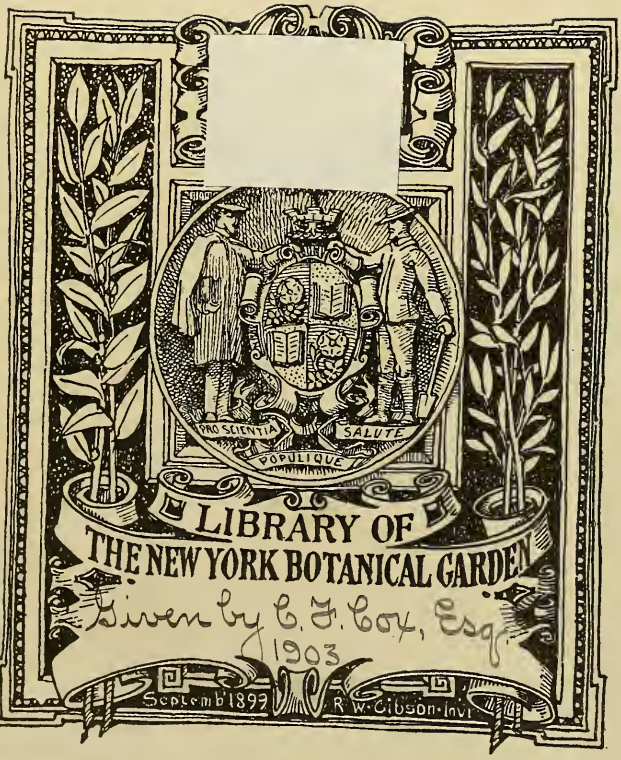

PRO SCIENTIA
SALUTE
POPULIQUE
LIBRARY OF
THE NEW YORK BOTANICAL GARDEN
Given by C. F. Cox, Esq.
1903
Septemb 1893
R. W. Gibson. Invt.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.



---

*Edited by*

**FRANK CRISP, LL.B., B.A.,**

*One of the Secretaries of the Society*

*and a Vice-President and Treasurer of the Linnean Society of London ;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S.,
*Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A., F.Z.S.,
*Professor of Comparative Anatomy in King's College,*

JOHN MAYALL, JUN., F.Z.S.,

FRANK E. BEDDARD, M.A., F.Z.S.,

B. B. WOODWARD, F.G.S.,
*Librarian, British Museum (Natural History),*

R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

J. ARTHUR THOMSON, M.A.,

FELLOWS OF THE SOCIETY.

Ser. II.—VOL. V. PART 2.


PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

1885.

Ser. 2
vol. 5
pts. 4-6

The Journal is issued on the second Wednesday of
February, April, June, August, October, and December.

Ser. II.
Vol. V. Part 4. AUGUST, 1885. To Non-Fellows, Price 5s.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

## CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

## ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

## MICROSCOPY, &c.

*Edited by*

FRANK CRISP, LL.B., B.A.,
*One of the Secretaries of the Society*
*and a Vice-President and Treasurer of the Linnean Society of London;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S.,
*Lecturer on Botany at St. Thomas's Hospital,*

JOHN MAYALL, JUN., F.Z.S.,

F. JEFFREY BELL, M.A., F.Z.S.,
*Professor of Comparative Anatomy in King's College,*

FRANK E. BEDDARD, M.A., F.Z.S.,

AND

B. B. WOODWARD, F.G.S.,
*Librarian, British Museum (Natural History),*

FELLOWS OF THE SOCIETY.


WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED.] [STAMFORD STREET AND CHARING CROSS.

# CONTENTS.


TRANSACTIONS OF THE SOCIETY— PAGE

XI.—THE PATHOGENIC HISTORY AND HISTORY UNDER CULTIVATION OF A NEW BACILLUS (B. ALVEI), THE CAUSE OF A DISEASE OF THE HIVE BEE HITHERTO KNOWN AS FOUL BROOD. By Frank R. Cheshire, F.R.M.S., F.L.S., and W. Watson Cheyne, M.B., F.R.C.S. (Plates X. & XI. & Fig. 134) .. 581

XII.—EXPERIMENTS ON FEEDING SOME INSECTS WITH THE CURVED OR "COMMA" BACILLUS, AND ALSO WITH ANOTHER BACILLUS (B. SUBTILIS?). By R. L. Maddox, M.D., Hon. F.R.M.S... 602

XIII.—ON FOUR NEW SPECIES OF THE GENUS FLOSCULARIA, AND FIVE OTHER NEW SPECIES OF ROTIFERA. By C. T. Hudson, LL.D., F.R.M.S. (Plate XII.) .. .. .. .. .. .. 608

**SUMMARY OF CURRENT RESEARCHES.**

ZOOLOGY.

**A. GENERAL, including Embryology and Histology of the Vertebrata.**

LAULAINÉ—*Unity of the Process of Spermatogenesis in Mammalia* .. .. .. .. 615
DUVAL, M.—*Formation of the Blastoderm in the Bird's Egg* .. .. .. .. .. 615
DARESTE, C.—*Physiological Purpose of Turning the Incubating Hen's Eggs* .. .. 617
LASCHENBERG, O.—*Colours of Birds' Eggs* .. .. .. .. .. .. .. .. .. 618
SARASIN, P. B. & C. F.—*Development of Epicrium* .. .. .. .. .. .. .. 618
RYDER, J. A.—*Translocation forwards of the Rudiments of the Pelvic Fins in the Embryos of Physoclist Fishes* .. .. .. .. .. .. .. .. .. 618
LOEW, O., & T. BOKORNY—*Silver-reducing Animal Organs* .. .. .. .. .. 619
COLEMAN, J. J., & M'KENDRICK—*Effects of Very Low Temperatures on Living Organisms* .. .. .. .. .. .. .. .. .. .. .. .. .. 619
BELL, F. JEFFREY—*Bell's 'Comparative Anatomy and Physiology'* .. .. .. .. 620

**B. INVERTEBRATA.**

RICHARD—*Action of Cocain on Invertebrates* .. .. .. .. .. .. .. .. .. 621
MACMUNN, C. A.—*Enterochlorophyll and Allied Pigments* .. .. .. .. .. .. 621

**Mollusca.**

VIALLETON, L.—*Buccal Membrane of Cephalopoda* .. .. .. .. .. .. .. 622
GRIFFITHS, A. B.—*Pancreatic Function of the Cephalopod Liver* .. .. .. .. 622
PATTEN, W.—*Artificial Fecundation of Mollusca* .. .. .. .. .. .. .. 623
BROCK, J.—*Development of Generative Organs of Pulmonata* .. .. .. .. .. 623
FOL, H.—*Microscopic Anatomy of Dentalium* .. .. .. .. .. .. .. .. 623
BOUTAN, L.—*Nervous System of Fissurella* .. .. .. .. .. .. .. .. .. 624
POIRIER, J.—*Anatomy and Systematic Position of Halia priamus Risso* .. .. .. 624
VAYSSIÈRE, A.—*Tectibranchiata of the Gulf of Marseilles* .. .. .. .. .. 624
NEUMAYR, M.—*Classification of the Lamellibranchs* .. .. .. .. .. .. 625
ZIEGLER, H. E.—*Development of Cyclas cornea* .. .. .. .. .. .. .. 625
CATTIE, J. T.—*Manner in which Lamellibranchs attach themselves to Foreign Objects* .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. 626
MACDONALD, J. D.—*General Characters of Cymbulia* .. .. .. .. .. .. .. 627

**Molluscoida.**

*a.* **Tunicata.**

SEELIGER, O.—*Development of Social Ascidians* .. .. .. .. .. .. .. .. 627
BARROIS, J.—*Genetic Cycle and Germination of Anchinia* .. .. .. .. .. .. 630
ROULE, L.—*New Species of Simple Ascidians* .. .. .. .. .. .. .. .. 631

PAGE

β. Polyzoa.

HARMER, S. F.—*Structure and Development of Loxosoma* .. .. .. .. .. .. 631
MACGILLIVRAY, P. H.—*Australian Bryozoa* .. .. .. .. .. .. .. .. .. .. 633

γ. Brachiopoda.

JOUBIN—*Anatomy of Crania* .. .. .. .. .. .. .. .. .. .. .. .. .. 633

Arthropoda.

α. Insecta.

HICKSON, S. J.—*Eye and Optic Tract of Insects* .. .. .. .. .. .. .. .. 633
ZEILLER, R.—*Tracks of Insects resembling the Impressions of Plants* .. .. .. 635
WALTER, A.—*Morphology of the Lepidoptera* .. .. .. .. .. .. .. .. 635
PACKARD, A. S.—*Number of Abdominal Segments in Lepidopterous Larvæ* .. .. 636
LEE, A. B.—*Structure of the Halteres of Diptera* .. .. .. .. .. .. .. .. 636
ROMBOUTS, J. E.—*Movement of Flies on Smooth Surfaces* .. .. .. .. .. .. 636
CREUTZBURG, N.—*Circulation in Ephemera Larvæ* .. .. .. .. .. .. .. 637
SOMMER, A.—*Macrotoma plumbea* .. .. .. .. .. .. .. .. .. .. .. 637

β. Myriopoda.

LATZEL'S *Myriopods of Austria* .. .. .. .. .. .. .. .. .. .. .. .. 638

δ. Arachnida.

LANKESTER, E. RAY—*New Hypothesis as to the Relationship of the Lung-book of Scorpio to the Gill-book of Limulus* .. .. .. .. .. .. .. .. .. .. 639
PELSENEER, P.—*Coxal Glands of Mygale* .. .. .. .. .. .. .. .. .. .. 639
DAHL, F.—*Anatomy of Spiders* .. .. .. .. .. .. .. .. .. .. .. .. 640
MACCOOK—*Hibernation and Winter Habits of Spiders* .. .. .. .. .. .. 640

ε. Crustacea.

SPENCER, W. BALDWIN—*Urinary Organs of Amphipoda* .. .. .. .. .. .. 640
BLANC, H.—*Development of the Egg and Formation of the Primitive Layers in Cuma Rathkii* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 641
URBANOVICS, F.—*Development of Cyclops* .. .. .. .. .. .. .. .. .. .. 641
HOEK, P. P. C.—*Anatomy of the Cirripedia* .. .. .. .. .. .. .. .. .. .. 641
NASSONOW, N.—*Embryology of Balanus* .. .. .. .. .. .. .. .. .. .. .. 643

Vermes.

VOIGT, W.—*Oogenesis and Spermatogenesis in Branchiobdella* .. .. .. .. .. 643
LEIDY, J.—*New Parasitic Leech* .. .. .. .. .. .. .. .. .. .. .. .. 643
MICHAELSEN, W.—*Archenchytræus Möbii* .. .. .. .. .. .. .. .. .. .. 643
PRUVOT, G.—*Nervous System of Polychætous Annelids* .. .. .. .. .. .. .. 644
FEWKES, J. W.—*Larval forms of Spirorbis borealis* .. .. .. .. .. .. .. 644
SCHARFF, R.—*Skin and Nervous System of Priapulus and Halicryptus* .. .. .. 645
JOLIET, L.—*Development of Sphærularia bombi* .. .. .. .. .. .. .. .. 646
FERUMENT, L.—*New Nematoid from Merlangus* .. .. .. .. .. .. .. .. 646
NIEMIEC, J.—*Nervous System of Bothriocephalidæ* .. .. .. .. .. .. .. 646
ZSCHOKKE, F.—*Parasites of Fresh-water Fishes* .. .. .. .. .. .. .. .. 647
RAMSAY-WRIGHT, R.—*Free-swimming Sporocyst* .. .. .. .. .. .. .. .. 648
PEREYASLAWZEW, Mlle. S.—*Development of Turbellaria* .. .. .. .. .. .. 648
SILLIMAN, W. A.—*Fresh-water Turbellaria of North America* .. .. .. .. .. 648
BATESON, W.—*Later Stages in the Development of Balanoglossus* .. .. .. .. 650

Echinodermata.

NACHTRIEB, H. F.—*Phylogeny of Echinoderms* .. .. .. .. .. .. .. .. 651
DUNCAN, P. MARTIN, & W. P. SLADEN—*Arbaciadæ* .. .. .. .. .. .. .. 652
HAMANN, O.—*Histology of Asterida* .. .. .. .. .. .. .. .. .. .. 652
CARPENTER, P. HERBERT—*Stalked Crinoids of the 'Challenger' Expedition* .. .. 653
PERRIER, E.—*Development of Comatula* .. .. .. .. .. .. .. .. .. .. 655

Cœlenterata.

BALE, W. M.—*Australian Hydroid Zoophytes* .. .. .. .. .. .. .. .. 656
LENDENFELD, R. VON—*Cœlenterates of the Southern Seas* .. .. .. .. .. .. 656
MACMUNN, C. A.—*Chromatology of Actiniæ* .. .. .. .. .. .. .. .. .. 656

Porifera.

SCHULZE, F. E.—*Relationship of Sponges to Choano-flagellata* .. .. .. .. .. 657
CARTER, H. J.—*New Variety of Meyenia fluviatilis* .. .. .. .. .. .. .. 658
POTTS, E.—*New Fresh-water Sponge* .. .. .. .. .. .. .. .. .. .. 658
HANSEN, G. A.—*Sponges of the Norwegian North Sea Expedition* .. .. .. .. 658

### Protozoa.

PAGE

GRUBER, A.—*Further Experiments on the Artificial Division of Infusoria* .. .. 658
STOKES, A. C.—*Vorticellæ with two Contractile Vesicles* .. .. .. .. .. .. 659
" " *New Fresh-water Infusoria* .. .. .. .. .. .. .. .. 659
KENT, W. SAVILLE—*Infusorial Parasites of the Tasmanian White Ant* .. .. .. 662
BUCK, E.—*Unstalked Variety of Podophrya fixa* .. .. .. .. .. .. .. .. 662
LOCKWOOD, S.—*Pseudo-cyclosis* .. .. .. .. .. .. .. .. .. .. 663
DEECKE, T.—*New Protozoon* .. .. .. .. .. .. .. .. .. .. .. 663
RUSCHHAUPT, G.—*Development of Monocystid Gregarines* .. .. .. .. .. .. 665

## BOTANY.

### A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

#### α. Anatomy.

VRIES, H. DE—*Circulation and Rotation of Protoplasm as a means of Transport of Food-material* .. .. .. .. .. .. .. .. .. .. .. .. 665
GUIGNARD, L.—*Divison of the Cell-nucleus in Plants and Animals* .. .. .. .. 666
FROMMANN, C.—*Changes in the Cell-walls of Epidermal Cells and in the Hairs of Pelargonium zonale* .. .. .. .. .. .. .. .. .. .. .. 668
CARNOY'S (J. B.) *Biology of the Cell* .. .. .. .. .. .. .. .. .. .. 669
REINKE, J.—*Decomposition of Solutions of Chlorophyll by Light* .. .. .. .. 669
WEGSCHEIDER, R.—*Spectra of the Pigments of Green Leaves and their Derivatives* 670
WORTMANN, J.—*Red Pigment in Flowering Plants* .. .. .. .. .. .. .. 670
ARNAUD—*Identity of the Orange-red Colouring Matter of Leaves with Carotine* .. 670
CUBONI, G.—*Formation of Starch in the Leaves of the Vine* .. .. .. .. .. 670
FISCHER, A.—*Starch in Vessels* .. .. .. .. .. .. .. .. .. .. 671
MAUMENE, E. J.—*Presence of Manganese in Plants* .. .. .. .. .. .. .. 671
GIRARD, A.—*Nutritive Properties of the various portions of the Grain of Wheat* .. 671
PFITZER, E.—*Assimilating Cavities in the interior of Tubers of Bolbophyllum* .. .. 671
HEINRICHER, E.—*Idioblasts containing Albuminoids in some Cruciferæ* .. .. .. 672
TIEGHEM, P. VAN—*Annular and Spiral Cells of Cactaceæ* .. .. .. .. .. .. 672
HECKEL, E.—*Formation of Secondary Cortex* .. .. .. .. .. .. .. .. 673
MOROT, L.—*Pericycle of the Root, Stem, and Leaves* .. .. .. .. .. .. .. 673
SCHENCK, H.—*Changes of Structure in Land-Plants when growing submerged* .. .. 674
COSTANTIN, J.—*Epidermis of the Leaves of Aquatic Plants* .. .. .. .. .. 674
MARIÉ, P.—*Structure of Ranunculaceæ* .. .. .. .. .. .. .. .. .. 674
RUSBY, H. H.—*Opening of the Anthers in Ericaceæ* .. .. .. .. .. .. .. 675
VESQUE, J.—*Anatomy of the Leaf in Visnieæ* .. .. .. .. .. .. .. .. 675
HEINRICHER, E.—*Reduced Organ in Campanula* .. .. .. .. .. .. .. .. 675
SAVASTANO, L.—*Hypertrophy of the Bud-cones of the Carob* .. .. .. .. .. 675
TOWNSEND, F.—*Homology of the Floral Envelopes in Gramineæ and Cyperaceæ* .. 676
DUCHARTRE, P.—*Bulbils of Begonia socotrana* .. .. .. .. .. .. .. .. 676
MASTERS, M. T.—*Petalody of Ovules* .. .. .. .. .. .. .. .. .. .. 676
HABERLANDT'S *Physiological Anatomy of Plants* .. .. .. .. .. .. .. .. 677
BEHRENS'S *Text-book of General Botany* .. .. .. .. .. .. .. .. .. 677

#### β. Physiology.

HOFFMANN, H.—*Production of Male and Female Plants* .. .. .. .. .. .. 677
JÖNSSON, B.—*Fertilization of Naias and Callitriche* .. .. .. .. .. .. 677
BUYSMAN—*Influence of direct Sunlight on Vegetation* .. .. .. .. .. .. 678
DEHÉRAIN, P. P., & L. MAQUENNE—*Absorption of Oxygen and Evolution of Carbon dioxide in Leaves kept in Darkness* .. .. .. .. .. .. .. .. .. 678
BONNIER, G., & L. MANGIN—*Variation of Respiration with Development* .. .. 679
WORTMANN, J.—*Thermotropism of Roots* .. .. .. .. .. .. .. .. .. 679
SCHEIT, M.—*Air in Water-conducting Wood* .. .. .. .. .. .. .. .. .. 679
LADUREAU, A.—*Ammoniacal Ferment* .. .. .. .. .. .. .. .. .. .. 680
DIETZELL, B. E.—*Source of the Nitrogen of the Leguminosæ* .. .. .. .. .. 680
ATWATER, W. O.—*Absorption of Atmospheric Nitrogen by Plants* .. .. .. .. 680

### B. CRYPTOGAMIA.

#### Cryptogamia Vascularia.

ZEILLER, R.—*Affinities of Lacoopteris* .. .. .. .. .. .. .. .. .. .. 681
DIEULAFAIT—*Composition of the Ash of Equisetaceæ, and its Bearing on the Formation of Coal* .. .. .. .. .. .. .. .. .. .. .. .. .. 681
TÖPFFER, A.—*Transitional Equisetum* .. .. .. .. .. .. .. .. .. .. 681

### Muscineæ.

PAGE

HABERLANDT, G.—*Conduction of Water in the Stem of Mosses* .. .. .. .. .. 681
SCHLIEPHACKE, K.—*Pottia Güssfeldti, a new Moss* .. .. .. .. .. .. .. 682
SABLON, LECLERC DU—*Elaters of Hepaticæ* .. .. .. .. .. .. .. .. .. 682

### Algæ.

HICK, T.—*Protoplasmic Continuity in the Fucaceæ* .. .. .. .. .. .. .. 682
BERTHOLD, G.—*Fertilization of Cryptonemiaceæ* .. .. .. .. .. .. .. 683
WILLE, N.—*Sieve-hyphæ in Algæ* .. .. .. .. .. .. .. .. .. .. .. 684
HANSGIRG, A.—*Algæ of Bohemia* .. .. .. .. .. .. .. .. .. .. .. 684
SOLLA, R. F.—*Pelagic Algæ* .. .. .. .. .. .. .. .. .. .. .. .. 684
RABENHORST'S *Cryptogamic Flora of Germany* (*Marine Algæ*) .. .. .. .. .. 685
TAYLOR, H., & F. KITTON.—*Diatoms and Bladderwort* .. .. .. .. .. .. 685
MÜLLER, O.—*Structure of the Cell-wall of Diatoms* (Fig. 135) .. .. .. .. .. 685
VAN HEURCK'S *Synopsis of the Diatoms of Belgium* .. .. .. .. .. .. .. 686

### Lichenes.

ZUKAL, H.—*Structure of Lichens* .. .. .. .. .. .. .. .. .. .. .. 687
CROMBIE, J. M.—*Algo-Lichen Hypothesis* .. .. .. .. .. .. .. .. .. .. 688

### Fungi.

SCHRÖTER, J.—*Classification of Fungi* .. .. .. .. .. .. .. .. .. .. 689
FISCH, C.—*Development of Ascomyces* .. .. .. .. .. .. .. .. .. .. 689
KLEIN, L.—*Nocturnal Spore-formation in Botrytis cinerea* .. .. .. .. .. 690
WINTER, G.—*Rabenhorst's Cryptogamic Flora of Germany* (*Fungi*) .. .. .. .. 690
ZOPF'S *Myxomycetes* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 690

