electrical Apparatus in relation to X-rays).—Dr. R. Morton: The Efficiency of High-Tension Transformers as used for X-ray Purposes.—Major C. E. S. Phillips: The Problems of Interrupted and Fluctuating Currents.—R. S. Wright: High-Tension Transformers.

COLD STORAGE AND ICE ASSOCIATION (at Royal Society of Arts), at 5.—H. J. Deane: The Development of the Cold Storage of the Port of London Authority.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. W. E. C. Dickson: Some Pathological Aspects of Tuberculosis.

CONCRETE INSTITUTE (at Vauxhall Bridge Road), at 7.30.—E. F. W. Grimsbaw: Reinforced-Concrete Fences and Posts.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 27.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Dr. Mellanby and Others: Discussion on The Influence of Accessory Food Factors (Vitamine) in Infant Feeding.

PHYSICAL SOCIETY, at 5.—T. Smith: The Balancing of Errors.—Dr. N. W. McLachlan: The Testing of Bars of Magnet Steel.—G. D. West: The Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases.—Miss N. Hosali: Exhibit of Models of Crystals.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—F. W. C. Dean and Others: Discussion on The Education of the Engineer.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. H. Kenyon: Defects found on Inspection of Boilers.

WIRELESS SOCIETY OF LONDON (at Royal Society of Arts), at 8.—A. A. Campbell Swinton: Some Wireless Wonders (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. M. Young: An Investigation into the Periodicity of Epidemics of Whooping Cough from 1870 to 1910 by means of the Periodogram.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—W. B. Hardy: Problems of Lubrication.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

MONDAY, MARCH 1.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND, at 4.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—R. H. Cunningham: Some Engineering Work done by the 277th Railway Coy. (R.E.) in France and Belgium during the War.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—R. E. Dickinson: The Future of Labour in the Engineering Industry.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. Austen Hall: The Planning of American Departmental Stores.

ROYAL SOCIETY OF ARTS, at 8.—C. F. Cross: Recent Researches in the Cellulose Industry (Cantor Lecture).

SOCIETY OF CHEMICAL INDUSTRY AND FARADAY SOCIETY (at Chemical Society), at 8.—Dr. T. M. Lowry and F. C. Hemmings: (1) The Caking of Salts and Other Crystalline Substances. (2) The Setting of Dental Cements.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt. E. W. P. Chinnery: The Opening of New Territories in Papua.

MEDICAL SOCIETY OF LONDON, at 9.—Dr. H. R. Spencer: Tumours complicating Pregnancy, Labour, and the Puerperium (Lettsomian Lecture).

TUESDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: British Ethnology—The Invaders of England.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Anniversary Meeting.

ROYAL SOCIETY OF ARTS (Colonial Section), at 4.30.—G. F. Scott Elliot: Trade Routes for the Empire in Africa.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—Miss Olive Edis: Women on Active Service during the War in France and Flanders.

RÖNTGEN SOCIETY (at Royal Society of Medicine), at 8.—Prof. W. H. Bragg: Analysis by X-rays (Silvanus Thompson Memorial Lecture).

WEDNESDAY, MARCH 3.

ROYAL SOCIETY OF ARTS, at 4.30.—W. J. Garnett: Mongolia from the Commercial Point of View.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Prof. B. Melvill Jones: Flying over Clouds in relation to Commercial Aviation.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—P. J. Worsley: Gears and Gear-cutting.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—C. Ainsworth Mitchell: The Detection of Finger-prints on Documents.—C. J. Ward: Photomicrography with Simple Apparatus.—R. V. Wadsworth: The Solubilities of Theobromine.

ENTOMOLOGICAL SOCIETY, at 8.—*Probable Paper:* G. J. Arrow: Sexual Dimorphism in Coleoptera (with lantern slides.)

THURSDAY, MARCH 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lt.-Col. E. Gold: The Upper Air: (1) Modern Methods of Investigation, and their Application in the War.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 5.—Dr. A. B. Rendle, E. G. Baker, and S. L. Moore: A Contribution to the Flora of New Caledonia, based on the Collections of R. H. Compton in 1914.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

CHEMICAL SOCIETY, at 8.

FRIDAY, MARCH 5.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(A Geophysical Discussion.) J. de Graaf Hunter and Others: The Earth's Axes and Figure.

CONCRETE INSTITUTE (at 296 Vauxhall Bridge Road), at 6.—E. S. Andrews: Some Properties of Steel.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at City and Guilds (Engineering) College), at 7.—Roger T. Smith: Presidential Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Hon. J. W. Fortescue: Military History.

SATURDAY, MARCH 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

CONTENTS.

	PAGE
Meteorology and the State	685
The Birth of Oceanography. By Prof. D'Arcy W. Thompson, C.B., F.R.S.	686
Industrial Psychology. By H. M. V.	687
Criminology and Nervousness	687
Practical Chemistry. By C. J.	688
A Mathematician's Miscellany. By N. R. C.	689
Our Bookshelf	690
Letters to the Editor:—	
Organisation of Scientific Work.—Prof. Frederick Soddy, F.R.S.; Dr. A. B. Rendle, F.R.S.	691
Gravitational Deflection of High-speed Particles.—Leigh Page	692
Biological Science in Secondary Schools.—Prof. Sydney J. Hickson, F.R.S.	693
Change of Colour in Captive Birds.—Right Hon. Sir Herbert Maxwell, Bart., F.R.S.	693
Volcanic Rocks in Northern Kordofan, Sudan.—W. Campbell Smith	693
Scientific Workers and a National Federation.—Major A. G. Church	693
Cotton Growing in the British Empire. By Sir George Watt	694
Industrial and Medical Radiology. (*Illustrated.*) By Dr. G. W. C. Kaye	696
Rear-Admiral R. E. Peary, U.S.N. By H. R. M.	699
Robert Etheridge. By A. S. W.	700
Notes	701
Our Astronomical Column:—	
Holmes's Comet	704
Minor Planet GM	704
Nova in Lyra	704
Tides in Pipes	705
Luminosity in Centipedes. By T. R. R. S.	705
The Position of the Meteorological Office	705
Pre-history of Man in Britain	706
Recent English Marine Biology. By J. J.	707
The Red Colouring Matter of Plant Galls	707
Ions and Ionisation	707
The Species Concept among Fungi	708
The Upper Limit of Unpleasant Beats	708
Researches at High Temperatures and Pressures. (*Illustrated.*) II. By The Hon. Sir Charles A. Parsons, K.C.B., F.R.S.	709
University and Educational Intelligence	712
Societies and Academies	712
Books Received	715
Diary of Societies	716

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