### Protophyta.

HANSGIRG, A.—*Distribution of Chromatophores and Nuclei in the Schizophyceæ* .. 691
BILLET, A.—*Formation of the Spores of Cladothrix* .. .. .. .. .. .. .. 692
BORNET, E., & C. FLAHAULT—*Aulosira* .. .. .. .. .. .. .. .. .. .. 692
RICHTER, P.—*Microcystis* .. .. .. .. .. .. .. .. .. .. .. .. .. 692
BUNGENER, H.—*Degeneration of Yeast* .. .. .. .. .. .. .. .. .. .. 693
CERTES, A., & D. COCHIN—*Effect of High Pressures on the Vitality of Ferments and on Fermentation* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 693
BÉCHAMP, A.—*Organisms Productive of Zymosis* .. .. .. .. .. .. .. .. 693
WOLLNY, E.—*Microbes in the Soil* .. .. .. .. .. .. .. .. .. .. .. 693
FREIRE, D., & REBOURGEON—*Microbe of Yellow Fever* .. .. .. .. .. .. .. 694
LÖFFLER—*Micro-organisms as a cause of Diphtheria in Man, Pigeons, and Calves* .. 694
BRIEGER, L.—*Bacteria* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 695
BILLET, A.—*Bacterium ureæ* .. .. .. .. .. .. .. .. .. .. .. .. .. 696
MOORE, SPENCER LE M.—*Identity of Bacterium fœtidum* (*Thin*) *with Soil Cocci* .. 696
KOCH, GAFFKY, & LÖFFLER—*Artificial Attenuation of Bacillus anthracis* .. .. .. 696
BIGELOW, H. R.—*Cholera Bacillus* .. .. .. .. .. .. .. .. .. .. .. 697
HERICOURT, J.—*Curved Bacilli in Air and Water* .. .. .. .. .. .. .. .. 697
WOODHEAD & HARE'S '*Pathological Mycology*' .. .. .. .. .. .. .. .. 698

## MICROSCOPY.

### *a.* Instruments, Accessories, &c.

REVOLVING *Stage Microscope* (Fig. 136) .. .. .. .. .. .. .. .. .. .. 699
PORTABLE *Microscopes* (Figs. 137–140) .. .. .. .. .. .. .. .. .. .. 700
PFAFF'S *Microgoniometer* (Figs. 141 and 142) .. .. .. .. .. .. .. .. 702
DOUBLE-DRUM *Microscope* (Fig. 143) .. .. .. .. .. .. .. .. .. .. 703
THEILER'S "*Universal* (*Achromatic*) *Pocket Microscope*" (Fig. 144) .. .. .. .. 704
TOLMAN, H. L.—*Eye-piece Micrometers* .. .. .. .. .. .. .. .. .. .. 704
BOECKER'S *Holder for Analysing Prism and Goniometer* (Figs. 145 and 146) .. .. 705
GUNDLACH, E.—"*An Improvement in Objectives*" .. .. .. .. .. .. .. 705
WALES, W.—*Care and Use of Objectives* .. .. .. .. .. .. .. .. .. 708
GRIFFITH'S *Mechanical Finger Objective* (Fig. 147) .. .. .. .. .. .. .. 709
HUNT, G.—*Right-angled Prism instead of a Plane Mirror* .. .. .. .. .. .. 709
ZENTMAYER'S *Abbe Condenser* (Fig. 148) .. .. .. .. .. .. .. .. .. 710
TOPLER'S *Illuminating Apparatus* (Figs. 149–151) .. .. .. .. .. .. .. 710

PAGE

Bausch & Lomb *Optical Company's "Universal Accessory"* (Figs. 152 and 153) .. 713
Nelson, E. M.—*Illumination* (Figs. 154–170) .. .. .. .. .. .. .. .. .. 713
Hawkins's *Observatory Trough* .. .. .. .. .. .. .. .. .. .. .. .. 719
Pringsheim's *Gas Chambers* (Figs. 171 and 172) .. .. .. .. .. .. .. .. 720
Deby, J.—*Test for the Hand-Lens* .. .. .. .. .. .. .. .. .. .. .. 720
Aperture *Puzzle* (Figs. 173–175) .. .. .. .. .. .. .. .. .. .. .. 721
Govi—*Discovery of Pseudoscopy* .. .. .. .. .. .. .. .. .. .. .. 722
Carpenter, W. B.—*Focal Depth with the Binocular* .. .. .. .. .. .. .. 726
Schoolroom, *Microscope in* .. .. .. .. .. .. .. .. .. .. .. .. 728

### β. Collecting, Mounting and Examining Objects, &c.

Löwe, L.—*Preparing Embryos* .. .. .. .. .. .. .. .. .. .. .. 729
Brass, A.—*Methods of Investigating Animal Cells* .. .. .. .. .. .. .. 729
Ladowsky—*Demonstrating the Nuclei in Blood-corpuscles* .. .. .. .. .. .. 730
Tizzoni—*Demonstration of Karyokinesis in Epithelial Tissues* .. .. .. .. .. 730
Stilling, J.—*Investigating the Structure of the Central Nervous Organs* .. .. .. 730
Sahli, H.—*Application of Borax-methylen-blue in the Examination of the Central Nervous System* .. .. .. .. .. .. .. .. .. .. .. .. 731
Golgi, C.—*Preserving Sections of the Nervous System treated with Bichromate of Potash and Nitrate of Silver* .. .. .. .. .. .. .. .. .. .. .. 731
Zawarykin, Th.—*Study of Fat-absorption in the Small Intestine* .. .. .. .. 731
List, J. H.—*Preparing the Cloacal Epithelium of Scyllium Canicula* .. .. .. 731
Maurice, C., & A. Schulgin—*Preparing Embryos of Amarœcium proliferum* .. 731
Gillo, R.—*Mounting Insects without Pressure* .. .. .. .. .. .. .. .. 732
Sharp, H.—*Mounting the Proboscis of the Blow-fly in Biniodide of Mercury* .. .. 733
Emery, C.—*Preparing Luciola italica* .. .. .. .. .. .. .. .. .. .. 733
Kennel, J. v.—*Preparing Embryo of Peripatus Edwardsii and P. torquatus* .. .. 734
Courroux, E. S.—*Preparing Diatoms from the Stomachs of Mollusca and Crustacea* 734
Bayberry *Tallow for Imbedding* .. .. .. .. .. .. .. .. .. .. .. 735
Fischer, P. M.—*Imbedding and Examining Trematodes* .. .. .. .. .. .. 735
Hatfield's *Rotary Section-cutter* (Figs. 176 and 177) .. .. .. .. .. .. .. 735
Mark, E. L.—*Notes on Section-cutting* .. .. .. .. .. .. .. .. .. .. 737
Spee, F.—*Sections in Series* .. .. .. .. .. .. .. .. .. .. .. .. 740
Hamann, O.—*New Carmine Solution* .. .. .. .. .. .. .. .. .. .. 740
Hickson, S. J.—*Method of Preparing Hæmatoxylon Staining Fluid* .. .. .. .. 741
Bizzozero, G., & Torres—*Staining for the Study of Red Blood-corpuscles* .. .. 741
Sahli, H.—*New Double Stain for the Nervous System* .. .. .. .. .. .. 741
Adamkiewicz, A.—*New Method of Staining the Spinal Cord* .. .. .. .. .. 742
Kupffer, C.—*Staining the Axis-cylinder of Medullated Nerve-fibres* .. .. .. .. 742
Turner, W. B.—*Staining Desmids* .. .. .. .. .. .. .. .. .. .. .. 742
Wire, A. P.—*Boro-glyceride for Mounting* .. .. .. .. .. .. .. .. .. 742
Douglas, J. C.—*Litharge and Glycerin as a Cement* .. .. .. .. .. .. .. 743
Hamlin's *Ideal Slide* (Figs. 178 and 179) .. .. .. .. .. .. .. .. .. 743
Hays, J. E.—*Finish for Slides* .. .. .. .. .. .. .. .. .. .. .. 744
Hansen, E. C.—*Counting of Microscopic Objects for Botanical Purposes* .. .. .. 744
Aubert, A. B., & J. Deby.—*Styrax and Balsam* .. .. .. .. .. .. .. .. 744
Bureau *of Scientific Information* .. .. .. .. .. .. .. .. .. .. .. 745
A New *Departure* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 745
Rex, G. A.—*Collecting and Preserving Myxomycetes* .. .. .. .. .. .. .. 748
Volvox globator, *Keeping Alive and Mounting* .. .. .. .. .. .. .. .. 749
Wedding, H.—*Examination of Malleable Iron* .. .. .. .. .. .. .. .. 749

Proceedings of the Society .. .. .. .. .. .. .. .. .. 750

# ROYAL MICROSCOPICAL SOCIETY.

## COUNCIL.

ELECTED 11th FEBRUARY, 1885.

**PRESIDENT.**

Rev. W. H. Dallinger, LL.D., F.R.S.

**VICE-PRESIDENTS.**

John Anthony, Esq., M.D., F.R.C.P.L.
G. F. Dowdeswell, Esq., M.A.
Prof. P. Martin Duncan, M.B., F.R.S.
Albert D. Michael, Esq., F.L.S.

**TREASURER.**

Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

**SECRETARIES.**

*Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.
Prof. F. Jeffrey Bell, M.A., F.Z.S.

**Twelve other MEMBERS of COUNCIL.**

Joseph Beck, Esq., F.R.A.S.
A. W. Bennett, Esq., M.A., B.Sc., F.L.S.
*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
James Glaisher, Esq., F.R.S., F.R.A.S.
*J. William Groves, Esq.
John Matthews, Esq., M.D.
John Mayall, Esq., Jun.
*John Millar, Esq., L.R.C.P., F.L.S.
Urban Pritchard, Esq., M.D.
Stuart O. Ridley, Esq., M.A., F.L.S.
*Prof. Charles Stewart, M.R.C.S., F.L.S.
William Thomas Suffolk, Esq.

**LIBRARIAN and ASSISTANT SECRETARY.**

Mr. James West.

* Members of the Publication Committee.

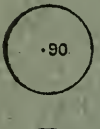
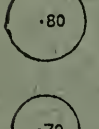
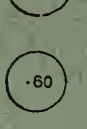
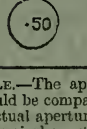
### MEETINGS FOR 1885, at 8 p.m.

| | | | |
|---|---|---|---|
| Wednesday, January .. .. | 14 | Wednesday, May .. .. .. | 13 |
| „ February .. .. | 11 | „ June .. .. .. | 10 |
| *(Annual Meeting for Election of Officers and Council.)* | | „ October .. .. | 7 |
| „ March .. .. | 11 | „ November .. .. | 11 |
| „ April .. .. .. | 8 | „ December .. .. | 9 |

## I. Numerical Aperture Table.

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n \sin u$, $n$ being the refractive index of the medium and $u$ the semi-angle of aperture. The value of $n \sin u$ for any particular case is the "*numerical aperture*" of the objective.

| Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (¼ in.) from 0·50 to 1·52 N. A. | Numerical Aperture. ($n \sin u = a$.) | Angle of Aperture ($= 2u$). | | | Illuminating Power. ($a^2$.) | Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.) | Penetrating Power. $\left(\frac{1}{a}\right)$ |
|---|---|---|---|---|---|---|---|
| | | *Dry* Objectives. ($n = 1$.) | *Water-Immersion* Objectives. ($n = 1{\cdot}33$.) | *Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.) | | | |
|   | 1·52 | .. | .. | 180° 0′ | 2·310 | 146,528 | ·658 |
| | 1·50 | .. | .. | 161° 23′ | 2·250 | 144,600 | ·667 |
| | 1·48 | .. | .. | 153° 39′ | 2·190 | 142,672 | ·676 |
| | 1·46 | .. | .. | 147° 42′ | 2·132 | 140,744 | ·685 |
| | 1·44 | .. | .. | 142° 40′ | 2·074 | 138,816 | ·694 |
| | 1·42 | .. | .. | 138° 12′ | 2·016 | 136,888 | ·704 |
| | 1·40 | .. | .. | 134° 10′ | 1·960 | 134,960 | ·714 |
| | 1·38 | .. | .. | 130° 26′ | 1·904 | 133,032 | ·725 |
| | 1·36 | .. | .. | 126° 57′ | 1·850 | 131,104 | ·735 |
| | 1·34 | .. | .. | 123° 40′ | 1·796 | 129,176 | ·746 |
|   | 1·33 | .. | 180° 0′ | 122° 6′ | 1·770 | 128,212 | ·752 |
| | 1·32 | .. | 165° 56′ | 120° 33 | 1·742 | 127,248 | ·758 |
| | 1·30 | .. | 155° 38′ | 117° 34′ | 1·690 | 125,320 | ·769 |
| | 1·28 | .. | 148° 28′ | 114° 44′ | 1·638 | 123,392 | ·781 |
| | 1·26 | .. | 142° 39′ | 111° 59′ | 1·588 | 121,464 | ·794 |
| | 1 24 | .. | 137° 36′ | 109° 20′ | 1·538 | 119,536 | ·806 |
| | 1·22 | .. | 133° 4′ | 106° 45′ | 1·488 | 117,608 | ·820 |
|   | 1·20 | .. | 128° 55′ | 104° 15′ | 1·440 | 115,680 | ·833 |
| | 1·18 | .. | 125° 3′ | 101° 50′ | 1·392 | 113,752 | ·847 |
| | 1·16 | .. | 121° 26′ | 99° 29′ | 1·346 | 111,824 | ·862 |
| | 1·14 | .. | 118° 00′ | 97° 11′ | 1·300 | 109,896 | ·877 |
| | 1·12 | .. | 114° 44′ | 94° 56′ | 1·254 | 107,968 | ·893 |
| | 1·10 | .. | 111° 36′ | 92° 43′ | 1·210 | 106,040 | ·909 |
| | 1·08 | .. | 108° 36′ | 90° 33′ | 1·166 | 104,112 | ·926 |
|   | 1·06 | .. | 105° 42′ | 88° 26′ | 1·124 | 102,184 | ·943 |
| | 1·04 | .. | 102° 53′ | 86° 21′ | 1·082 | 100,256 | ·962 |
| | 1·02 | .. | 100° 10′ | 84° 18′ | 1·040 | 98,328 | ·980 |
| | 1·00 | 180° 0′ | 97° 31′ | 82° 17′ | 1·000 | 96,400 | 1·000 |
| | 0·98 | 157° 2′ | 94° 56′ | 80° 17′ | ·960 | 94,472 | 1·020 |
| | 0·96 | 147° 29′ | 92° 24′ | 78° 20′ | ·922 | 92,544 | 1·042 |
| | 0·94 | 140° 6′ | 89° 56′ | 76° 24′ | ·884 | 90,616 | 1·064 |
|   | 0·92 | 133° 51′ | 87° 32′ | 74° 30′ | ·846 | 88,688 | 1·087 |
| | 0·90 | 128° 19′ | 85° 10′ | 72° 36′ | ·810 | 86,760 | 1·111 |
| | 0·88 | 123° 17′ | 82° 51′ | 70° 44′ | ·774 | 84,832 | 1·136 |
| | 0·86 | 118° 38′ | 80° 34′ | 68° 54′ | ·740 | 82,904 | 1·163 |
| | 0·84 | 114° 17′ | 78° 20′ | 67° 6′ | ·706 | 80,976 | 1·190 |
|   | 0·82 | 110° 10′ | 76° 8′ | 65° 18′ | ·672 | 79,048 | 1·220 |
| | 0·80 | 106° 16′ | 73° 58′ | 63° 31′ | ·640 | 77,120 | 1·250 |
| | 0·78 | 102° 31′ | 71° 49′ | 61° 45′ | ·608 | 75,192 | 1·282 |
| | 0·76 | 98° 56′ | 69° 42′ | 60° 0′ | ·578 | 73,264 | 1·316 |
| | 0·74 | 95° 28′ | 67° 36′ | 58° 16′ | ·548 | 71,336 | 1·351 |
| | 0·72 | 92° 6′ | 65° 32′ | 56° 32′ | ·518 | 69,408 | 1·389 |
|   | 0·70 | 88° 51′ | 63° 31′ | 54° 50′ | ·490 | 67,480 | 1·429 |
| | 0·68 | 85° 41′ | 61° 30′ | 53° 9′ | ·462 | 65,552 | 1·471 |
| | 0·66 | 82° 36′ | 59° 30′ | 51° 28′ | ·436 | 63,624 | 1·515 |
| | 0·64 | 79° 35′ | 57° 31′ | 49° 48′ | ·410 | 61,696 | 1·562 |
|   | 0·62 | 76° 38′ | 55° 34′ | 48° 9′ | ·384 | 59,768 | 1·613 |
| | 0·60 | 73° 44′ | 53° 38′ | 46° 30′ | ·360 | 57,840 | 1·667 |
| | 0·58 | 70° 54′ | 51° 42′ | 44° 51′ | ·336 | 55,912 | 1·724 |
| | 0·56 | 68° 6′ | 49° 48′ | 43° 14′ | ·314 | 53,984 | 1·786 |
| | 0·54 | 65° 22′ | 47° 54′ | 41° 37′ | ·292 | 52,056 | 1·852 |
|   | 0·52 | 62° 40′ | 46° 2′ | 40° 0′ | ·270 | 50,128 | 1·925 |
| | 0·50 | 60° 0′ | 44° 10′ | 38° 24′ | ·250 | 48,200 | 2·000 |

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

## II. Conversion of British and Metric Measures.

### (1.) Lineal.

*Micromillimetres, &c., into Inches, &c.*

| μ | ins. | mm. | ins. | mm. | ins. |
|---|---|---|---|---|---|
| 1 | ·000039 | 1 | ·039370 | 51 | 2·007892 |
| 2 | ·000079 | 2 | ·078741 | 52 | 2·047262 |
| 3 | ·000118 | 3 | ·118111 | 53 | 2·086633 |
| 4 | ·000157 | 4 | ·157482 | 54 | 2·126003 |
| 5 | ·000197 | 5 | ·196852 | 55 | 2·165374 |
| 6 | ·000236 | 6 | ·236223 | 56 | 2·204744 |
| 7 | ·000276 | 7 | ·275593 | 57 | 2·244115 |
| 8 | ·000315 | 8 | ·314963 | 58 | 2·283485 |
| 9 | ·000354 | 9 | ·354334 | 59 | 2·322855 |
| 10 | ·000394 | 10 (1 cm.) | ·393704 | 60 (6 cm.) | 2·362226 |
| 11 | ·000433 | 11 | ·433075 | 61 | 2·401596 |
| 12 | ·000472 | 12 | ·472445 | 62 | 2·440967 |
| 13 | ·000512 | 13 | ·511816 | 63 | 2·480337 |
| 14 | ·000551 | 14 | ·551186 | 64 | 2·519708 |
| 15 | ·000591 | 15 | ·590556 | 65 | 2·559078 |
| 16 | ·000630 | 16 | ·629927 | 66 | 2·598449 |
| 17 | ·000669 | 17 | ·669297 | 67 | 2·637819 |
| 18 | ·000709 | 18 | ·708668 | 68 | 2·677189 |
| 19 | ·000748 | 19 | ·748038 | 69 | 2·716560 |
| 20 | ·000787 | 20 (2 cm.) | ·787409 | 70 (7 cm.) | 2·755930 |
| 21 | ·000827 | 21 | ·826779 | 71 | 2·795301 |
| 22 | ·000866 | 22 | ·866150 | 72 | 2·834671 |
| 23 | ·000906 | 23 | ·905520 | 73 | 2·874042 |
| 24 | ·000945 | 24 | ·944890 | 74 | 2·913412 |
| 25 | ·000984 | 25 | ·984261 | 75 | 2·952782 |
| 26 | ·001024 | 26 | 1·023631 | 76 | 2·992153 |
| 27 | ·001063 | 27 | 1·063002 | 77 | 3·031523 |
| 28 | ·001102 | 28 | 1·102372 | 78 | 3·070894 |
| 29 | ·001142 | 29 | 1·141743 | 79 | 3·110264 |
| 30 | ·001181 | 30 (3 cm.) | 1·181113 | 80 (8 cm.) | 3·149635 |
| 31 | ·001220 | 31 | 1·220483 | 81 | 3·189005 |
| 32 | ·001260 | 32 | 1·259854 | 82 | 3·228375 |
| 33 | ·001299 | 33 | 1·299224 | 83 | 3·267746 |
| 34 | ·001339 | 34 | 1·338595 | 84 | 3·307116 |
| 35 | ·001378 | 35 | 1·377965 | 85 | 3·346487 |
| 36 | ·001417 | 36 | 1·417336 | 86 | 3·385857 |
| 37 | ·001457 | 37 | 1·456706 | 87 | 3·425228 |
| 38 | ·001496 | 38 | 1·496076 | 88 | 3·464598 |
| 39 | ·001535 | 39 | 1·535447 | 89 | 3·503968 |
| 40 | ·001575 | 40 (4 cm.) | 1·574817 | 90 (9 cm.) | 3·543339 |
| 41 | ·001614 | 41 | 1·614188 | 91 | 3·582709 |
| 42 | ·001654 | 42 | 1·653558 | 92 | 3·622080 |
| 43 | ·001693 | 43 | 1·692929 | 93 | 3·661450 |
| 44 | ·001732 | 44 | 1·732299 | 94 | 3·700820 |
| 45 | ·001772 | 45 | 1·771669 | 95 | 3·740191 |
| 46 | ·001811 | 46 | 1·811040 | 96 | 3·779561 |
| 47 | ·001850 | 47 | 1·850410 | 97 | 3·818932 |
| 48 | ·001890 | 48 | 1·889781 | 98 | 3·858302 |
| 49 | ·001929 | 49 | 1·929151 | 99 | 3·897673 |
| 50 | ·001969 | 50 (5 cm.) | 1·968522 | 100 (10 cm.=1 decim.) | |
| 60 | ·002362 | | | | |
| 70 | ·002756 | | | | |
| 80 | ·003150 | | | | |
| 90 | ·003543 | | | | |
| 100 | ·003937 | | | | |
| 200 | ·007874 | | | | |
| 300 | ·011811 | | | | |
| 400 | ·015748 | | | | |
| 500 | ·019685 | | | | |
| 600 | ·023622 | | | | |
| 700 | ·027559 | | | | |
| 800 | ·031496 | | | | |
| 900 | ·035133 | | | | |
| 1000 (=1 mm.) | | | | | |

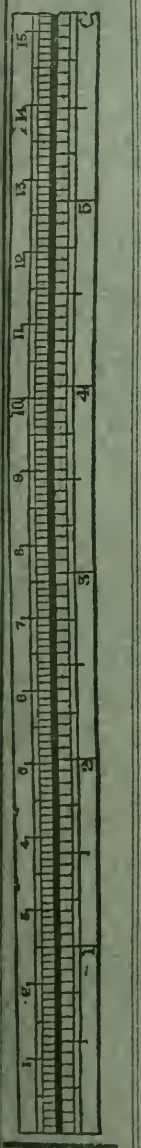
| decim. | ins. |
|---|---|
| 1 | 3·937043 |
| 2 | 7·874086 |
| 3 | 11·811130 |
| 4 | 15·748173 |
| 5 | 19·685216 |
| 6 | 23·622259 |
| 7 | 27·559302 |
| 8 | 31·496346 |
| 9 | 35·433389 |
| 10 (1 metre) | 39·370432 |
| = | 3·280869 ft. |
| = | 1·093623 yds. |

*Inches, &c., into Micromillimetres, &c.*

| ins. | μ |
|---|---|
| $\frac{1}{25000}$ | 1·015991 |
| $\frac{1}{20000}$ | 1·269989 |
| $\frac{1}{15000}$ | 1·693318 |
| $\frac{1}{10000}$ | 2·539977 |
| $\frac{1}{9000}$ | 2·822197 |
| $\frac{1}{8000}$ | 3·174972 |
| $\frac{1}{7000}$ | 3·628539 |
| $\frac{1}{6000}$ | 4·233295 |
| $\frac{1}{5000}$ | 5·079954 |
| $\frac{1}{4000}$ | 6·349943 |
| $\frac{1}{3000}$ | 8·466591 |
| $\frac{1}{2000}$ | 12·699886 |
| $\frac{1}{1000}$ | 25·399772 |
| | mm. |
| $\frac{1}{9000}$ | ·028222 |
| $\frac{1}{800}$ | ·031750 |
| $\frac{1}{700}$ | ·036285 |
| $\frac{1}{600}$ | ·042333 |
| $\frac{1}{500}$ | ·050800 |
| $\frac{1}{450}$ | ·056444 |
| $\frac{1}{400}$ | ·063499 |
| $\frac{1}{350}$ | ·072571 |
| $\frac{1}{300}$ | ·084666 |
| $\frac{1}{250}$ | ·101599 |
| $\frac{1}{200}$ | ·126999 |
| $\frac{1}{150}$ | ·169332 |
| $\frac{1}{100}$ | ·253998 |
| $\frac{1}{50}$ | ·507995 |
| $\frac{1}{25}$ | 1·015991 |
| $\frac{1}{20}$ | 1·269989 |
| $\frac{1}{16}$ | 1·587486 |
| $\frac{1}{15}$ | 1·693318 |
| $\frac{1}{12}$ | 2·116648 |
| $\frac{1}{10}$ | 2·539977 |
| $\frac{1}{8}$ | 3·174972 |
| $\frac{3}{16}$ | 4·233295 |
| $\frac{3}{16}$ | 4·762457 |
| $\frac{1}{5}$ | 5·079954 |
| $\frac{1}{4}$ | 6·349943 |
| $\frac{5}{16}$ | 7·937429 |
| $\frac{3}{8}$ | 9·524915 |
| | cm. |
| $\frac{7}{16}$ | 1·111240 |
| $\frac{1}{2}$ | 1·269989 |
| $\frac{9}{16}$ | 1·428737 |
| $\frac{5}{8}$ | 1·587486 |
| $\frac{11}{16}$ | 1·746234 |
| $\frac{3}{4}$ | 1·904983 |
| $\frac{13}{16}$ | 2·063732 |
| $\frac{7}{8}$ | 2·222480 |
| $\frac{15}{16}$ | 2·381229 |
| 1 | 2·539977 |
| 2 | 5·079954 |
| 3 | 7·619932 |
| | decim. |
| 4 | 1·015991 |
| 5 | 1·269989 |
| 6 | 1·523986 |
| 7 | 1·777984 |
| 8 | 2·031982 |
| 9 | 2·285979 |
| 10 | 2·539977 |
| 11 | 2·793975 |
| 1 ft. | 3·047973 |
| | metres. |
| 1 yd. = | ·914392 |

cale showing
he relation of
Millimetres,
c., to Inches.

mm.
and
cm. ins.



000 μ =1 mm.
10 mm.=1 cm.
10 cm. =1 dm.
10 dm. =1 metre.

Fig. 1 × 700.

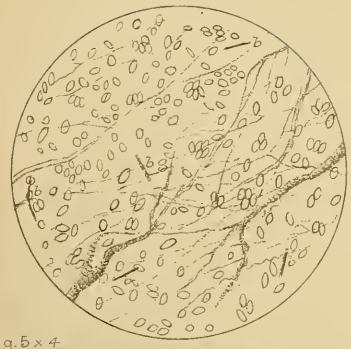


Fig. 2 × 700.

Fig. 3 × 600.

Fig. 5 × 4

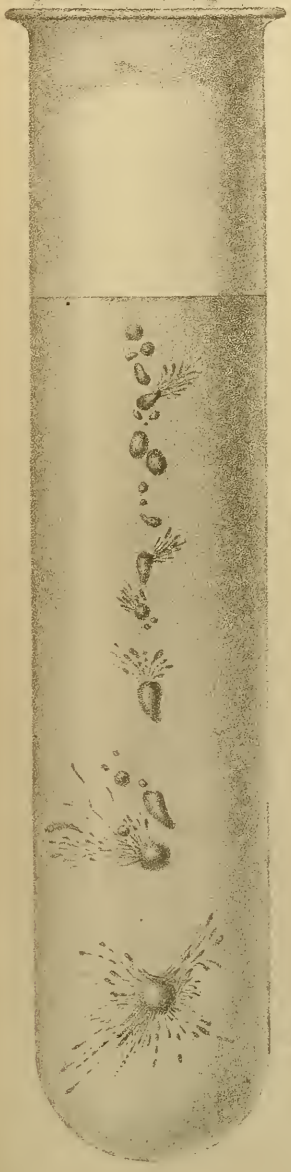


Fig. 6 × 4

Fig. 4 × 3.

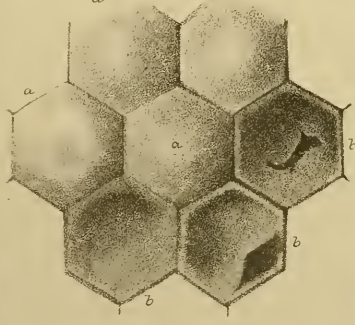



Fig. 7

Fig. 8

Bacillus alvei.

Fig 12 × 80

Fig 13 × 80

Fig. 9 × 3000

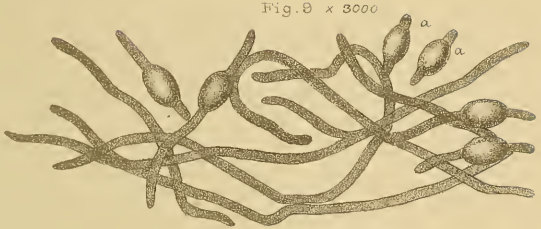
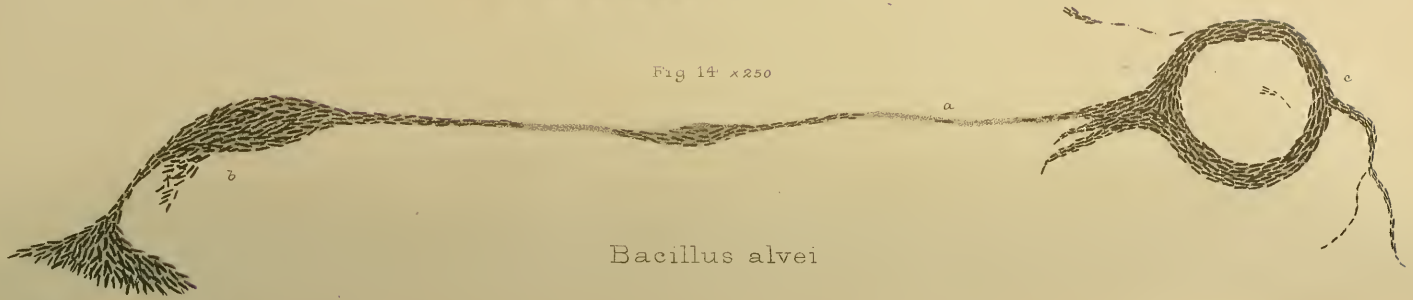



Fig. 11

Fig. 10

Fig 14 × 250




Bacillus alvei

Frank R. Cheshire del. ad nat.

West, Newman & Co. lith.

JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1885.

## TRANSACTIONS OF THE SOCIETY.

### XI.—*The Pathogenic History and History under Cultivation of a new Bacillus (B. alvei), the Cause of a Disease of the Hive Bee hitherto known as Foul Brood.*

By Frank R. Cheshire, F.R.M.S., F.L.S., and W. Watson Cheyne, M.B., F.R.C.S.

(*Read 11th March*, 1885.)

Plates X. & XI.

#### Part I.—*Pathogenic History.* (By Mr. Cheshire.)

Some indistinct references made by ancient writers as early as the Christian era to a devastating disease existing then amongst domesticated bees, render it not unlikely that the malady known as "foul brood" is far from a novelty; but be this as it may, it is

EXPLANATION OF PLATES X. and XI.

Fig. 1.—Residue of larva three days dead of *Bacillus alvei*. *b*, bacilli. Spores and degenerated tracheæ cover the field.

Fig. 2.—Healthy juices of larva.

Fig. 3.—Juices of larva (living) with disease in acute stage. *a a*, leptothrix forms.

Fig. 4.—Bee-comb from a diseased stock. *a a*, cells containing healthy pupæ. *b b*, cells in which pupæ have died; the covers are sunken and often torn or punctured.

Fig. 5.—Cultivation in sterilized agar-agar showing the colony-form.

Fig. 6.—Same cultivation twenty-four hours later.

Fig. 7.—Passage of spore in bacillus condition.

Fig. 8.—Passage of bacillus in spore condition.

Fig. 9.—*Bacillus alvei* grown in blood-serum. *a a*, spores.

Fig. 10.—Spores in line from agar-agar cultivation.

Fig. 11.—Bacilli budding? from a cultivation.

Fig. 12.—Cultivation in thin layer of peptonized gelatin, showing colony-form and bursting-off of lines of bacilli.

Fig. 13.—Drawing from another flat cultivation.

Fig. 14.—Flat cultivation more enlarged; the bacilli by liquefying the gelatin form tracks along which they freely swim backwards and forwards. *a*, bacillus swimming along track. *b*, bacilli in mass. *c*, bacilli breaking from concentric rings of growth previously formed.

certain that not until very recent times have its ravages become so wide-spread as to make it the terror of bee-keepers. Since the investigation to which I now invite attention conclusively shows that a bacillus is the mischief-worker, it will be at once understood why modern methods of management have been the occasion of spreading far and wide that which formerly existed, though confined to narrow limits. In ancient days bees rarely changed hands except at the death of the owner, and in our country, at least, the selling of a hive was even half a century back discountenanced as "unlucky"; but now bee-dealing is an established industry not only here but on the continents of Europe and America, and the stock of the bee farmer having once become infected, is inevitably the means of distributing the fatal germs into the private apiaries which he supplies. Man not alone then suffers from diseases propagated by modern civilisation, but the animals which he has associated with himself necessarily suffer with him. Let us now consider this matter under three heads:—Firstly, the nature of this germ disease; secondly, the means of its propagation; and thirdly, the method of its cure.

1st. The nature of foul brood as a germ disease.—If a comb be removed from near the centre of a healthy hive during the summer months, its cells will normally be filled with eggs, larvæ, and pupæ in every stage of development. The eggs as left by the ovipositor of the queen or mother adhere commonly by the end to the base of the cells they occupy, and favoured by the high temperature constantly maintained within the hive, the germinal vesicle at about the end of three days matures into a larva ready for hatching. These eggs I have shown are liable to the disease even before they leave the body of the mother, but most careful microscopic examination is needful to make this apparent (and of which I shall speak presently more particularly). On the contrary, the larvæ, which are constantly fed by the workers, so change in appearance soon after infection, that a practised eye at once detects the presence of the disease. Whilst healthy their bodies are of a beautiful pearly whiteness, lying, at first floating, in the abundant pabulum the nurses are ever at hand to supply. As they grow they curl themselves at the bottom of the cells until these become too strait for their occupants, which now advance the head to be in readiness for the cocoon-spinning which follows upon the close of the eating stage. When the disease strikes the larvæ they move uneasily in their cells, and often then present the dorsal surface to its mouth, as I have indicated in the illustration of diseased comb, fig. 134, so that mere posture is no insufficient evidence of an unhealthy condition. The colour changes to yellow, passing on by degrees towards a pale brown, whilst the skin becomes flaccid and opaque; death soon occurs, when the body, now

shrunken by evaporation, lies on the lower side of the cell, increasing in depth of tone, until in a few days nothing more than a nearly black scale remains. Should the larvæ, however, escape contamination until near the period of pupahood, they are sealed over in the normal way by a cover made of pollen-grains and wax, plate X.

Fig. 134.

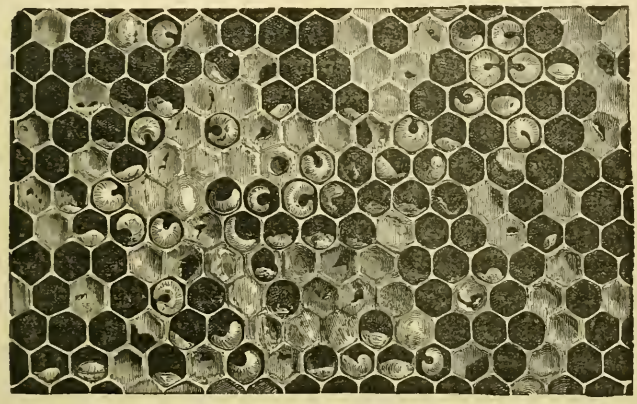


fig. 4 *a*, and which is pervious to air. The cover furnishes a screen, on which part of the cocoon is soon after spread, but the inhabitant of the cell is marked out for death, and before very long the capping or sealing sinks and becomes concave, and in it punctures of an irregular character appear, fig. 4 *b* and fig. 134, and this is a nearly conclusive sign of the diseased condition of the colony. The sense of smell is also appealed to, as a peculiar very offensive and extremely characteristic odour now escapes from the diseased combs. The bees in addition lose energy, but become unusually active in ventilating their hive by standing at the door, heads towards home, and flapping their wings persistently so that a strong out-current, and as a necessary consequence, a corresponding indraught, are set up. Should any attempt be made at removing a dead larva which has assumed a deep brown tint, its body tenaciously adhering to the cell-wall will stretch out into long and thin strings like half dried glue. The microscopist can easily explain this. The thin chitinous aerating sacs and tracheæ do not undergo decomposition at all easily, and these remaining, occasion the peculiarity referred to. These tracheæ are well shown in fig. 1. The disease is terribly infectious, and once started, soon spreads from cell to cell and not unfrequently from stock to stock.

Should a speck of this tenacious coffee-coloured matter be examined by a 1/4 in., it would be found to contain countless

swarms of very minute bodies which appear under a 1/12 in. as seen in fig. 1, and which dance in the field with a pronounced Brownian movement. These have been supposed to be micrococci, in consequence of some reported experiments made in Germany about ten years since by Dr. Schonfeld, of whose account of the same it is desirable here to give only a very short summary. He states that having procured some foul-broody matter (i. e. the brown scales mentioned previously), he by a simple contrivance aspirated air which he passed over the "foul-broody" mass through cotton wool, which then he found full of micrococci. But since he made presumably no attempt at staining, this statement, I submit, can only be received with great reserve. He adds that this cotton wool spread over the cells of a comb in which larvæ were advancing, the latter took the disease and died, with their bodies filled with micrococci. That lastly, having infected the larva of *Musca vomitoria*, it not only died crammed with micrococci, but that these micrococci communicated foul brood to previously healthy larvæ in the bee-hive. These experiments were accepted as so conclusive and satisfactory that for ten years they were quoted as authoritative, but many observations which could not be reconciled with commonly received ideas respecting this malady induced me in June last to attempt to repeat Schonfeld's experiments, with such additions or modifications as might seem most suitable to my purpose. This attempt has left me in intense bewilderment so far as any possible explanation of the causes of the errors into which Schonfeld undoubtedly fell. My results showed that in foul-broody matter no micrococci necessarily existed; the disease could not be at all easily communicated to *Musca vomitoria;* but that every dead larva of this fly contained micrococci innumerable, and that when larvæ of *Apis mellifica* were artificially infected with "foul-broody matter" the bacillus nature of the disease was incontestable, while no micrococci, and not even the bacillus spore which Schonfeld had taken for a micrococcus, could be discovered. The confidence with which I, at the outset, left the old ideas which Schonfeld had promulgated was increased by the helpful interest which Mr. G. F. Dowdeswell took in my investigation, and for whose suggestions I now have the pleasure of returning my thanks. Taking a small quantity of the juices of a healthy larva and examining under a cover-glass, one is presented with the appearance of fig. 2. Fat-globules are numerous, whilst here and there we note the large white blood-disks, and scattered throughout may be seen minute globular particles with lively Brownian movements. But if a speck of coffee-coloured "foul-broody matter," as previously hinted, be similarly treated, we find neither fat-globules, blood-cells, nor molecular base, but observe amidst the remains of broken-down tracheæ the field crowded with

small ovoid bodies, as I have shown at fig. 1. These are the micrococci of Schonfeld; but if this substance be stained according to the plan of Weigert and Koch, and then carefully examined even with a good 1/4, we shall in all probability discover a very few undoubted bacilli, fig. 1*b*. Whilst operating thus, the absence of dumb-bell forms and the distinctly oval shape of what I presently found to be spores of the associated bacilli, arrested at once my attention. Now possessing myself of an infected stock, so that the course of the disease could be traced, I submitted first the body of a grub dead, but in a fresher state, to the Microscope; and here the bacilli were numerous, although still few in relation to the number of the spores. Then selecting larvæ still feeding, but of suspicious colour, and examining their juices with a power of 600, I was delighted by seeing hundreds of bacilli actively swimming backwards and forwards and worming their way amongst the blood-cells and fat-globules, as presented at fig. 3, whilst the leptothrix form was not uncommon.

The examination of a larger number of larvæ, not only from the stock referred to, but from combs coming from various parts of Great Britain and Ireland, showed most conclusively that each individual at the beginning of the attack contained many bacilli of an average diameter of $0 \cdot 5\ \mu$, and length $4\ \mu$, mostly swimming with a corkscrew-like movement, and that if an end view were obtained of any one of them the termination of the rod constantly described a small circle; that when the disease was in rapid progress, leptothrix forms were common, some of these even reaching $250\ \mu$ in total length; that as the fluids of the grub failed by loss of fats and albumenoids, the bacilli began to swell centrally, drawing the mycoprotein from their extremities, as seen in fig. 8, and thus gradually becoming spores, fig. 8; that after the death of the grub and during the assumption of the viscid, putrid condition, this constant alteration of bacilli into spores continues; that after removal from the hive it goes on so rapidly that in a day or two scarcely a bacillus as such is discoverable, whilst the spores are innumerable, and, in addition, that a very cautious preparation of some broken down viscus showed that the bacilli and spores arranged themselves in that most singular line fashion (fig. 10) which Mr. Watson Cheyne found subsequently to be characteristic in his agar-agar jelly cultivations of the same micro-organism.

Since the force of conviction obliged me to deny the accuracy of Schonfeld's conclusions, I felt it incumbent upon me to repeat his experiments, for if the disease be really due to a bacillus, how could the communication of it to *Musca vomitoria* produce, as he says, micrococci in that insect? I experimented on sixty individuals: twenty were not brought near foul-broody matter, twenty I attempted to infect with bacilli in their active condition, and

twenty by spores, but only three of the latter and none of the former contracted the disease. The general appearance of the tissues of the dead fly larvæ much resembled that of bees similarly affected.

Striving to prove irrefragably the accuracy of the etiology I have given, I took a number of well-developed drone larvæ from a healthy stock, and expressed their juices into two test-tubes 3 in. long and 1/2 in. wide. No. 1 now received a very minute quantity of coffee-coloured matter containing spores, whilst No. 2 was infected with a trace of a bacillus-containing fluid from a larva just dead or dying. These tubes were each supported by a simple arrangement between the combs of a stock of bees, so that the temperature for germination should be kept up. In twenty-two hours, examining No. 1, I found no spores, but that bacilli, mostly in threads, existed in considerable numbers, whilst the bacilli added to No. 2 were increasing by division, proving again that the spores produce bacilli so soon as they pass into condition for germination, the reverse process obtaining when these conditions cease.

The somewhat extensive literature of this disease had always gone on the assumption that it affected larvæ, but larvæ only. This position did not appear to me to agree with many facts I had observed; e. g. we may take away two or three combs containing 5000 larvæ each from a stock, and it will continue to progress pretty much as though it had lost nothing, while if foul brood attacks it and kills say 1000 of its grubs, it as a rule very perceptibly diminishes in strength. The only theory that appeared to me as satisfactory was that the adults of the hive die with the disease, but that according to a necessary instinct they leave the hive and finish their course alone. Going to the diseased stock then in my possession, I noticed on the ground and close to its entrance one bee nearly dead on its back, another hopping in abortive flights of 3 or 4 inches, and presently found a third and fourth worn out and too far gone to enter the hive again. The first bee presented nothing remarkable, but the second was almost an empty shell, the air-sacs occupying nearly the whole of the abdomen. The stomach and colon were exceedingly small, and the amount of fluid I could obtain truly microscopic; but this was full of active bacilli of the same size and character I had previously discovered in the larvæ. The third and fourth bees were in similar condition.

The consequences flowing from this discovery have more to do with practical apiculture than with general science, and so here I content myself with saying that bee-dealers who had in ignorance of the facts always proclaimed that swarms were incapable of being affected by it, and that queens constantly passing from one owner to another could never communicate it, were now to be told that this error had in all probability been the reason why foul brood had grown to be a veritable pest, and that large apiaries were in

some instances actually dying out in spite of every effort to save them, and that in America alone the losses through it had risen to very many thousands annually.

Continuing the investigation, I found that a large proportion of imago workers and drones die of this disease if they are raised in infected stocks, and that this explained the marked dwindling in numbers in a colony from the very incidence of an attack. But further, if workers and drones are liable, why may not queens be so also? and if this be possible, may we not get a solution of certain peculiarities with which bee-keepers of experience are familiar, e.g. some months earlier I had imported some queens from Italy, one of which was inserted into a stock which quickly after developed foul brood, while the queen lived on six or seven weeks only. In addition, if the queen may be infected, why not the egg? In the case of pébrine this had already been proved to be the case. The bee's egg is to the size of the bacillus enormous; its diameter of 0·36 mm. and its length of 1·8 mm. would enable it to accommodate 100,000,000 spores of this organism, which stands to the egg itself as a single drop to 1500 gallons. Following this line, and knowing that foul brood had in some cases appeared to be more particularly destructive amongst the smaller larvæ, I not unnaturally judged that in these cases possibly the egg contained the germs of the disease at the time of deposition. I communicated my suspicions to several owners of large numbers of colonies, and explained what would be the probable peculiarities of genetic foul brood if such a form really existed. Mr. Hart, of Stockbridge, soon after sent me a queen from a hive which presented the indicated symptoms, viz. the early death of the larvæ in most cases; the earnestness of the bees in attempting to raise a new queen, although their numbers were so small that swarming * was out of the question, this earnestness seeming to indicate that they were conscious of some unfitness about the mother, which they desired to remedy by displacing her, and lastly a continuance of their hospitality to drones at a period of the season when other stocks have destroyed theirs. The queen was fortunately alive at her arrival, and I forthwith commenced a careful dissection. Having removed the left air-sac (which lies within the first and second abdominal rings), which was very much above the average size, a constant indication as I have found it of the presence of bacilli, I came upon the ovary, of which I had upon previous occasions removed many dozens. This one was abnormally yellow and very soft, so that it was difficult to detach it from the larger external tracheæ without tearing. I separated an ovarian tube and placed it under a second Microscope using 250 diameters, and at once saw four or five bacilli

* Healthy stocks only raise new queens in the prospect of swarming, or when the mother is fading through age.

swimming along with a lazy sort of progression. Detaching now a half-developed egg, and exercising great care to eliminate every possible source of accidental contamination, I placed the egg with a trace of water upon a glass slip and crushed it out flat with a thin cover, and in a few minutes I had counted no less than nine bacilli. The right ovary was nearly free from disease. During a prolonged search I traced three bacilli only, which may not impossibly have floated on to it during the dissection. Many other subjects I have since had the opportunity of dissecting, some of whose ovaries contained bacilli in countless profusion. In one remarkable case the receptaculum seminis contained no spermatozoa, although the queen was young and had mated since she had produced worker bees, but was filled with a dirty fluid through which were scattered innumerable minute and irregular granules, amongst which swam large numbers of bacilli. Here then was a distinct point of incidence for an attack, which left the ovaries still in perfect health. A question of some difficulty here to my mind presents itself. The disease seems always acute in the case of the larvæ, embracing all parts of their organization. This may possibly result from the thinness of their membranes, the freedom of their viscera, the frequency of invagination, and the rapidity of interstitial changes in their case. In the imago, on the contrary, the disease assumes a chronic condition, and confined to a portion of the frame at least temporarily, may be several weeks, and possibly in queens even months, in running its course.

The name foul brood, given in ignorance of the nature and scope of the malady, is manifestly utterly inappropriate. To say that a queen is suffering from foul brood would be as illogical and ridiculous as talking of toothache in the liver. I therefore have proposed the name *Bacillus alvei*, which has been at once accepted and adopted amongst intelligent apiarians both in England and America.

The necessity of a specific name has recently become more apparent, since during these investigations I have found that bees are not only liable to suffer from attacks of the organism now engaging our attention, but from many others producing certain characteristic symptoms, and of which I hope to speak in particular in a future communication. The old notion that the adult bee had perfect immunity from diseases, and which no doubt was based upon the constancy of its external appearance as the outcome of an external skeleton, turns out to be the opposite of the truth, and the Microscope has supplied me at once with the means of explaining observed singularities in special stocks by revealing in each case disease organisms of some destructive type. These industrious creatures live in numerous colonies, of which the members are always in the closest contact; their usual system of communication

is by actual touch; they habitually pass their food from one stomach to another; all food has been carried either within or upon the bodies of their fellows; their very home is formed of one of their secretions; and their beds, cradles, and larders are all interchangeable. These are the conditions indeed in which disease organisms have the highest opportunity of running riot, and which makes the discovery of many pathogenic bacteria in their colonies to me the reverse of surprising.

It is needful before passing to the second head to anticipate one or two points to which Mr. Watson Cheyne will especially refer. After very many cultivations conducted in series by that gentleman, a small quantity of sterilized milk was inoculated from the last tube. It behaved characteristically, as Mr. Cheyne will describe, the flask emitting upon the drawing of the plug the unmistakable odour so distinctive of the disease in the hive. Some of this milk I diffused through water, and sprayed from an atomizer over a healthy comb of larvæ, part of which was protected by a cardboard sheet into which four lozenge shapes had been cut. The larvæ protected matured in health; those exposed to the spray in many cases were removed by the bees, while the rest died, their bodies filled with *Bacillus alvei*. This last experiment seems to complete the chain of evidence in favour of "foul brood" not being accidentally associated with this bacillus, but actually its result.

2ndly. The means of the propagation of the disease. Popular apiculture has greatly suffered because its supposed leaders have only very rarely been equal to any scientific analysis, and so crude guesses have frequently been as unhesitatingly accepted as though they had been theories supported by an exhaustive examination of facts. It is so here; the larvæ alone were supposed to suffer from the disease under discussion, and so it was confidently asserted that it was propagated by bees from healthy colonies getting into contact with these larvæ by taking advantage of the weakened dispirited condition of infected stocks by invading them and stealing from them their honey, which honey was said to abound with micrococci, but I have searched most carefully in honey in contiguity with cells holding dead larvæ, have examined samples from stocks dying out with rottenness, inspected extracted honey* from terribly diseased colonies, and yet in no instance have I found a living bacillus, and never have been able to be sure of discovering one in the spore condition, although it must be admitted that the problem has its microscopic difficulties, because the stains used to make the bacilli apparent attach themselves very strongly to all pollen-grains and parts thereof, and somewhat interfere with examination.

* Honey thrown out from the comb by a centrifugal machine called an extractor.

All attempts at propagating bacilli in honey I have found utterly futile. The presence of bacilli in honey as an accidental contamination would, it may be remarked, in no way render it injurious, for many pathogenic bacteria may be swallowed without risk if there be no internal rupture of the mucous membrane, and placing this bacillus in a skin wound has in my own case produced no disagreeable results.

My belief is that the grubs are most usually infected by the antennæ of the nurses. These travelling in the darkness of the hive become aware of the condition and needs of the occupants of the brood-cells by constantly inserting their antennæ, which must continually where disease reigns be brought into contact with bacilli, and also into contact with those sticky masses into which the larvæ change about two days after death. The removal then of spores is highly probable, and these transferred to the next grub fed will there start the disease. These sticky masses will be found too to extend to the very front of the cells, and as the bees perambulate their combs the pulvillus will be in danger of removing spores and depositing them upon other cell edges to infect other grubs at the critical time of cocoon spinning. It is also extremely likely that the tramp of the bees frequently detaches numbers of spores, which fly about in the air and settle here and there, often where they take effect, many of them being carried into healthy stocks with the indraught set up by the fanners.*

A large number of observations has shown that the disease in the larva at least is not one of the digestive tube, but of the blood, and through it of every viscus. If honey were the means of communicating it, certainly traces of it should be found in the alimentary sac; but here I find only very occasionally bacilli. In the adult bee, however, although the disease fills the blood, it is still very prominent indeed in the chyle stomach. Microscopists will have no difficulty in accepting the idea of these organisms being carried about in air currents when it is remembered that a single cubic inch of material would form a quadruple line of these bacilli from London to New York. Ordinary dust motes are to such organisms as hens' eggs to sand grains. Nor is their multitude less remarkable than their minuteness. I have examined many larvæ which must at least have contained 1,000,000,000; so that the means by which they are disseminated must be altogether too varied. In the royal jelly—so called—of a queen pupa dead of bacillus I could discover no bacilli, nor have I succeeded better with the food provided to the workers, notwithstanding that I examined several hundreds of the cells containing feeding larvæ where disease was rife; so that, although I would not dogmatize, my strong opinion is that commonly neither honey nor pollen carry the disease, but that the feet and

* See *supra*, p. 583, line 13 *et seq.*

antennæ of the bees usually do. I also think it probable that occasionally at least, nurse bees infected bring the disease-germs to the mouth in feeding the larvæ, and then, turning foragers, leave a germ or germs on the nectary of a flower, which, visited by another bee, becomes the means of infection to it. The malady is thus carried into other, and perhaps somewhat distant, apiaries.

Balancing all the probabilities, it would appear that most generally the adult bee takes the disease, and then carries it directly or indirectly to the brood. In a somewhat different malady, *Empusa musci* of the housefly, the germs are known to take effect by settling on the spiracles or between the abdominal rings, and the spiracle of the bee in all its stages may be the especially vulnerable point.

3rdly. The method of the cure of *Bacillus alvei*. Upon this question the scientific is perhaps less than the practical interest, and so I shall content myself with a bare outline. Salicylic acid has been used in attempting to combat this disease with fluctuating and partial success, but phenol I have found perfectly specific. The difficulty of administration I overcame as follows: phenol was mingled with ordinary sugar syrup of a density most suitable for feeding purposes in the proportion of 1 to 500 by weight of the syrup, and this was then poured into the comb in which brood was being raised. The nurse bees immediately accepted the medicated food, and as a result the malady in the very worst cases disappeared, the exceptions being those in which the queen herself was badly diseased. This would rather seem to indicate that the drug acts as a prophylactic, but upon this most vital point time has not at present enabled me to settle the ground for an opinion. The problem is beset by difficulties, but during the advancing summer experiments will be made in the hope of gaining evidence respecting it. Even apart from the solution of this question, this investigation promises to have a very important bearing upon the future of apiculture by exposing the errors of the past and supplying a satisfactory method of treating a disease which had promised to so increase as to thoroughly imperil the very existence of apiculture as an industry.

### Part II.—*History under Cultivation.* (By Mr. Cheyne.)

On August 11th, 1884, Mr. Cheshire brought to me a piece of comb containing larvæ affected with foul brood, with which I performed the following experiments:—Selecting cells which were closed, but which Mr. Cheshire thought contained diseased larvæ, I brushed them over with a watery solution of bichloride of mercury (1 : 1000) to destroy the organisms on the outside. With several forceps that had been heated and allowed to cool, the covering of

the cell was picked off so as to display the diseased larvæ. These larvæ were dead, of a yellowish colour, and almost liquid; and on examination afterwards their juices were found to contain numerous moving bacilli. By means of a heated platinum wire, tubes of meat infusion rendered solid by gelatin (10 per cent.), or by Japanese isinglass, were inoculated from several of these larvæ and kept at a suitable temperature. Development of bacilli, microscopically similar to those seen in the juices of the larvæ, occurred: the characteristics of this development will be presently described. Further, in the tubes, kept at the body temperature, there was not only a development of bacilli, but also of spores.

These bacilli, as seen in the larval juices, measure about 1/7000 in. in length, and 1/20,500 in. in breadth. They are rounded or slightly tapering at their ends, and often have a clear space near one end. In the juices of the larva during life they apparently do not produce spores, although after death spores abound.

In the cultivation in the peptonized meat infusion, rendered solid by agar-agar, the bacilli vary considerably in size, their average length being 1/7260 in., some being as small as 1/10,000 in. and others as large as 1/5000 in. When they have attained the latter size, division of the rod seems to begin. They are always somewhat pointed at their ends. Their average breadth is 1/30,000 in., varying from 1/35,000 to 1/25,000.

The spores are largish oval bodies, averaging in length 1/12,000 in. (varying from 1/13,100 to 1/10,200 in.), and in breadth 1/23,700 in. (varying from 1/24,000 to 1/25,000 in.).

In the agar-agar material the spores are generally arranged side by side in long rows, and in old cultivations only a few bacilli can be seen, some forming spores, some without any indication of spores (figs. 10 and 11). That these small bacilli can produce such large spores seems at the first glance at a microscopical specimen almost inconceivable, but I have been able to trace on the one hand the development of the spores in the rods, and on the other the sprouting of the spores into adult bacilli. This can be done in the following very simple manner:—

Take a number of glass slides, each having a moderate-sized cell hollowed out in its middle; clean it, and pass through a Bunsen flame several times to destroy any bacteria on its surface. With a brush apply a very little vaseline around the depression, and then place the slide under a glass shade to keep it from the dust. Clean a number of cover-glasses, purify them in the flame, and place them on a pure glass plate beneath another shade. With a fine pure pipette put a small drop of sterilized cultivating fluid (meat infusion with peptone) on the centre of each of these cover-glasses; then with a fine platinum wire inoculate each of the drops with the spores, or with non-spore-bearing bacilli; rapidly invert

them over the cell, press down the cover-glass so as to diffuse the vaseline around its edge, and place the slides in an incubator kept at the temperature of the body. These slides are removed at different intervals of time, and as soon as each is taken out the cover-glass is turned over and the drop of fluid rapidly dried. The specimen can then be stained, mounted in Canada balsam, and studied at leisure. This method seems to me to be much more satisfactory than the observation of the organisms swimming about in the drop of fluid, while the specimens can be kept permanently and compared with one another.

In order to study the growth of the spores I used a cultivation on the agar-agar cultivating material which had been kept at the temperature of the body for fourteen days, and which consisted almost entirely of spores, though a few bacilli were present. As the result of several experiments, I have got a series of preparations which have been taken at various times (15 min., 30 min., 40 min., 1 hour, 1½ hour, 1 hour 50 min., 2 hours, 2 hours 20 min., 2 hours 50 min., 2 hours 55 min., 3 hours 20 min., 4 hours 20 min., 5 hours, 5 hours 35 min., 5 hours 40 min., and 7 hours 50 min.), and the course of events is shown in plate X. The bacilli stain with various anilin dyes—best, I think, with methyl-violet; but the spores resemble the spores of other bacteria in not taking on the stain. The cover-glasses on which the organisms are dried are passed three times through the gas flame and floated on the surface of a fairly strong watery solution of methyl-violet for one to two hours. They are then washed in water, and afterwards laid in weak acetic acid (1 per cent.) till no more stain comes out. They are again washed in water, allowed to dry at the ordinary temperature, and mounted in Canada balsam. A spore-bearing cultivation shows the bacilli stained violet, and the spores unstained, with the exception of their outline, which is of a faint violet colour. In most cases no trace of the rod in which the spore was formed can be seen (see fig. 7). The first change which is observed on cultivation is that in many cases the outline of the rod in which the spore was formed becomes faintly visible (see fig. 7). This can be seen in fifteen minutes, and is, I think, simply due to swelling by the fluid, as it is also evident to some extent in the case of spores soaked in water for the same length of time. In from half an hour to an hour it is evident that the bacilli which were present in the original material are beginning to multiply, and a considerable number of rods are now seen containing spores. It is evident that these spores are newly formed, as extremely few bacilli containing spores were seen in the original material, whereas in the preparations taken from in half an hour to an hour a considerable number are present. That some of the rods, instead of growing by fission, at once proceed to form spores

is probably to be explained in this way. When the cultivation was removed from the incubator, some bacilli were growing by fission, some were forming spores, and some had passed into a state ready to form spores. The first go on growing by fission, the last complete their spore-formation, which was arrested by removal from the warm temperature. That actively growing rods would not have formed spores so early is evidenced by the facts observed in the second series of observations on the formation of spores. The next thing that is observed is that several of the spores take on the stain, and are as intensely violet as the adult bacilli (see fig. 7). The number of the spores which take on the stain in this way goes on increasing as time passes, till in about four hours almost all the spores stain violet. In three hours the first indication of sprouting of these spores becomes evident. The stained part of the spore loses its oval shape, becomes elongated, and is soon seen to burst through the spore-capsule at one part (see fig. 7). It then presents the appearance of a short rod, with a pale envelope embracing one end. This rod gradually leaves the spore-capsule and then goes on multiplying as a full-grown bacillus. In specimens taken from four to five hours all stages of growth can be seen, and the remains of the ruptured spore-capsules are evident (see fig. 7).

The bacilli appear to grow mainly by fission, but I have seen appearances which seem to me only explicable on the supposition that they also grow by sending out buds from one end (see fig. 11). A bacillus may be seen with a small somewhat conical stained point attached to one end, though separated by a marked division. This is certainly not the common mode of growth by fission, for there the rod seems to divide into two pretty equal halves, while here we but have a minute piece attached to one end.

The mode of formation of spores may be traced in a similar manner to that described above in the case of the sprouting of the spores. It is, however, as a rule necessary to leave the organisms to grow for a much longer time than in the former instance. I have not found development of spores as a rule before twenty-three hours, but this depends very much apparently on the amount of fluid that was present and the number of bacilli introduced at the time of inoculation. The first thing noticeable is that the rod begins to swell and becomes spindle-shaped (see fig. 8). This swelling, which generally affects the middle of the rod, but may in some cases be most marked toward one end, increases in size, and the centre of the swelling gradually ceases to take on the stain (fig. 8). The capsule of the spore apparently is also formed within the rod, and is not merely the outer part of the rod. In three or four hours the rod is seen to have almost or completely disappeared, leaving the spore lying free or within the faint outline of the original bacillus

(figs. 7 and 8). It seems to me that the view that spore-formation occurs when the food is getting exhausted is correct, for the time at which this appearance is found depends greatly on the size of the drop placed on the cover-glasses, and I have found in one experiment that in one specimen after twenty-three hours most of the rods were forming spores, while in another specimen where the drop was much larger there was no trace of spore-formation after twenty-eight hours. I have here described the results of my earlier and rougher attempts to study the formation of spores. I have, however, now improved the method in the following way. As I have just now shown, the period at which spores are first seen seems to depend mainly on the amount of fluid used and the number of of bacilli introduced, and as in the above method both these factors vary in each case, one cannot get a regular series of preparations showing the different stages at different times. In studying the sprouting of spores the amount of fluid and the number of spores does not matter, for if sufficient nutriment is present and a proper temperature maintained the spores must sprout, and probably they always take about the same length of time. The difficulty of obtaining a series of specimens illustrating spore-formation is easily obviated in the following manner. Take a pure flask containing a small quantity of sterilized infusion, and inoculate it from a cultivation containing only bacilli. Place it in the incubator for two or three hours, so that the bacilli may increase somewhat in number and diffuse themselves through the liquid. Thus the cultivating material contains bacilli pretty equally diffused through it, and if after shaking the flask drops of equal size are taken, each will probably contain about the same number of bacilli. The minutest quantity of fluid can easily be obtained by means of a syringe having a fine screw on its piston and a large nut revolving on this screw. The circumference of the nut being equally divided into a number of small segments, the same quantity of fluid can always be expelled from the syringe. By proceeding in this way equal sized drops containing an equal number of bacilli can be used and a regular series of specimens obtained. I have found that using 2/5 of a minim containing one bacillus and keeping the specimen at 36° C., the earliest appearance of spore-formation was evident in forty-one hours.

Leaving these matters, which are of great interest not only in regard to the *Bacillus alvei*, but to all spore-bearing bacteria, and which I have therefore dwelt on at length, we must pass on to the further consideration of this particular organism. The first point to be determined in investigating its relation to foul brood was whether this was a new bacillus, unknown except in connection with this disease of bees, or whether it was a more or less well-known form. To ascertain this point with regard to micro-

organisms the Microscope is of little use; recourse must be had to the study of their life-history, more especially of their peculiarities of growth on different soils. Of all the materials employed as cultivating media, Koch's gelatinized meat infusion is the most useful for purposes of diagnosis. This is composed of an infusion of meat containing 1 to 3 per cent. of pepton, 10 per cent. gelatin made neutral by carbonate of soda, and thoroughly sterilized. This material was first introduced with the view of having a highly nutritive solid and at the same time transparent medium, on which to carry on pure cultivations, but it was soon found that owing to the remarkably diverse ways in which different micro-organisms grew in it, it could be used as a means of diagnosis of the kind of organism, a means more certain than any other which we at present possess. For purposes of diagnosis as well as with the view of carrying on pure cultivations this material is used in three ways. While the material is still fluid a small portion is poured into a number of pure tubes plugged with cotton wool, sterilized, and allowed to solidify. A fine platinum wire, heated in a flame and allowed to cool, is dipped into the material containing the bacterium in question, and then, after the removal of the cotton-wool plug, is rapidly plunged down through the gelatin to the bottom of the tube and then withdrawn. The plug is reinserted and the tube kept at a temperature suitable for the development of most forms of bacteria, but not high enough to melt the gelatin. If growth takes place at this temperature it occurs either on the surface around the point of entrance of the needle or along the needle track, or in both places, and the appearance of the growth varies remarkably, according to the different species of micro-organisms studied. The second way is to liquefy and pour out a little of the gelatinized material on microscopic slides or on larger plates of glass which have been sterilized by heat. These plates are placed in glass vessels containing moist blotting-paper to prevent drying of the gelatin and to protect them from the dust. After the gelatin has solidified the purified platinum needle charged with the bacteria is drawn rapidly over the surface of the gelatin. Bacteria are sown along the track, grow there, and the whole can be placed under a Microscope and the characteristics of the growth studied with a low power. In the third mode a tube of the gelatin mixture is inoculated with a very minute quantity of the bacteria. The tube is then placed in water at the body temperature to melt the gelatin. When the material has melted it is thoroughly shaken up to diffuse the bacteria through it, and while still liquid is poured out on sterilized glass plates kept in a moist chamber, as in the former case. Solidification very soon occurs, and the bacteria being caught at various parts of the gelatin grow there in the form of groups or colonies, which can be observed under a low power of

the Microscope. I shall now describe the characteristics of the *Bacillus alvei* when cultivated in these three modes.

*a*. Test-tube cultivations.—If an infected needle be plunged into a tube of gelatinized meat infusion, in the manner described above, growth occurs both on the surface and along the needle-track. On the surface the bacilli shoot out in all directions from the point of entrance of the needle, forming a delicate ramifying growth on the top of the gelatin ; the characteristics of this growth will be presently described under *b*. Along the track whitish irregular-shaped masses appear, which slowly increase in size and run together. In a few days processes are seen to shoot out from these masses, which may extend through the gelatin for long distances from the track, being thickened at various parts and clubbed at the ends. These processes do not appear to join one another at their ends (see figs. 5 and 6). A very beautiful and characteristic appearance is got where very few bacilli are introduced with the needle and where therefore at various parts of the track, more especially at the lower part, individual bacilli or groups of bacilli are planted at a considerable distance from each other. In a few days minute round whitish specks become visible to the naked eye. These increase in size till in about ten days shoots begin to appear. These radiate from the central mass in all directions and become nodular at various parts as described above. When such a cultivation is old the white branches disappear, and only little whitish collections of bacilli are seen at various parts. On examining such a tube with a pocket lens, however, numerous watery-looking tracks are seen running through the gelatin from the central mass to the whitish collections. The gelatin at the upper part of the track generally evaporates, to some extent giving rise to the air-bubble appearance so characteristic of the cholera bacillus (see fig. 6). These are the appearances seen where the material contains gelatin in the proportion of 10 per cent. Where less gelatin is present the naked eye appearances, while possessing the same characteristics, are somewhat different. The shoots are much more numerous and appear much more rapidly, giving rise to a haziness around the needle track which with the pocket lens is seen to consist of numerous delicate branches clubbed at the ends as in the former case. I think the amount of peptone present also makes a difference in the appearance, though of this point I am not yet absolutely certain. The most characteristic growth is, however, obtained when the material contains 3 per cent. peptone as well as 10 per cent. gelatin, the shoots being then less numerous and much coarser. And I can easily understand that this would be the case, for the bacilli would have a large supply of nutriment in their immediate vicinity without the necessity of having, so to speak, to spread out through the gelatin in search of food, as may be the

case where no peptone, or only a small amount, is present. This appearance is quite characteristic of this bacillus, and is not seen in the cultivation of any other organism that I know of. The bacilli of anthrax and of mouse septicæmia also spread out from the needle track, but the appearance of their cultivation is quite different. In anthrax delicate threads, not clubbed, shoot out from the track, soon anastomosing with other threads and forming a delicate network throughout the gelatin. In mouse septicæmia the appearance is that of a delicate cloudiness spreading through the gelatin. These foul brood bacilli, growing in this material, render it liquid after a time, the liquefaction beginning at the surface and only spreading slowly downwards, but ultimately the whole tube becomes liquid. After two or three weeks' growth the appearance presented by the tube is that of a layer of liquid at the upper part, and the growth along the needle track with the other appearances described at the lower part. The liquid portion is clear except at the bottom of the liquid, where there is a loose white flocculent deposit of bacilli, and on the surface there may be a very thin scum. The liquid becomes yellowish in colour after a time, and gives off an odour of stale, but not ammoniacal urine, or what may be better described as a shrimpy smell. This yellowish colour and the peculiar odour have been found by Mr. Cheshire to be distinctive of the diseased larvæ.

*b.* If gelatin be poured out on a plate, allowed to solidify, and then stroked with an infected needle, we learn the explanation of the appearances seen in the test-tube cultivations. The bacilli at first grow along the needle track, but very soon they are seen to be collecting at parts forming pointed processes. From the processes the bacilli grow out into the gelatin, often a single series of rods, in Indian file, or two or three rods side by side. These processes are not quite straight, but tend to curve, and at a little distance from the track they grow round so as to form a circle (see figs. 13 and 14*c*). From this circle, which may be formed of single bacilli, the process continues forming a fresh circle further on. The bacilli in the circle increase in number till ultimately it becomes completely filled up, and we have a nodule consisting of bacilli in the course of the shoot. These shoots may also join one another, forming a curved anastomosis, and the gelatin in the immediate vicinity of the bacilli becoming liquid, a series of channels are formed in the gelatin containing fluid in which the bacilli swim backwards and forwards. Later on, parts of these channels become apparently deserted by the bacilli, so that the circles look to the naked eye as if they were detached from the main track, but with a low power of the Microscope the empty channels can be traced. (See figs. 13 and 14.)

It is impossible to give a proper idea of the appearances of the

growth. The forms assumed are the most beautiful shapes I have ever seen, but they are very numerous, always however retaining the tendency to form curves and circles; thus we have the explanation of the appearances previously described in the test-tube cultivations.

*c.* The appearances of the colonies on plates on which the mixture of bacilli and gelatinized infusion has been poured out is also very characteristic. The earliest appearance of colonies is a small oval or round group of bacilli. This group is not homogeneous in appearance under a low power of the Microscope, but lines indicating the bacilli are seen in it. It very soon becomes pear-shaped, and from the sharp end of the pear processes begin to pass out into the gelatin, as before described. (See fig. 12.)

These bacilli do not grow below 16° C. The best growth in gelatin is obtained at a temperature of about 20° C. They grow most rapidly in cultivating materials kept at the body temperature. Very few spores are formed at the lower temperatures, but they appear rapidly and in large numbers at the body temperature. I have several times observed bacilli containing spores swimming about freely. The reaction of the medium is not of any very great importance, but a neutral medium is apparently the best. The bacilli swim freely in fluids with a slow oscillating movement.

They grow readily at the body temperature in meat infusion with peptone and rendered solid by agar-agar, but the appearance of their growth is not nearly so characteristic as in gelatin. This, indeed, is the case with most bacteria, so that agar-agar preparations, though very useful for carrying on pure cultivations at the temperature of the body, are of little value for diagnostic purposes. They grow most rapidly on the surface of the agar-agar, forming a whitish layer, but the shoots described above in the case of gelatin do not occur, or only very imperfectly, in agar-agar. Here the bacilli arrange themselves apparently side by side, and, producing spores in this position, we have as a result, after a few days' cultivation, long rows of spores lying side by side with here and there an adult bacillus. (See figs. 10 and 11.)

On potatoes they grow slowly, forming a dryish yellow layer on the surface. They grow very slowly indeed at the lower temperature. In order to get good growth it is necessary to keep the potato at the body temperature.

In milk they grow well at the body temperature, and in a few days cause coagulation of the milk, which also assumes a yellowish colour and gives off the odour previously described. The coagulum is not firm, like that caused by the *Bacterium lactis*, but is like a tremulous jelly, and may remain for a considerable time without the separation of any fluid, but ultimately it becomes liquid, and after some months assumes the appearance of a dirty, brownish-yellow, glairy fluid. It is very slightly, if indeed at all, acid.

They grow extremely slowly in coagulated blood serum, though kept at the body temperature, and there form very long filaments (see fig. 9) with comparatively few spores.

In meat infusion kept at the temperature of the body they grow readily, causing muddiness, and after a few days a slight but not tenacious scum. The same peculiar odour is also developed here, more especially if the infusion contains a considerable amount of peptone. I do not think that there is any change in the reaction of the fluid; I generally make the infusions faintly alkaline, and after the growth of this organism in it it is faintly alkaline.

These characteristics show that this is a new bacillus, and one which, so far as my knowledge and experience goes, is only found in foul brood. The constant presence in large numbers of a characteristic organism in a disease and its absence elsewhere must, according to our accumulating experience, afford a strong presumption that the organism is the cause of the disease. In the case of foul brood this matter has been completely proved by the following experiments, the details of which will be found in Mr. Cheshire's part of this paper. With a cultivation in milk he sprayed a comb containing a healthy brood, allowing the spray to act only on a particular part of the comb. This part and no other became affected with foul brood. He has also succeeded in infecting adult bees by feeding them with material containing these cultivated bacilli.

I have also had the opportunity of watching the effect of feeding flies with material containing spores and bacilli. I was one day testing some milk in which these bacilli were growing; a large bluebottle fly settled on it and commenced to eat. I at once put a large glass funnel over the insect, leaving plenty of air. When I came to the laboratory twenty-two hours later the fly was in the sitting posture on the table and was dead. Its juices were full of these bacilli, as shown by microscopical examination and by cultivation.

Other animals which I have tested are more or less refractory to this bacillus. I have kept cockroaches for days in a box in which was milk containing these bacilli mixed up with sugar. I have also kept them in a box containing a piece of paper which had been thoroughly smeared with the spores. None of them died, but I cannot be certain that in either case they ate any of the material, for I never saw them even near it.

I inoculated two mice and one rabbit with a spore-bearing cultivation without effect.

I injected half a syringeful of a spore-bearing cultivation into the dorsal subcutaneous tissue of each of two mice. One of these died in twenty-three hours, the other seemed unaffected, but in the second case I doubt whether the full quantity was introduced. In the case of the mouse which died the seat of injection and the neigh-

bouring cellular tissue was found to be very œdematous, but no macroscopic changes were apparent in the internal organs. Numerous bacilli were found in the œdematous fluid, as also a number of spores which had not yet sprouted, and there were also a few bacilli in the blood taken from the heart. This was proved, of course, by cultivation as well as by microscopical examination. On examining sections of the various organs no morbid changes were found, and only very few bacilli were seen in the blood-vessels.

At the same time that I injected the mice I injected a syringeful of the same cultivation subcutaneously into a guinea-pig. This animal died six days later with extensive necrosis of the muscular tissue and skin, and cheesy looking patches distributed through it. There was no true pus. On making sections of the necrosed tissue, numerous bacilli, apparently *Bacillus alvei*, were seen, but there were other bacteria and also micrococci, as of course would be the case on account of the death of the skin. No micro-organisms were seen in the internal organs. It thus remains questionable whether the necrosis was due to the *Bacillus alvei* or not, more especially as I have since injected three guinea-pigs subcutaneously with spore-bearing cultivations, but without effect. I must reserve the action of these bacilli on the higher animals for further investigation, as well as several other points of interest in regard to this organism to which I have not here alluded.

I venture to think that when all the evidence brought forward by Mr. Cheshire and myself is carefully weighed no doubt can be entertained that this bacillus is new to science, and is the cause of foul brood. Many questions of course still remain open, requiring further investigation into the life-history of the disease.

XII.—*Experiments on Feeding some Insects with the Curved or "Comma" Bacillus, and also with another Bacillus (B. subtilis?).*

By R. L. Maddox, M.D., Hon. F.R.M.S.

(*Read 13th May*, 1885.)

The record of a few experiments on feeding insects with the "comma" bacillus, and also with a straight bacillus (*B. subtilis?*) may be of some interest, as I am not aware that a similar attempt has been previously made and published. Although these experiments are too few to speak positively as to results, they are brought before the Fellows of the Society in the hope that others may be induced to extend them. They are of interest as bearing on the question of a possible mode of contagion, and are deserving of a more methodical inquiry, which as the season advances, I may perhaps be able to follow out.

On the morning of the 23rd of April a bee and two blowflies were captured and put under a clean tumbler resting in a saucer, a small square of clean glass being also placed in the saucer. Each was then fed off a bit of lump sugar well saturated with a liquefied impure gelatin culture of the "comma" bacillus abounding in living specimens of this organism, but contaminated with micrococci. One of the flies appeared to have been somewhat injured in the capture.

A few minutes afterwards a large wasp and another blowfly were captured, and placed together under the same conditions in another tumbler, and fed in the same way. Each insect was seen to feed freely off the saturated sugar. Provision was duly made for ventilation by supporting the tumblers on strips of card placed in the saucers. On the 24th, 9 A.M., the bee seemed very dull, and one of the flies, the injured one, scarcely able to stand. The bee was now fed with a drop of fresh milk from the breakfast table, of which it partook freely, and about three minutes after it had a violent dejection on the square piece of glass, and then appeared very lively, but for more than twenty minutes it seemed unable to clean itself of the excreta or make itself presentable. Part of the dejection was at once placed on some clean thin covers and allowed to dry without heat; also examined wet; some of the curved bacilli were in motion. The wasp was also fed with the milk, and the blowflies partook of the same, but without any similar result. The small lump of sugar in each saucer was again moistened with the culture fluid. Later in the forenoon another hive bee was caught and put under the tumbler with the first one. All were now seen to again feed off the sugar, and the wasp in the interim had had a

copious dejection on the side of the tumbler, consisting of solid and fluid matter. The tumbler was removed and a fresh one substituted. Part of the excreta was taken up by a flattened clean needle and spread on some clean cover-glasses and allowed to dry; also examined wet; the bacilli were not in motion; one of each of the covers was then stained with rose-anilin acetate in glycerin, the others with a watery solution of methyl-violet. Among the débris of the excreta of the wasp, which contained some fatty substance, were many of the "comma" bacilli, some micrococci, and some short straight bacilli. In the dejection from the bee, the "comma" bacilli were very abundant, as likewise the micrococci, mingled with some pollen-grains. On the 25th they were all again fed with the liquefied culture, but on the 26th the sugar was moistened with distilled water only. On the 27th they were all fed as on the 25th. On the 28th the injured blowfly was found dead; it was not examined. The others were fed with the curved bacilli culture. Another bee was caught and put into the tumbler with the two bees—there was an instant recognition and welcome by the second bee—they were each seen to partake of the moistened sugar.

On the same day a very large humble bee was captured, placed in captivity under similar conditions, and fed in the same way with the liquefied gelatin culture, of which it partook freely.

On the 29th all were again fed in the same way, save the bee which had been the first caught. It was found lying on its back and soon died. It was easily recognised as the first one, by being smaller than the other two. It was at once examined. A section was made at each side of the abdomen and the abdominal plates lifted, the viscera were removed to a clean slide with some distilled water freshly boiled, then placed on a cover with some rose-anilin in glycerin and spread out. Some of the water the viscera had been placed in was put on thin covers, allowed to dry, then stained and examined, whilst another portion was examined wet and without staining, when several curved bacilli were seen in each field, many of them in active motion and among them numerous micrococci. The stained covers showed also the "comma" bacilli and micrococci. This examination took some time, hence the viscera were much overstained; no soaking unfortunately detached the stain sufficiently for the slide to be of use for further investigation.

The 30th the rest were fed as before, save the blowfly in company with the wasp, which had succumbed; the legs and wings had been bitten off and part of the thorax destroyed by the wasp. Part of the contents of the abdominal cavity, the perivisceral fluid, was spread out on a thin cover and showed a few curved bacilli and short rods, also some micrococci, but none abundant; some of the curved bacilli had a very slight motion.

*May* 1*st.*—A culture medium made with gelatin, Carragheen moss, and Liebig's extract of meat, and rendered rather too alkaline, which had not been used in any way from the time of making, nearly a month before, was found broken down, very much liquefied, and contaminated with a straight bacillus, which had formed cloud-like dense folds, exceedingly tender, and near to the surface. The two bees and blowfly, also the humble bee and wasp, were each fed with some of this culture on sugar. They all fed eagerly of the same. A medium-sized blackbeetle which had been caught on the 27th and treated to the culture of the "comma" bacillus on bread-crumb, was likewise fed with the same straight bacillus. The excreta of the beetle abounded in bacteria and bacilli, and amongst them the comma bacillus in motion.

This food was repeated on the next day with all the insects, and on the 3rd they were found to be, so far as could be judged, unaffected. The two bees, humble-bee, and blowfly were allowed their liberty in the garden; the bees immediately went to some flowers, but the humble bee circled round until as high as the house, when it immediately flew off in one direction.

On the 4th and 5th the wasp and beetle were fed with the straight bacillus, and on the 6th another blowfly was put with the wasp. All were again fed with the same culture up to the 9th, when, about 9 A.M., the fly was found on its back, and died very soon after; the abdomen appeared tense and swollen. Within a few minutes a cut was made along one side of the abdomen, when the perivisceral fluid gushed out from this dropsical fly. Several covers were smeared with this clear but very sticky fluid, which would not dry well, but remained tacky and bright like albumen.

Upon staining, a few short straight rods were found on all the covers, also some diplococci. The fluid was miscible with water, remaining clear. Whether this effusion into the perivisceral cavity was due to the food, or to some by-play on the part of the wasp, I cannot say, but I suspect the latter as the cause of the intense effusion. Unfortunately engagements prevented the examination of the viscera. The wasp was dull and sleepy, and would not feed freely of the culture and sugar. The culture medium had now a rather more unpleasant smell, and when examined was found, though abounding in resting and motile rods, to be largely contaminated with *Bacterium termo*, the reaction being still markedly alkaline.

10*th.*—The wasp had much recovered, and was again fed in the same way.

11*th.*—While changing the saucers and squares of glass the wasp had a very fluid dejection, containing only a small lump of solid matter. The mixed dejection was at once placed on some thin covers, dried without heat, and when examined with the Microscope found to be swarming with short rods and the débris

of the bacilli. There were also a few diplococci and *Bacterium termo*. The wasp seemed very sleepy the greater part of the day, and at one time I thought it was dead.

12*th*.—It was as lively as before. The sugar was now only moistened with distilled water. The beetle remained dull during the daytime since its captivity, and I could never see it actually partaking of the gelatin culture, though I could see the bread had been on many occasions partially eaten, and the curved bacilli had been found in the excreta.

The question will naturally arise as to the value of these experiments. I think we may conclude that the "comma" bacillus is not pathogenic to the insects upon which the experiments were instituted. The two bees by being fed with a culture medium rich in this organism, one for seven days, had ample time for the effect of the organism, if pathogenic, to have been established, as also the wasp and the humble bee. In reference to the blowflies that died, I think they must be withdrawn from the list, and the one that was loosed from captivity had also sufficient time for any ill effects to be noted. The wasp has been in captivity twenty-one days, and has withstood the variety of feeding with the comma bacillus and the straight bacillus, as also has the blackbeetle; but it is possible these organisms may have had some pernicious effect, as a diet contrary to the natural one, and may have caused in the three observed instances the increased dejections. They moreover show that the "curved" bacillus can be passed through their intestines and ejected as a living organism, so that were this organism truly pathogenic to man and animals, the chances of contagion might be enhanced.

Since commencing these experiments I see recorded in the 'British Medical Journal' for the 9th inst. that Mr. Watson Cheyne, who had already, I believe, proved the *Bacillus alvei* of the bee to be pathogenic to the blowfly, has also met with a curved bacillus in a diseased bee.

These experiments I regard as simply preliminary; though not coupled with control experiments, they appear to me worth recording.

Some experiments were also commenced by growing seeds on a damp clean medium, as embroidery canvas and coarse flannel. When the radicles had passed through the meshes, the whole was placed on some diluted "comma" bacillus culture for forty-eight hours, and afterwards transferred to distilled water for twenty-four hours, when the whole was again transferred to a weak watery solution of methyl-violet for forty-eight hours, and then again placed on distilled water for a day or more before examining them by the Microscope. In the case of the fine side radicles of the common *Sinapis* or mustard-seed, I thought I could in several

instances, when mounted in water on a slide, detect the "comma" bacillus amongst the plasm of the cells, but I could not speak positively on this rather difficult point. The experiments require repetition. Still, if it be a fact that the rootlets can take up these organisms, it may point to another source for the conveyance of such into the intestines of man and animals, especially of birds and rodents.

It may be an error, but I believe these experiments with these particular bacilli to be the first recorded. In reference to the straight bacillus, I cannot positively say it is *Bacillus subtilis*, but I expect it is. My friend Mr. Dowdeswell, who is more acquainted with these organisms than I am, has had some for examination, and I am now able to add his opinion, which is that they closely resemble *Bacillus subtilis*, if not it. Experiments in these directions open a large field of inquiry, and I am not aware they are trammelled by any Act of Parliament.

P.S. 19*th*.—The abdominal sac of the bee that had been overstained and left covered on the slide in weak acetate of potash, was laid open in a little freshly boiled distilled water on the slide. A considerable number of bacteria were seen, some as narrow rods of various lengths, another kind with slight motion, and some curved bacilli. A very few amongst these had slight though perceptible motion. There were also straight rod-spores in full development.

The dejections of the wasp after feeding on lump-sugar moistened with distilled water for five days, yielded scarcely a rod and the micrococci were much less numerous. The dejections had a very small portion of solid matter.

21*st*.—A long red-bodied fly I had put with the wasp was soon killed; the head, legs, and wings were nipped off and the contents of the thorax speedily devoured.

22*nd*.—Fed with the sugar and water, and a blow-fly (*Musca vomitoria*) put with it in the same tumbler.

23*rd*.—Both were seen to feed freely off a lump of sugar moistened with old dried blood of mouse, dead of anthrax, mixed with distilled water. In the mixture only a few rods were noticed when examined microscopically.

24*th*.—Fed in the same way, and both watched feeding.

25*th*.—The two insects were separated, and just as the vessels, &c., had been changed, and before feeding them with the same blood-mixture, the wasp had a clear fluid dejection, which was immediately examined. Only six rods were counted in many fields. Within a quarter of an hour after feeding the wasp had three other dejections on the fresh square of glass, one with a tiny lump of solid matter. Within ten minutes another clear fluid dejection was passed. This had some peculiar bodies which I regarded as intestinal parasites, ranging in size from the sixth to the half

diameter of the human blood-corpuscle. Seen on one surface they appeared circular and bright, with a central dot; seen on the reverse side, the largest had a pale centre, then a darkish ring, then a pale ring surrounded by a dark outline. The window-frame could be, with a little care, focused on this surface, but not on the opposite side. Seen in side view they were concavo-convex, the protoplasm forming a dark body like a comma lying closely against the inner edge of the outer convexity. Most of them had a gentle rolling, tumbling kind of motion, often springing up suddenly and being for the moment lost to view, but directly after found in the same spot. This springing occurred only when seen with the ringed side upwards. It seemed as if the little organism had got twisted upon flagella which suddenly untwisted, throwing the object immediately out of focus, though I could not with certainty detect any flagella. The organism was quite new to me. In the other three dejections nothing of moment was noticed, save a very few of the same organisms and a few rods in the solid portion, the longest being beaded. The wasp was exceedingly restless all the forenoon. The blow-fly some little time after feeding on the sugar with the blood-mixture had a dejection, which was directly examined, and found to contain a few beaded rods amongst a considerable amount of débris. The rods in each resembled the anthrax rods.

*26th and 27th.*—Again fed on the sugar moistened with distilled water, and a humble bee (*Bombus lapidarius*) which had been captured on the 27th, was fed in the same way. A dejection from it that had been passed on to the square of glass was examined and furnished amongst the débris a few very thick short non-motile rods with rather pointed ends.

On the 28th, after changing the vessels and feeding with sugar, the three insects were unfortunately placed on the outside window-ledge in full sunshine, the window being slightly open. All were found dead at 3 P.M., supposed to be due to the powerful heat of the sun and a very free current of air. In the perivisceral cavities of the wasp and *Bombus* nothing of moment was noticed. The fly was not examined. The beetle (*Blaps mortisaga*) had not been fed on the blood-mixture, but on a variety of ordinary food-articles, and is still living.

That specimen of anthrax blood, it seems, was not pathogenic to the fly or wasp. The death of the three insects appeared to be solely due to the high temperature (136° F.) under confinement (heat asphyxia?), as all were lively enough when the vessels were changed.

## XIII.—*On Four New Species of the Genus Floscularia, and Five other New Species of Rotifera.*

By C. T. Hudson, LL.D., F.R.M.S.

(*Read 13th May*, 1885.)

Plate XII.

When in 1883 I described in the pages of this Journal four new species of Floscules, I did not anticipate that, in two years' time, I should have as many more to add to the genus; and yet such is the case.

Scotland sends us two; one (discovered by Mr. J. Hood, of Dundee) with only two lobes, and one (discovered by Mr. W. Dingwall, of Dundee) without any lobes at all; so that there is now a regular series of Floscules with 7, 5, 3, 2 and 0 lobes.

England, however, caps these additions to our rotiferous fauna, with two of the strangest species that have yet been found in the genus *Floscularia*. The one has setæ which appear to be always in motion, each slowly extending and contracting in amœboid fashion, but always in the direction of its length. The other, to the horror of every classifier, is a swimming Floscule; and, as if that were not absurdity enough, it carries its eyes nearly at the summit of its dorsal lobe.

The former of these was discovered by Mr. W. G. Cocks, of the Quekett Club, and the latter by Mr. T. Bolton, of Birmingham. Mr. Bolton has also added to his swimming Floscule a solitary swimming *Conochilus*, with an extraordinary pair of antennæ; a large new *Notommata* with four spiky antennæ; and a new species in each of Mr. Gosse's rare genera *Taphrocampa* and *Pompholyx*; while Mr. J. Hood has found yet another species of the rapidly extending genus *Stephanops*.

Indeed, the record of the last three or four years shows how many pleasant surprises Nature has yet in store for us, if there were only reapers for the harvest. If the Scotch lakes and the English ponds have contributed so many new and strange forms, when

---

EXPLANATION OF PLATE XII.

Fig. 1.—*Floscularia mutabilis* (at rest).
„ 2.— „ „ (swimming).
„ 3.— „ „ male.
„ 4.—*Conochilus dossuarius*.
„ 5.—*Notommata spicata*.
„ 6.—*Stephanops armatus*.
„ 7.—*Pompholyx sulcata* (side view).
„ 8.— „ „ (front view).
„ 9.—*Taphrocampa Saundersiæ*.


8
2
1
4
6
7
3
5
9

skilfully fished by Mr. Bolton and Mr. Hood, why should not the Welsh and Irish lakes, marsh ponds, and moorland pools yield forms equally curious and beautiful under similar treatment?

Let any one reflect that during the hundred years from 1766 to 1866 there were only three known species of Floscules, and that in the next twenty years no less than eleven very remarkable species have been added to the older three, mainly through the persistent researches of Mr. Bolton in England and Mr. Hood in Scotland, and he will at once admit that it is rather the lack of skilled observers, than the poverty of Nature, which we have to complain of.

*Floscularia mira* n. sp. mihi.

This is perhaps the most remarkable of all the strange creatures that belong to the genus. It was discovered by Mr. W. G. Cocks.

It is a small Rotiferon; at least the only specimen that I have seen was but 1/100 in from the tops of the knobbed lobes to the extremity of the foot. It closely resembles *F. ornata* except in two points, viz. its tube and its setæ. The tube is much more like the case of a *Stephanoceros* than that of a Floscule: but no great stress should be laid on this, as the cases of the tube-maker often differ a good deal from one another, even in the same species; and of this species, as I have already said, I have seen but one specimen.

The setæ, however, are absolutely unique; no other Rotiferon that I am acquainted with has anything resembling them. When seen by transmitted light there is nothing remarkable about them, except their great length and abundance; but, with dark-field illumination, they are at once seen to be all lengthening and contracting like the fine processes of an *Actinophrys*, only at a more rapid rate.

The setæ move quite independently of each other, not at all in groups; so that any score of them in view at once are in every phase of extension and contraction: and tiny particles may be seen to move along inside them as if carried by some current.

When a contracted seta begins to extend in length, its tip is often driven forward with a curious flourish, such as the end of an empty elastic tube might give if a stream of water were suddenly driven along it.

*Floscularia mutabilis* n. sp. Bolton. Plate XII. figs. 1, 2, and 3.

This swimming tube-maker was discovered by Mr. Bolton in September 1884, and named, figured, and described by him in one of his fly-leaves sent out with each specimen. It is about 1/65 in. long; and, when quiet in its tube (fig. 1), looks as if it

were some two-lobed Floscule that had dropped off its perch. The setæ surrounding the trochal cup are somewhat scanty and short, but do not seem to differ from those of an ordinary species. After a few moments' rest, however, the Floscule pulls down its two lobes, and so alters the aperture of its disk (fig. 2) that it now resembles that of an Œcistes.

At the same time the setæ lash the water as cilia do, and the creature sails away, case, eggs, and all, stern foremost. Mr. Bolton thinks that the setæ are held stiffly out (as usual) when the Floscule swims, and that the motion is effected by a row of small cilia running round the trochal cup, just under the bases of the setæ. In favour of this supposition is the fact, that some species of Floscules have such a row of cilia, and that just such an arrangement appears to exist in the male (fig. 3): but I confess that my own opinion is adverse to this suggestion. I spent much time watching the disk of *F. mutabilis* as it swam, and it appeared to me that it was the row of setæ themselves which set up the apparent ciliary action. It was very striking how each individual seta became instantly visible as the action ceased, though quite invisible before.

I saw two forms of young, one of which (fig. 3) I have little doubt is the male. I did not, however, succeed in catching it, and in viewing its internal organs.

*Floscularia calva* n. sp. mihi.

This is a rare Rotiferon, and was found last year by Mr. J. Hood in the lochs and marsh-pools of Fife and Forfar, on *Myriophyllum* and *Sphagnum*.

It is a very bad traveller, for it appears to withdraw its foot from the plant it is on, and to fix it in the tube itself. In consequence of this the tube and the Rotiferon are easily knocked off the stem they were originally on; and every specimen, that came to me alive, was lying at the bottom of the tube mixed up with débris of all kinds. Under these circumstances it was difficult to observe it well; still I made out distinctly that it had only two lobes, a dorsal and a ventral one, and that the setæ were remarkably short. The dorsal lobe, as usual, was the larger, and was a little swollen at its highest point, so as to give it rather a knobbed look when seen sideways. The body too was unusually slender for its length, so that the whole outline from the junction of the foot to the top of the trochal cup was almost cylindrical.

It resembles *F. mutabilis* in having only two lobes, but differs from it in its cylindrical shape, in the position of the eyes (which is normal), and in the inability to alter its disk and swim.

It is the first two-lobed Floscule that has ever been found.

*Floscularia edentata* (?) Collins.

In this species the lobes of the trochal disk have vanished altogether. There is a wrinkled edge to the trochal cup, and a few short setæ rise from it, chiefly towards the dorsal and ventral sides; but its roughly circular outline has no elevations or hollows, and lies in a plane transverse to the long axis of the body. This animal was discovered by Mr. W. Dingwall, of Dundee, in July 1884, near Blair Athol. I have only seen two specimens, but they were exactly alike. It is a very stout Floscule with a broad body and short foot, and the internal organs in each case were obscured by the gorged stomach. In each case too there were eggs, both within the body, and attached to the foot. The lobeless trochal cup in no way resembled the delicate contrivance with which *Apsilus lentiformis* fishes for its prey: it was a stout inverted cone, just such a one as might be produced by trimming off the lobes of an ordinary Floscule.

I have considerable doubt as to whether this is a new species, or whether it is *Floscularia edentata*, which was discovered by Dr. F. Collins near Sandhurst about 1866, and described and figured by him in 'Science-Gossip' for 1872, p. 9.

The figure and the description tally with Mr. Dingwall's Rotifer in many respects; but Dr. Collins says that his animal had neither maxillary apparatus nor tube. The apparent absence of tube is of little consequence, as this structure has been repeatedly overlooked in Floscules that are well known to have it. The absence of maxillary apparatus in a female rotifer is, however, a much greater difficulty; yet Dr. Collins says that his specimen had no teeth, and that its food passed directly through the throat into a very capacious stomach. He also adds, that each of his specimens laid an egg while under observation, thus showing that they were females. The length of his specimens was 1/80 in., and that of those sent to me by Mr. Dingwall was 1/55.

I am inclined to think that these Rotifera are the same, and so I have retained Dr. Collins' name *edentata;* although it unluckily asserts as a specific distinction a doubtful fact: probably the teeth, which are at best small and inconspicuous, were lost to view in the gorged intestine.

*Conochilus dossuarius* n. sp. Bolton. Plate XII. fig. 4.

This is another swimming tube-maker, and is also one of Mr. Bolton's prizes. The specimens sent to me were all solitary, and all swimming about in their cases; but Mr. Bolton noticed that the larger individuals have generally one or two younger specimens adhering to them.

The most remarkable features, in the new *Conochilus*, are the position and form of the antennæ. These are long, and grow together for nearly two-thirds of their height; and, as they stand perched on the ventral surface, remind one a little of a rifle-sight. They are too, for a *Conochilus*, in an unusual position; for in *C. volvox* they are close to the mouth, and within the inner circlet of cilia. In *C. dossuarius* they are far away from the mouth, and entirely outside the trochal disk.

The young of *C. volvox* are in the habit of clustering together, with their feet all tending to a common centre; and, after swimming for some time in this odd fashion round about one another, they secrete tubes that fill up the spaces between the individual animals, and clasp them all together into one sphere.

But, from Mr. Bolton's observation, this does not seem to be the case with *C. dossuarius*. Here young animals of different ages are attached by their tubes to the much larger tube of their common parent, forming clusters irregular in shape, and varying in size. However, I will not pursue the subject, as I hope that this summer fresh specimens will enable us to see whether this *Conochilus* ever forms clusters, like the beautiful spheres of *C. volvox*.

*Notommata spicata* n. sp. mihi. Plate XII. fig. 5.

Mr. Bolton sent me this very large and remarkable *Notommata* in May 1884. It is 1/25 in. in length, and is surrounded with a transparent gelatinous covering, out of which peep the ends of its four dart-like antennæ. It is something like *N. centrura*, but this latter has only one anterior antenna on the median dorsal line; and its two posterior dorsal antennæ are not nearly as long as those of *N. spicata*, and are quite buried under the creature's gelatinous coat. They both have the same funnel-like ciliated mouth, with its edges hanging down from under the ventral surface, but their general contour is unlike; *N. centrura*, when viewed dorsally, is wider across the posterior end in proportion to its length: *N. spicata* tapers much more gradually. However, the four antennæ are enough, I believe, to distinguish it from all other species.* It has a very long tapering stomach, much sacculated at its anterior end, and four gastric glands close beneath the mastax. The ovary, in the specimens I saw, was a long thick rope, with the germs lying in it singly one above another.

I had the good fortune to see the adorning of a lasting-egg with

* *N. spicata* has a superficial resemblance to *N. copeus;* but the latter has a dorsal antenna on the median line (which the former lacks), as well as two stout, flexible, cylindrical auricles, which it moves into various positions, and each of which bears a circle of cilia on its free extremity. If *N. spicata* has ciliated auricles, I have not seen them exhibited: I only know *N. copeus* from Ehrenberg's drawings and description.

its bristles. The large egg shown in fig. 5 was, when I first saw it, quite smooth; and was separated by a clear space from its outermost covering. After a little while the outline of the egg grew wavy, owing to small protuberances which projected into the clear space, and which by focusing I could see extended all over its surface. The growth of these protuberances was quite perceptible at the end of every ten minutes or so, and in two hours' time they had grown long enough to stretch almost across the clear space that separated the two coverings of the egg. They were stouter than mere hairs, but cannot be effectively rendered on the small scale of fig. 5.

*Stephanops armatus* n. sp. mihi. Plate XII. fig. 6.

This three-spined *Stephanops* was first found by Mr. J. Hood in Roscobbie Loch, in August 1884. I have not seen it; and the figure I have given is copied from a drawing of Mr. Hood's. Its specific distinction lies in the presence of two posterior lateral spines, along with one long dorsal one.

As this genus has received several additions lately, I here subjoin an analysis of its species.

* No dorsal spine.

| | |
|---|---|
| Without posterior spines . . | *Stephanops muticus* Ehrenberg. |
| With two „ „ . . | *S. cirratus* Müller. |
| With three „ „ . . | *S. lamellaris* Müller. |

** With a dorsal spine.

| | | |
|---|---|---|
| Without posterior spines | two toes . . | *S. longispinatus* Tatem. |
| | three toes | *S. uniseta* Collins. |
| With one posterior spine . . . . . | | *S. bifurcus* Bolton. |
| With two posterior spines . . . . . | | *S. armatus* Hudson. |

Besides these there are *S. ovalis* Schmarda and *S. tridentatus* Fresenius; but I have not seen the descriptions of these. Possibly the latter of the two may be the same as *S. armatus*. Mr. J. E. Lord's three-toed *Stephanops*† is I think probably Dr. Collins's *S. uniseta*.

*Pompholyx sulcata* n. sp. Bolton. Plate XII. figs. 7 and 8.

This new species differs from Mr. Gosse's *P. complanata* in the shape of the lorica. In this latter the lorica is greatly compressed dorsally and ventrally, so as actually to be concave at the median line on both surfaces. But in *P. sulcata* the dorsal and ventral

† Microscopical News, iv. (1881) p. 146, fig. 24.

surfaces are both sharply convex, and there are convex lateral surfaces as well; in fig. 8 a transverse section of the lorica is given, showing its four-lobed form. This may be easily obtained from the live animal, as it has a habit of swimming head downwards with its trochal disk close to the glass.

Mr. Bolton found this pretty little rotifer last summer in the same water with *Conochilus dossuarius*.

*Taphrocampa Saundersiæ* n. sp. Gosse. Pl. XII. fig. 9.

Mr. Bolton sent me several specimens of a new *Taphrocampa* in July 1884. It is somewhat like Mr. Gosse's *T. annulosa*, but differs from it in having a square curved hood projecting downwards over the head, and looking like a hook in profile; also in having two colourless spots like eyes on the head; as well as a stout short truncate tail, just above the forked foot.

I did not notice the slightest trace of ciliary action about the head, neither has Mr. Gosse observed any, either in this species or in *T. annulosa*; and yet it is possible that both animals possess ciliated auricles, for Mr. E. B. Brayley, the Hon. Secretary of our Bristol Microscopical Society, has given me a rough sketch of an animal which is probably *T. annulosa*, and which on several occasions he observed to put out little tufted auricles from the sides of its head and swim with "a slight vermiform movement." He thinks also that "a row of very short cilia extend right across the forehead."

Mr. Gosse has named this new animal *T. Saundersiæ*, after Miss Saunders, of Cheltenham, who has sent both to Mr. Gosse and myself several specimens of rare Rotifera.

I have been compelled by lack of leisure to give very brief notices of the above new species, and but few figures; but they will be dealt with in a more satisfactory manner in the Monograph on the Rotifera by Mr. Gosse and myself, which is now being prepared for publication.

# SUMMARY

OF CURRENT RESEARCHES RELATING TO

# ZOOLOGY AND BOTANY

*(principally Invertebrata and Cryptogamia)*,

# MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Unity of the Process of Spermatogensis in Mammalia.†**—M. Laulainé recognizes two periods in the process of spermatogenesis; the first is one of proliferation (formation of spermatoblasts), the second of differentiation (evolution of spermatoblasts); the former has been observed to take place either endo- or exo-genetically. In the horse and the pig spermatogenesis is similar to that in the rat, but the author does not agree with Balbiani in regarding the phenomenon as exogenetic in character; indeed, the term exogenetic can only be used if we ceased to ascribe to it the meaning of there being proliferation by budding, and limit it to the intervention of the ramified cells first described by Sertoli. In mammals with an exogenetic method of spermatogenesis, the spermatoblasts are collected by the cells of Sertoli, and go through all the phases of their development on the surface of these cells; the last are only permanent elements of support. In all mammals proliferation takes place by division.

**Formation of the Blastoderm in the Bird's Egg.‡**—M. M. Duval denies that there is any absolute line of demarcation beyond the germ proper and the white yolk; indeed, we cannot even say that the "vitellus de formation" only takes part in the process of segmentation, and that the "vitellus de nutrition" has no share in it, for after the formation of the blastoderm a secondary segmentation goes on in the remainder of the yolk; and it is impossible to say exactly where this secondary segmentation ends. Segmentation, as Kölliker has pointed out, is excentric, or commences at a point which does not correspond

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, or for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† Comptes Rendus, c. (1885) pp. 1407-9.

‡ Ann. Sci. Nat.—Zool., xviii. (1884) 208 pp. and 5 pls.

to the centre of the future blastoderm, and goes on most actively in this region; to this the author adds the rider that the point where the most active segmentation commences corresponds to the future posterior region of the blastoderm, and we can, therefore, early distinguish the front from the hind end. Like those of lower vertebrates the ova of birds have a true segmentation cavity, which has the form of a slit, is often difficult to recognize, and marks the point where the ectodermal are separated from the subjacent elements; as segmentation extends more deeply it affects the yolk-layers which ought to be considered as belonging to the white yolk; but at a certain depth this segmentation seems to stop; it does not really do so, there is only a modification of its rhythm; the cavity formed by the furrows is the subgerminal cavity which is produced from behind forwards, and is the homologue of the primitive enteron of Batrachians, or in other words, represents the gastrula-invagination of lower vertebrates.

After the formation of this subgerminal cavity a number of free nuclei are to be found in the yolk which forms its floor; these arise from nuclei which, during the formation of the cavity, had divided into two; of the halves one remained in one of the deeper spheres of the blastoderm, and the other in the floor of the segmentation cavity. A secondary segmentation appeared around these nuclei, which, at first inactive, afterwards became very active; the multiplication of nuclei in the yolk gives rise to the production of the vitelline endoderm.

The blastoderm of the freshly laid egg is formed of two layers; the upper consists of a single row of cells, which form a distinct ectoderm; the cells of the lower layer vary in size, are in the stage of segmentation, and form an irregular mass from which arises both endoderm and mesoderm; this may be called the primitive endodermic mass.

From the time when segmentation ends until the appearance of the primitive groove, the edge of the blastoderm passes through three stages; it is at first raised into a ridge, and the ectoderm is continuous with the endoderm; the latter consists of several layers of cells and forms the greater part of the swelling. The ectoderm then separates from the primitive endoderm along the edges of the blastoderm, and, while the ectoderm extends very far over the yolk, the margin of the endoderm fuses with the yolk, to form an endodermo-vitelline enlargement; as the yolk divides around each nucleus there appear large cells which, by further division, increase the surface of the endoderm. We next have a large vitelline layer (vitelline endoderm) with free nuclei, and finally a layer of yolk without nuclei.

The author finds that it is necessary to distinguish the axial plate and the primitive line as two successive phases of one and the same formation; the former has the same constitution as the blastodermic ridge.

All along the axial plate the connections of the ectoderm with the primitive endodermic mass exist from the moment when there first appear the rudiments of this plate; when its groove becomes more

deeply hollowed, the connections between the ectoderm and the axial plate seem to become more intimate along its base, and, at the same time, the groove becomes divided into proper endoderm and mesoderm. It is the multiplication of the elements of this mesodermic plate that causes the greater distinctness of the groove of the primitive line. The axial plate of birds ought to be considered as the homologue of the anus of Rusconi in Batrachians; it is rudimentary, indeed, its lips being fused in a kind of antero-posterior median raphe, and it is at these lips that we have most actively multiplying the elements which are destined to form the mesoderm. At the bottom of the groove the mesoderm grows at the expense of a cellular mass which is common to the mesoderm and ectoderm; but this fact must not be thought to prove the origin of the middle from the outer germinal layer.

In combining with his own the results of other workers, M. Duval takes occasion to consider the work of his predecessors.

**Physiological Purpose of Turning the Incubating Hen's Egg.*** —The sitting fowl frequently turns her eggs during incubation, and when this process is carried on artificially, mechanical means must be adopted to effect the same purpose.

M. C. Dareste finds that during the first week of artificial incubation, eggs which are turned develope in essentially the same manner as those which are allowed to rest, but the monstrosities which have already been formed in the latter soon take on an excessive development, and in very few eggs which are allowed to remain unmoved during the whole period of incubation does the body-cavity of the embryo become closed in. The cause of death in the unmoved eggs is, according to Dareste, the union by growth of the allantois with the egg-yolk, which latter is thus prevented from becoming finally absorbed into the alimentary canal preliminary to the closure of the body-cavity. These adhesions of the allantois with the vitelline membrane lead to frequent rupture of the latter, whose contents are thus largely lost to the embryo. Death of the chick in the unturned eggs usually occurs about the second week of incubation. When the eggs are turned over it is probable that the position of the allantois upon the yolk is shifted, and this daily movement prevents adhesion between the two surfaces.

Sixteen eggs were placed under the same conditions of artificial incubation, but eight were allowed to remain unmoved, while the eight remaining were turned over twice a day. In the first set absorption of the yolk did not occur in any specimen, and all the embryos died in the course of the second or third week. In the second set, in six eggs the yolk was absorbed in the normal manner; in a seventh, opened on the twenty-second day, the chick was alive and hearty and the yolk was being absorbed; in the eighth egg the chick was dead on the twentieth day, and adhesion between the allantois and yolk had prevented absorption of the latter.

* Comptes Rendus, c. (1885) pp. 813-4. See Amer. Naturalist, xix. (1885) pp. 619-20.

**Colours of Bird's Eggs.***—Dr. O. Laschenberg has published a short abstract of his investigations into this subject; the more important results are as follows:—As Krukenberg has stated, the ground coloration originates in a different way from the spots and markings, though both are derived from the blood and not from special pigment-glands. The ground coloration is caused by a transudation through the uterus which is richly supplied with blood-vessels; the spots are formed by particles of pigment which are found throughout the oviduct and probably arise in the Graafian follicle; the formation of pigment is no doubt to be referred to a process similar to that which causes the corpus luteum in the ovary of mammals.

**Development of Epicrium.†**—Herren P. B. and C. F. Sarasin have taken advantage of their visit to Ceylon to investigate the developmental history of *Epicrium glutinosum*. The ovarian eggs are more like those of reptiles than of amphibians, are oval in form, and about 9 mm. in their longest and 6·5 mm. in their shortest diameter; there was a considerable quantity of yolk, and a rounded whitish germinal disk, in the centre of which is the darker germinal vesicle; the arrangement of the yolk was not unlike that which is seen in the bird; in the oviducts the ova become surrounded by a quantity of albumen, and a spirally coiled cord appears at either pole. *Epicrium*, unlike its American ally *Cœcilia*, lays eggs, and also hatches them. Embryos about 4 cm. long move livelily in their shells; on either side of and behind the head arises a tuft of three blood-red external gills, which constantly move about in the ovarian fluid. The three tufts vary in length, the shortest being 2, the longest 9 mm. long; the tail, which is short but quite distinct, has a well-marked fin; the eye appears to be proportionately very large and distinct; dermal sensory organs can be made out with the aid of a magnifying glass, and have the appearance of white dots: the body is of a greyish-blue colour, clearer below, and has a black stripe along the dorsal middle line; the two beautiful yellow bands which are found in the adult are absent from the embryo. The gills develope very early; when they are lost, the young pass into the nearest pool and begin to lead a free life. In the water they grow to a length of about 16 cm., and lose their gill-clefts and caudal fin; the structure of the skin changes, and they become adapted to a terrestrial mode of life.

The authors are of opinion that the Gymnophiona are to be associated with or stand quite close to the Urodela; as embryos they are perennibranchiata, as larvæ derotrematous, and in their adult terrestrial condition they correspond to the Salamandrina. Embryology is supported in this view by histology, for the spermatozoa have been found to have an undulating membrane, and by anatomy, for there is a fourth arterial arch in the vascular system of the adult.

**Translocation forwards of the Rudiments of the Pelvic Fins in the Embryos of Physoclist Fishes.**—Mr. J. A. Ryder cites the

* Zool. Anzeig., viii. (1885) pp. 243-5.
† Arbeit. Zool.-Zoot. Inst. Würzburg, vii. (1885) pp. 291-9.
‡ Amer. Natural., xix. (1885) pp. 315-7.

observations of A. Agassiz on the translocation forwards of the rudiments of the pelvic fins in the young larva of *Lophius*, as demonstrating beyond any doubt that the Physoclisti have descended from the Physostomi.

**Silver-reducing Animal Organs.***—The success of Drs. O. Loew and T. Bokorny with vegetable cells induced the former to try and see if the protoplasm of animal cells would not likewise have a silver-reducing effect. Into between fifty and one hundred cubic centimetres of a solution which contained about 5 per cent. of silver the author placed the kidneys freshly taken from a frog or toad, with the ventral side turned upwards; the light was immediately cut off, but within fifteen minutes the bright bands on the surface became darkened, and in less than two hours were quite black. This very remarkable reaction is only to be observed with living tissues. The tissue may be seen under the Microscope to be traversed by black dots, more or less closely packed together. If the kidneys are left for twelve hours in the solution, a number of black dots may be observed in the interior of the kidney, and especially in the neighbourhood of such canals and other spaces as afford an easy means of passage for the reagent. These experiments are sufficient to show that living animal protoplasm can effect a reduction of silver.

**Effects of Very Low Temperatures on Living Organisms.**†—Mr. J. J. Coleman and Prof. M'Kendrick have made some remarkable experiments on the effects of low temperatures on living organisms, particularly microbes, using for this purpose the cold-air machinery invented by Mr. Coleman, which, in its ordinary working, delivers streams of air cooled to about 80° below zero (−63° C.), but by certain modifications as low temperatures can be secured as have yet been produced in physical researches.

The experiments consisted in exposing for hours to low temperatures putrescible substances in hermetically sealed tins or bottles, or in flasks plugged with cotton-wool. The tins or flasks were then allowed to thaw, and were kept in a warm room, the mean temperature of which was about 80° F. They were then opened, and the contents submitted to microscopical examination. The general result may be stated thus:—The vitality of micro-organisms cannot be destroyed by prolonged exposure to extreme cold. It is clear, therefore, that any hope of preserving meat by permanently sterilizing it by cold must be abandoned, for the microbes, which are the agents of putrefaction, survive the exposure.

Some of the experiments on which this conclusion rests are briefly described. Meat in tins, exposed to 63° C. for six hours, underwent (after thawing) putrefaction with generation of gases. Trials with fresh urine showed that freezing at very low temperatures delayed the appearance of the alkaline fermentation, but a temperature of 63° C. for eight hours did not sterilize the urine. Samples of fresh milk

* Pflüger's Archiv f. d. Gesammt. Physiol., xxxiv. (1885) pp. 596-601.

† Journ. of Anat. and Physiol., xix. (1885) pp. 335-41.

exposed to temperatures of from zero to −80° F. for eight hours, curdled, and showed the well-known *Bacterium lactis*; and so far as could be observed, freezing did not delay the process after the flasks were kept at a temperature of about 50° F. Similar results were obtained with ale, meat-juice, vegetable infusions, &c.

It is probable that the micro-organisms were frozen solid. One cannot suppose that in these circumstances any of the phenomena of life take place; the mechanism is simply arrested, and vital changes resume their course, when the condition of a suitable temperature is restored. These conditions led the authors to examine whether any of the vital phenomena of higher animals might be retained at such low temperatures. They ascertained that a live frog may be frozen through quite solid in about half-an-hour at a temperature of −20° to −30° F. On thawing slowly, in two instances the animal completely recovered. After longer exposure the animals did not recover. In two cases frogs were kept in an atmosphere of −100° F. for twenty minutes, and although they did not revive, yet, after thawing out, their muscles still responded feebly to electrical stimulation. One experiment was performed on a warm-blooded animal—a rabbit. The cold-blooded frog became as hard as a stone in from ten to twenty minutes, but the rabbit produced in itself so much heat as enabled it to remain soft and comparatively warm during an hour's exposure to −100° F. Still its production of heat was unequal to make good the loss, and every instant it was losing ground, until, at the end of the hour, its bodily temperature had fallen about 56° F. below the normal, but was still 143° F. above the surrounding temperature. When taken out the animal was comatose, and reflex action was abolished. Placed in a warm room, its temperature rose rapidly, and the rabbit completely recovered.

The observations are of great value and highly suggestive. Those upon the rabbit indicate that death from cold is preceded by loss of consciousness, owing to the early suppression of the activity of the grey matter of the encephalon. This confirms the belief that death by freezing is comparatively painless. The viability of microbes at low temperatures has also been demonstrated by Pictet and Yung,* who found that various bacilli can survive −70° C. for 109 hours. After such exposure, *Bacillus anthracis* retained its virulence when injected into a living animal.

"We cannot refrain from asking, Are not frozen micro-organisms the means of disseminating life through the universe? An affirmative answer is at least a better hypothesis than the assumption of spontaneous generation to account for the origin of life on the earth. May not life be coeval with energy? May it not have always existed?" †

**Bell's 'Comparative Anatomy and Physiology.'** ‡—In this manual Professor F. Jeffrey Bell arranges the elementary facts of zoology by

* See this Journal, iv. (1884) p. 432.

† Mr. C. S. Minot in Science, v. (1885) pp. 522–3.

‡ Bell, F. J., 'Comparative Anatomy and Physiology,' 555 pp. and 229 figs. 8vo, Cassell and Co., London, 1885.

organs instead of by the groups of animals; he says in his preface that he has constantly kept before himself, and hopes "the student will faithfully bear in mind that there has been an evolution of organs as well as of animals, and that he who desires to understand the most complicated organs must first know the structure of such as are more simply constituted." There are a large number of woodcuts, many of which are new to English text-books, and the more important discoveries of recent years appear to be incorporated with what the author calls "the general property of zoological workers." There is a copious index to the animals mentioned in the text.

## B. INVERTEBRATA.

**Action of Cocain on Invertebrates.***—M. Richard finds that an injection of hydrochlorate of cocain stops the heart of a snail in diastole; the animal will recover from a dose of 0·003 gr.; it takes longer to recover from twice as large a dose, and if 0·025 gr. are given the animal takes two days to recover. An earthworm soon has the middle part of its body rendered insensible by the injection of a dose of 0·006 gr., but the two ends retain their power of movement; a further dose of the same strength causes the voluntary movements to slowen gradually, but it takes 20 hours before they cease altogether. A small colony of Bryozoa was placed in 5 c.c. of fresh water to which 0·5 c.c. of 100 per cent. solution of cocain were added; the animals remained extended; ten minutes afterwards, a shaking of the glass made them retreat normally. *Daphniæ* resist for a long time the action of the drug. *Hydræ* in 5 c.c. of water to which 1 c.c. of the solution was slowly added, died in an extended state, and for them and for Bryozoa the author suggests the use of the drug as enabling us to preserve these delicate animals in an extended condition.

**Enterochlorophyll and Allied Pigments.**†—Dr. C. A. MacMunn in 1883 described the spectroscopic and other characters of enterochlorophyll which was obtained from the liver or other appendage of the enteron of various invertebrates. It is now shown that this pigment is *not* due to the presence of symbiotic algæ, or *immediate* food-products, but is built up by the animal containing it.

Taking the six bands ‡ of vegetable chlorophyll in alcoholic solution described by Kraus, the first two and the fourth are coincident with those of enterochlorophyll in a similar solution; the third band is, however, frequently missing from the latter. The fifth and sixth bands belong to the yellow constituent, which Hansen shows to be a lipochrome; the corresponding bands in the case of enterochlorophyll also belong to a lipochrome, and are not always coincident with the lipochrome bands of plant-chlorophyll. This was proved by saponifying enterochlorophyll by Hansen's method. But saponification of vegetable chlorophyll changes it considerably, as bands of a solution,

* Comptes Rendus, c. (1885) pp. 1409–11.

† Proc. Roy. Soc., xxxviii. (1885) pp. 319–22.

‡ The five bands in a leaf, as described by Kraus, can be seen by using a micro-spectroscope of small dispersion and a good substage achromatic condenser.

before saponifying, do not correspond with those of a similar solution after saponifying. Hansen's results were confirmed as far as the separation of "chlorophyll-green" and "chlorophyll-yellow" are concerned, and the crystals described by him obtained.

While the dominant band of "chlorophyll-green" in solutions of plant-chlorophyll is moved much nearer the violet by saponifying, or split up into two in some cases, the corresponding band of enterochlorophyll disappears *in toto*, or remains in the same place. Another difference was also noted in the case of enterochlorophyll and in the case of *Spongilla*-chlorophyll, namely, that it is impossible to bring about a *complete* separation of the constituents in most cases by saponifying and treating as Hansen directs.

All the bands of a solution of *Spongilla*-chlorophyll are coincident with those of a similar solution of plant-chlorophyll, as already proved by Prof. Lankester and Dr. Sorby.

From the enterochlorophyll of *Uraster rubens* crystals of "chlorophyll-yellow" and "chlorophyll-green" were obtained by saponifying.

Morphologically, enterochlorophyll occurs—as proved by the examination of fresh-frozen sections—in oil-globules, granules, and dissolved in the protoplasm of the liver-cells; no starch or cellulose could be found in such sections after adopting the usual botanical precautions.

Hence enterochlorophyll is an animal product, and a chlorophyll of which there are probably several recurring in animals.

### Mollusca.

**Buccal Membrane of Cephalopoda.***—M. L. Vialleton has studied the morphological nature of the buccal membrane of cephalopods by the aid of its nervous supply, and comes to the conclusion that the muscular mass of the lobes, the presence of suckers, and, above all, the existence in each of the ganglionic cord, analogous to the nerves of the arms and of the same origin as they, show that we must regard these lobes as true rudimentary arms; if this be so it is clear that the buccal membrane belongs to a series of arms in which the interbrachial membrane is proportionately better developed than the arms themselves. He rejects the view that the membranes are to be regarded as hypertrophied lips, inasmuch as the nerves are received from the sub-œsophageal portion of the cerebral mass, whereas the labial nerves arise from the supra-œsophageal portion. *Loligo vulgaris* and *Sepia officinalis* were the two types studied.

**Pancreatic Function of the Cephalopod Liver.**†—Mr. A. B. Griffiths, in addition to the facts already brought forward‡ to show that the cephalopod liver is pancreatic in function, now adduces the following.

Portions of the organ removed from a fresh *Sepia* had an alkaline

* Comptes Rendus, c. (1885) pp. 1301–3.

† Chem. News, li. (1885) p. 160. See Journ. Chem. Soc.—Abstr., xlviii. (1885) pp. 829–30.

‡ Chem. News, xlviii. (1884) p. 37.

reaction, converted starch into dextrose, and oil into fatty acids; 6 mgrms. of the tissue of the organ rendered 15 c.c. of milk transparent in four hours. Moreover, the ferment, removed from the organ, previously hardened by treatment with alcohol, by extraction with glycerol and subsequent precipitation with alcohol, converted starch into dextrose, and fibrin into leucine and tyrosine. The organ contains neither glycocholic nor taurocholic acid nor glycogen; it is therefore evident that this so-called "liver" is a true pancreas.

**Artificial Fecundation of Mollusca.***—Mr. W. Patten has succeeded in the artificial fertilization of the ova of *Haliotis* and *Patella;* this experiment has not been previously performed on any mollusc. Careful investigations were made in order to exclude the possibility of there having been a previous internal fertilization; the absence of an albuminiparous gland and external sexual organs in these molluscs appears to show that the ova undergo naturally an external fecundation.

**Development of Generative Organs of Pulmonata.†**—Herr J. Brock finds that the generative organs of pulmonate gastropods begin to be developed in the last stage of larval life; just below the cutis there is, on the right side and in front of the œsophageal ring, a fine cord of cells with a distinct lumen. A little later there is distinct evidence of the presence of a commencing hermaphrodite gland, and it is found that it and the efferent organs are developed in one and the same mesodermal blastema. Primordial ova appear very early. The author is convinced that in the formation of the external generative orifice the ectoderm does not take any share, by the formation of any invagination. After the formation of the oviduct the vas deferens appears; after this there is growth, but for a time no new formation; then the receptaculum seminis appears in the form of a wide-necked outgrowth of the genital atrium. The author was not able to follow out the later stages, but he thinks it is clear that the simple condition of the generative organs which is permanent in the Prosobranchiata is passed through during the development of the Pulmonata.

**Microscopic Anatomy of Dentalium.‡**—Prof. H. Fol finds that the epidermis of *Dentalium* is nothing more than a simple epithelium, the characters of which vary in different regions; at either extremity of the tube formed by the mantle some of the cells are modified to form a mass of very large glandular cells; each of these is imbedded in the subjacent dermal tissue and has a more or less flask-shaped form, and is filled by a granular secretion; one of these unicellular glands may be one hundred times as large as the ordinary epidermic cells; they are the chief agents in the formation of the shell.

The nerve-ganglia are formed of a cortical grey and an internal white substance; the latter consists solely of nerve-fibrils, without any neuroglia; the grey matter is made up of ganglionic cells which

* Zool. Anzeig., viii. (1885) pp. 236–7.
† Nachr. K. Gesell. Wiss. Göttingen, 1884, pp. 499–504.
‡ Comptes Rendus, c. (1885) pp. 1353–5.

are all unipolar. In the central ganglia groups of very large cells alternate quite regularly with other masses which are formed of much smaller cells.

The muscles are composed of ribbon-shaped smooth fibres, disposed like those of the non-striated muscles of higher vertebrates; in each fibre there is a rod-shaped nucleus. In the foot the muscles are very regularly arranged, and form two external circular layers, within which are some thirty longitudinal bundles.

The digestive tube is clothed by a simple epithelium, which is in some regions distinctly glandular, and in others ciliated; the liver and the kidney are hollow pouches, the wall of which is a simple glandular epithelium; below the anus there is a pouch common to the two halves of the kidney.

The generative organs are filled by a compact mass of generative products; near the surface of the ovary there are young ovules, the greater part of which is occupied by the nucleus, within which there is a nucleolus composed of two very dissimilar halves. In the mature ovum the double nucleolus disappears. M. Fol has not been able to find the efferent genital canal which has been described by Lacaze-Duthiers; the glands appear to him to empty themselves merely by dehiscence into the pallial cavity, the renal gland, or, as is most probable, by the anal gland.

**Nervous System of Fissurella.***—M. L. Boutan describes the nervous system of *Fissurella alternata* and comes to a different conclusion from that arrived at by Ihering from an investigation of *F. maxima*. In *Fissurella*, as in the typical nervous system of Gasteropoda, there are two cerebroid, two pedal, and five asymmetrical ganglia. There is, besides, a triangular nervous mass the morphological signification of which has been pointed out by Lacaze-Duthiers. This triangle is a simple extension of the pedal and the two first asymmetrical ganglia, which, being linked together, have acquired an exceptional development and become drawn out.

The nervous system of *Parmophora* is intermediate between that of *Haliotis* and of *Fissurella; Emarginula* is likewise furnished with the nervous mass above named and ranks between *Parmophora* and *Fissurella*, for the coalescence of the pedal and asymmetrical centres is carried in each animal a little less far than in the last-named type.

**Anatomy and Systematic Position of Halia priamus Risso.**†—M. J. Poirier gives a full description of the anatomical structure of *Halia priamus* Risso. With the exception of the operculum, which is wanting, the greater number of the organs resemble in form those of *Buccinum*. The formula of the radula is 1, 1, 1, not 1, 0, 1 as has been erroneously stated. Hence its systematic position is no longer with the Pleurotomidæ where lately it has been placed, but with the Buccinidæ.

**Tectibranchiata of the Gulf of Marseilles.**‡—M. A. Vayssière has examined thirty-seven species of Tectibranchs; they are all Opistho-

* Comptes Rendus, c. (1885) pp. 467-9.
† Ibid., pp. 461-4. ‡ Ibid., pp. 1389-91.

branchiata, and von Ihering was wrong in denying this. The incompletely known *Notarchus* has a small shell very like that of *Gastropteron meckelii*, its digestive tract and generative organs are almost exactly like those of *Aplysia*, and the same is true of its nervous system.

In *Umbrella mediterranea* the nervous system, as in almost all Tectibranchs, has a very delicate subœsophageal intercerebral commissure; the presence of otocysts was determined, and these organs, though lying in the pedal ganglia, are attached by very small nerves to the cerebral ganglion. The œsophageal nerve-collar of *Tylodina*, though very like that of *Umbrella*, has three instead of two visceral ganglia, and the median one gives rise to the genital nerves. Leach's name of *Ascanius* is applied to *Pleurobranchus membranaceus* and *P. tuberculatus*, and the genus is regarded as being intermediate between *Pleurobranchus* and *Pleurobranchea*.

**Classification of the Lamellibranchs.***—Dr. M. Neumayr gives a new classification of the Lamellibranchs, founded upon the hinge.

The oldest forms have no, or only the faintest, trace of hinge-teeth, the shells are thin, and there is usually neither mark of muscle nor of pallial sinus. For these forms, supposed to have two equal adductor muscles and an entire mantle-line, the order Palæconchæ is proposed. From these are supposed to diverge the Desmodonta, without hinge-teeth, or with irregular hinge-teeth, with two equal adductor muscles and with a pallial sinus; and the Taxodontæ, with numerous undifferentiated teeth and two equal muscles. To the first of these groups belong the Pholadomyidæ, Corbulidæ, Myidæ, Anatinidæ, Mactridæ, Paphidæ, Glycimœridæ, and Solenidæ (?), and to the second the Arcidæ and Nucalidæ. The Tubicolæ form a suborder of the Desmodonta. From the Taxodonta branch off in one direction the Heterodonta, with distinct cardinal and lateral teeth fitting into each other, and two muscle impressions (Najadæ, Carinidæ, Astartidæ, Crassatellidæ, Megalodontidæ, Chamidæ, (Rudistes) (Tridacnidæ), Erycinidæ, Lucinidæ, Cardiidæ, Cyrenidæ, Cyprinidæ, Veneridæ, Gnathodontidæ, Tellinidæ, Donacidæ, and in another, the Anisomyaria, with irregular or no hinge-teeth, two unequal muscles or one only, and no pallial sinus. These form two suborders, Heteromyaria (Aviculidæ, Mytilidæ, Prasinidæ, Pinnidæ) and Monomyaria (Pectinidæ, Mytilidæ, Spondylidæ, Anomidæ, Ostreidæ). The Trigonidæ are considered a suborder of Heterodonta.

**Development of Cyclas cornea.**†—Dr. H. E. Ziegler finds that the segmentation of the egg of *Cyclas* is, from the first, unequal; and the small cells, as usual, divide more rapidly than the larger. The egg, like those of the Najadæ, has a micropyle; the earlier stages of cleavage are passed through in the brood-sacs. The observations on the gastrulation were incomplete, but there was seen to be invagination, and two large primitive mesenchym-cells were detected. The differences in the quantity of fluid found between the ectoderm and endo-

* SB. K. Akad. Wiss. Wien, lxxxviii. (1884) pp. 385–420 (1 pl.). Amer. Natural., xix. (1885) pp. 404–5. See also this Journal, *ante*, p. 229.

† Zeitschr. f. Wiss. Zool., xli. (1885) pp. 525–69 (2 pls.).

derm of various individuals seem to be due to physiological relations. The blastopore is in the form of a slit, the length of which is about equal to that of the archenteron: the hinder end of the gut never separates from the ectoderm, and the anus arises at their point of junction. Dr. Ziegler compares the mode of development which obtains in Lamellibranchs with what is found in Gastropods, and shows how they both point to a common primitive mode of development.

The trochophore of *Cyclas* has all the organs homologous with those found in the corresponding stage of marine Lamellibranchs and Gastropods; as to the locomotor organs, the trochophore of *Cyclas* diverges somewhat from the marine Lamellibranchs and approaches rather the Pulmonata.

In describing the development of various organs, the author insists that the pericardiac cavity is not, as has been thought, part of the blood-vascular system, its fluid is not blood, and contains no blood-corpuscles. The gill-lamella is, at first, a simple fold; and, as differentiation extends from before backwards, it is possible in one and the same gill to observe various stages in the process of differentiation; from its lower margin the outer ectodermal layer gradually forms a fold which has the form of a groove, and this gradually grows upwards; there then appears on the lower margin of the fold a small corresponding infolding of the inner ectodermal layer; the lamellæ fuse, and vertical clefts appear in their substance. After describing the appearance of the brood-pouches, the author concludes with a short account of the genital glands; these form at an early stage two club-shaped masses which touch in the middle line; the sexes are united, and the disposition of parts is such that there appears to be self-impregnation.

**Manner in which Lamellibranchs attach themselves to Foreign Objects.***—Dr. J. T. Cattie describes the means by which the common mussel attaches itself to foreign objects. When the foot commences to grope about, it may become two or three times as long as the body of the animal without finding any object within its vicinity; it then moves about till it finds some point of support; when this is effected there appears from the transverse cleft, which terminates the ventral groove, a whitish substance which gradually becomes more opaque; sometimes the slit takes on the form of an equilateral triangle, and then the quantity of matter which exudes from it is greater; this matter obviously comes from the cylindrical tubes which are scattered in the glandular substance of the foot. A terminal plate having been formed the foot is withdrawn, and the plate and the byssus are merely connected by a delicate thread. The time necessary for an animal of average size to form the plate varies between 55 and 90 seconds; in some cases two connecting threads become developed. The terminal plate, when studied under the Microscope, was found to be formed of thousands of small granules, irregularly distributed, and varying considerably in size. The fine threads appear to be

* Tijdschr. Nederl. Dierk. Vereen., vi. (1882–5) pp. 56–63.

formed by the agglutination of granules of various sizes, but large granules are formed by the fusion of several smaller ones.

The formation of the byssus is regarded by the author as being very simple; the walls and the lamellæ of the byssus-cavity continually secrete a byssogenous matter; the lamellæ in the anterior and narrow part of the cavity unite and fuse with one another, while the narrower shape of the orifice gives the byssus-threads their form. Owing to the relations of the ventral groove of the foot each byssus-thread is immediately fused to the main trunk.

The author doubts the correctness of A. Müller's view that there is an agglutinating and a byssogenous substance; and speaks severely of the artificial character of that author's classification of the species.

**General Characters of Cymbulia.***—The Pteropoda being so purely pelagic in their habit, places them out of the reach of zoologists in general; and even systematic writers, as in other cases, are often misguided by incorrect figures and descriptions made up probably from scanty or defective data, but which have, nevertheless, been handed down to us with a show of truth. Dr. J. D. Macdonald was impressed with the idea that the figures and descriptions of the species of *Cymbulia* extant were not reliable; and having had an opportunity of examining some specimens taken in the Indian Ocean, he found that such was really the case.

In the natural position of the animal the toe of the hyaline slipper of *Cymbulia* should be taken as posterior, and the broadly notched heel as anterior. Both animal and shell are reversed in Mr. Adams's figure of *Cymbulia proboscidea*, but this is, after all, an error of less importance than that in De Blainville's figure, in which, although the shell is represented in its proper position, the animal is reversed. A pair of eyes are also given in a position where ears alone would be possible, while there is no more evidence of the existence of eyes in *Cymbulia* than in any other genus of Pteropods. The notion of a ventral connecting lobe between the fins is a mistake, though these organs are connected above and behind so as to form a broad, continuous plate.

## Molluscoida.

### *a.* Tunicata.

**Development of Social Ascidians.**†—Dr. O. Seeliger finds in the Salpidæ, Doliolidæ, and *Anchinia* various modifications of a true alternation of generation which, as a developmental cycle, was peculiar to their common stem-form. This form was free-swimming and developed ventral buds, just as now the tailed *Doliolum*-larva develops the rosette-shaped organ. Primitively the solitary forms may have passed over their capacity to develope generative products to the buds, but very soon the whole of the embryonic material appears to have passed into the buds, which had probably a somewhat complicated structure. The developmental cycle of the Pyrosomatidæ is also to be referred to the budding of the same free-swimming

* Proc. Roy. Soc., xxxviii. (1885) pp. 251–3 ( 1 fig.)

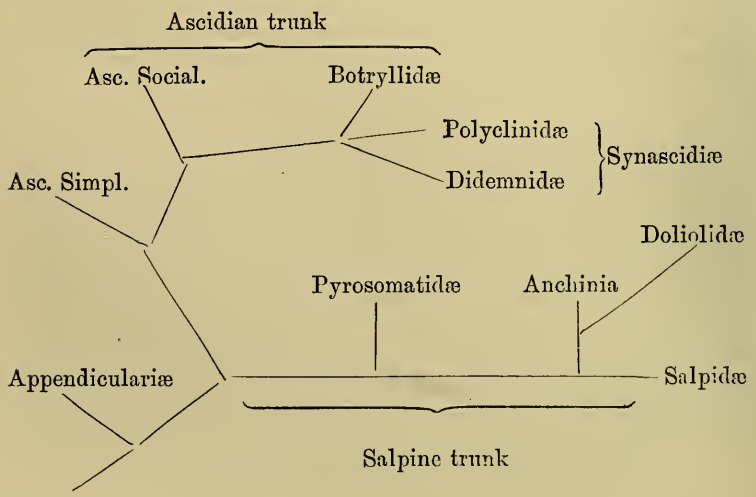
† Jenaisch. Zeitschr. f. Naturwiss., xviii. (1885) pp. 528–96.

stem-form; the generation of the ascidiozooid was, however, intercalated between the sexually formed solitary form, and the first generation of ventral buds. The cycle of the composite Ascidians had a somewhat different origin, for it sprang from a bud which appeared after the free-swimming stem-form became fixed: the various differences which we now observe only appeared later in its history.

It is probable that the pelagic Tunicates and the Ascidiæ are only connected by a very old larva-like stem-form, which was endowed with the power of multiplying asexually. This stem-form was distinguished from the Appendiculariæ by the two arterial passages fusing into a dorsal cavity, which opened to the exterior by an unpaired orifice.

In his second chapter the author considers the developmental history of the Ascidians in its relations to the theory of the germinal layers; he concludes that there is a fundamental difference between mesenchym and mesoblast, but that it is purely morphological, and that no genetic conclusions are to be based on its consideration. The mesoblast arises primitively from diverticula of the archenteron; secondly, from paired mesoblastic mother-cells which lie near the blastopore, and give rise to the mesoblastic sacs which inclose the secondary cœlom; thirdly, in the Tunicata it arises directly from the lateral walls of the archenteron. The formation of the first two kinds of mesoblast is associated with the formation of a new secondary cœlom; in the Tunicata, however, there is no secondary cœlom, but the primary, being narrowed not only by the peribranchial space, but also by mesenchymatous connective-tissue-cells, and by an inner mantle of cellulose (in some forms) must be regarded as a true pseudocœl.

In the third chapter the genetic relations of the Tunicate phylum are discussed, and the following table is given:—



With regard to the homologies of the most important organs of the Tunicata, the following useful table is given :—

| Appendiculariæ | Ascidian larvæ | Ascidiæ | Pyrosoma | Doliolidæ | Salpidæ |
|---|---|---|---|---|---|
| Branchio-enteric cavity | | | Respiratory cavity | | |
| Digestive tract | | | Digestive tract | | |
| Ciliated arches | | | Ciliated arches | | |
| Ciliated pit | | | Ciliated pit | | |
| — | — | Hypophysial gland | — | — | — |
| Brain | Sensory vesicle | Ganglion (?) | Ganglion | | Ganglion |
| — | Eye | — | Eye | — | Eye |
| Otolith | Otolith | — | Otolith | Otolith | — |
| Caudal muscle<br>Nerve-cord<br>Notochord | | Nutrient material and free meso-derm-cells | Elæoblast | | Elæoblast |
| 2 Atrial ducts | Cloacal vesicle | Peribranchial cavity and cloaca | Peribranchial tube | Cloaca | Cloaca |
| 2 Spiracula | Egestive orifice | | Egestive orifice | Egestive orifice | |
| — | Long. muscles | Muscle-cells | Mesenchym-muscle | Scattered mesenchym-muscle-cells | |
| Circular muscle | — | (?) | (?) | Circular muscular bands | |

Dr. Seeliger regards the Vertebrata and Tunicata as being two separate branches derived from a common root-form; whatever be the real position of *Amphioxus*, it cannot, he thinks, be regarded as the bond of connection between the Vertebrata and the Tunicata. The stem-forms may have had close relationships to the segmented worms, and it is even possible that they have several common ancestors; in such case the nerve-tube of the Tunicate larvæ might be the homologue of the ventral cord of worms. This view seems to be supported by the discoveries of Hatschek and Kowalevsky; but it is to be noted that the gastrula of Ascidians is not completely homologous with the primitive form common to all the Metozoa, inasmuch as it contains the materials of three segments, derived by a double gemmation from the primitive one.

**Genetic Cycle and Germination of Anchinia.***—Dr. J. Barrois recognizes in the life-cycle of *Anchinia* one sexual and two sterile forms; in all these we may regard the bud as being primitively formed of an ectoderm and endoderm, the latter composed of cells of various kinds; there soon appears an endodermal nucleus, around which groups of three different kinds of cells become arranged—these are nervous, genital, and "disseminated." In the proliferous stolon this endoderm forms a solid rod which is at first formed of cells of one kind only, but which very soon becomes differentiated. The endodermic nucleus, becoming constricted, forms on the ventral surface a pharyngo-stomachal mass; below is the nervous mass; behind, the genital and disseminated cells; the first of all of these comes into relation with the outer world by the buccal and anal orifices; the pharyngeal mass divides directly into pharyngeal sac and a pericardium, the endostyle is not formed till later, when it arises as a small swelling of the pharyngeal sac. In the sexual form the nervous mass is continuous posteriorly with a large cord which passes between the cloaca and the œsophagus, and terminates in a ganglion which is covered by the genital mass. In one sterile form the coil is formed by the constriction of a cylindrical nerve-tube, which extends along the whole length of the embryo, whose anterior part corresponds exactly to the entire nervous mass of the sexual form. It is very probable that this cord corresponds to the large dorsal nerve which, in the Appendiculariæ, connects the cephalic ganglion with the large swelling which is formed at the base of the tube. The anterior swelling is converted into a hypophysis, but it also gives rise to nervous parts of great importance.

The muscular layer divides into two bands, and then becomes broken up into six semicircles in just the same way as in *Doliolum*. The cloaca is the most important part which is formed by the ectoderm. The genital mass and the disseminated cells form for a long time a mass which is placed posteriorly, and which in the sexual forms gives rise to two genital glands, and in the sterile becomes reduced to a few cells which are found in the neighbourhood of the visceral ganglion. The disseminated cells unite into a ventral plate which possibly represents the elæoblast. Especial attention is to be directed to three points in which the history of their development approximates *Anchinia* to the *Appendiculariæ*: these are—

1. The primitive constitution of the cloaca, the two short tubes being comparable to the respiratory orifices of the *Appendiculariæ*.

2. The presence of a nerve-tube along the whole length of the body, and its termination by cephalic and visceral enlargements.

3. The primitive presence of the anal orifice on the surface of the skin. The formation of the cloaca at the expense of the ectoderm is a rare phenomenon.

*Anchinia* may, in a sense, be regarded as representing a *Doliolum* with six (instead of eight) bands; the stolon is extremely like that of *Doliolum*, but differs internally from that of any member of the

* Journ. Anat. et Physiol. (Robin), xxi. (1885) pp. 193–267 (4 pls.).

group of the Thaliacea, for there is but one cord, and that is solid, and is composed of endodermic cells; so far it resembles the cord rather of Ascidiæ than of Thaliacea; at the same time this character is to be put against the precocious differentiation of the young bud, the cells of which are derived from the endodermic cord.

**New Species of Simple Ascidians.***—M. L. Roule describes three new species of simple Ascidians from the shores of Provence. The first is most like the members of the genus *Molgula*, but is remarkable for having, as has *Eugyra*, only one genital gland; the structure of its gill is like that of both the genera just mentioned, so that it appears to be necessary to form for it a sub-generic division of *Molgula*, to which the name of *Eugyriopsis* may be applied.

There is a new species of *Microcosmos*, most like *M. vulgaris* of Heller, but differing by its larger size, the colour of its tunic, and the form of its tentacles. It is called *M. sabatieri*. The other new Cynthiad is like *Cynthia scutellata* of Hiller, but is larger, has its siphons approximated instead of separated, and differs by other characters, among which is the fact that the genital glands are broken up into small parts, each of which has its own excretory ducts; it is of a fine red colour, and is to be called *Cynthia corallina*.

### β. Polyzoa.

**Structure and Development of Loxosoma.**†—Mr. S. F. Harmer observed at Naples five species of *Loxosoma*, one of which, *L. leptoclini*, is new; it was not uncommon on the compound Ascidian *Leptoclinum maculosum*. The term ventral is, in opposition to Caldwell, applied to the line of the body between the mouth and anus; the dorsal region is drawn out into a stalk, on which the calyx or body of the animal is carried; when, in his descriptions, the author speaks of a transverse section, he means one which passes in the plane of the stalk through the right and left side; a horizontal plane is one which is at right angles to the long axis.

In *Loxosoma* the buds become free as soon as they reach maturity, and this genus differs therefore from all other Polyzoa in never forming colonies. The cells of the ectoderm were best studied by a special use of nitrate of silver; the tissues are washed "in a solution of a neutral salt ($KNO_3$), which gives no precipitate with nitrate of silver, the solution having the same specific gravity as sea-water"; there was thus no precipitate of silver chloride; these cells were found to be large and polygonal, or sense-cells, bearing one or more fine, stiff, tactile hairs which project into the water, and gland-cells; the last differ in character in different species. The foot-gland is either retained by the adult or found only in the bud; in some species it has wing-like lateral outgrowths. It seems to be composed of two distinct portions—the gland, which consists of a small number of granular nucleated cells arranged round a central lumen, and a "duct," which is really an open groove.

* Comptes Rendus, c. (1885) pp. 1015–7.
† Quart. Journ. Micr. Sci., xxv. (1885) pp. 261–338 (3 pls.).

Mr. Harmer considers that the true ganglion has been mistaken for part of the generative apparatus, and describes it as being dumb-bell-shaped and lying transversely across the intestine, as consisting mesially of a fibrous commissural portion and of two lateral ganglia, and as being altogether devoid of any central duct. The peripheral nervous system is best examined in living specimens, and the transparent *L. crassicauda* is a most favourable species for investigation; it is described in detail. There is no striking objection to the idea that the posterior sense-organs are homologous with the "osphradia" of Mollusca, but it is more probable that they are merely specialized sense-cells.

After describing briefly the alimentary and muscular systems, the author comes to the excretory organs, our knowledge of which is exceedingly incomplete; as described by Mr. Harmer they are seen to differ markedly from those of the Brachiopoda, but to have the closest similarity to the head-kidney of many Trochospheres. Dr. Meyer's as yet unpublished drawings of the head-kidneys of various Annelid larvæ present a striking resemblance to *Loxosoma* in the number of the excretory cells, in the relative size of the lumen in different parts of the organ, and in the mode of termination in a flame-cell, as well as in other points. The generative organs are next described, and are stated to be "idiodinic."

A careful account is given of the history of development, with numerous references to the illustrative figures, which must be seen if the account is to be fully understood; this much, however, may be here stated. The ova may be small, and be supplied with nutriment from the glandular epithelium of the brood-pouch, or large, when they take up the surrounding cells which play the part of a vitellarium; the blastopore appears to form the permanent anus, and a stomodœum is developed anteriorly; the greater part of the mesoblast arises from two cells which are placed at the sides of the blastopore. The so-called dorsal organ is of epiblastic and not of hypoblastic origin, and is not a budding structure, but the supra-œsophageal ganglion. Between the mouth and anus two epiblastic invaginations appear, and, later on, fuse medianly; they form the deeper part of the vestibule, and, by the thickening of their floor, give rise to the subœsophageal ganglia; coming into contact with the "wings of the crescent-shaped brain," they establish a complete circumœsophageal nerve-ring.

The Entoproctous Polyzoa, both larval and adult, are true Trochospheres, with a ventral flexure of the alimentary canal, no true body-cavity, and a pair of head-kidneys. The metamorphosis of the Ectoprocta is a process of budding; the Entoprocta have certain affinities with *Actinotrocha*, while the affinity of the Polyzoa to the Brachiopoda is more doubtful than to *Phoronis*. The nearest allies of the Entoproctous Polyzoa are the Trochosphere larvæ of Molluscs and Chætopods, and the adult Rotifera; the Entoprocta are the most archaic of the Polyzoa, but their relations to the rest are, as yet, obscure.

**Australian Bryozoa.***—In the new decade, which completes the first volume of the 'Prodromus of the Zoology of Victoria,' Professor P. H. MacGillivray continues his valuable contributions on the Polyzoa of Victoria. The present number deals with *Retepora*, a genus better represented in the southern hemisphere than in the northern. Twelve species are described and three varieties of the well-known *Retepora monilifera* MacG., and besides the figures of these, one plate is devoted to drawings of the opercula, which in Professor MacGillivray's hands have proved of great value for specific determination.

The preface is dated 1883, and the paper having been written nearly two years, there is consequently some overlapping with this and Mr. Busk's work on the 'Challenger' Polyzoa.

### γ. Brachiopoda.

**Anatomy of Crania.**†—In continuation of a previous paper,‡ M. Joubin describes further points in the anatomy of *Crania*.

The shell is formed of extremely fine calcareous fibres; it is traversed by perforations spreading out, in the upper valve, in arborescent ramifications, of which the final branches are attenuated filaments terminating on the external surface. In the ventral valve the perforations are only at the points where there are no muscular insertions. The mantle is composed of two portions—an interior and an exterior. There are three principal pairs of muscles, two of which are adductors; the less important muscles sustain the arms and perform other functions. The arms are not supported by any calcareous loop. Respiration is not effected by any special organs, and there is no circulatory system. The nervous system, as in *Lingula*, is very poorly developed.

## Arthropoda.

### α. Insecta.

**Eye and Optic Tract of Insects.**§—Dr. S. J. Hickson, in the first portion of his paper, gives a detailed account of the eye and optic tract of *Musca vomitoria*, and afterwards discusses and attempts to clear up the differences between his results and those of other investigators.

The account of the eye of *Musca* is only intelligible when studied with the aid of the accompanying illustrations; in it the following new terms are used: the *opticon* is the ganglionic swelling which is separated from the cerebral by a narrow constriction, which is, as Beyer has shown, the homologue of the optic nerve of other arthropods: the second swelling, which is separated from the opticon by a tract of fine nerve-fibrils, is called the *epi-opticon;* while the third, or *peri-opticon*, is separated by a bundle of long optic nerve-fibrils. The term *neurospongium* is given to the fine meshwork of minute

* Prodromus of the Zool. of Victoria, decade x., 1885.
† Comptes Rendus, c. (1885) pp. 464-6.
‡ Ibid., xcix. (1884) pp. 985-7. See this Journal, *ante*, pp. 233-4.
§ Quart. Journ. Micr. Sci., xxv. (1885) pp. 215-51 (3 pls.).

fibrils, which are similar to those described by Gerlach in the mammalian brain and spinal cord.

The comparative anatomy of these parts is thus summed up: "In the young *Periplaneta* the optic nerve-fibrils which leave the peri-opticon pass without decussating, to the ommateum (eye proper); in the adult *Periplaneta* there is a partial decussation, in *Nepa* there is no decussation, but the anastomosis is complicated by the presence of looped and transverse anastomoses. In *Musca*, the fibrils are split up into little cylindrical blocks of neurospongium, which I have called the elements of the peri-opticon; in bees, wasps, and many Lepidoptera, the elements of the peri-opticon are long, slender, and close-set; in *Æschna* they have partially fused with one another; and in *Bombyx*, *Eristalis*, and the Crustacea they have completely fused to form a complete and continuous ganglion, similar in every way to the opticon and epi-opticon.

Three series of pigment-cells are very constant throughout the Hexapoda; there are (1) a series of pigment-cells which insheath the cone and prevent extraneous rays of light from escaping; they may be called the cone pigment-cells. (2) In the outer region of the rhabdom there is a series of external pigment-cells, which have long processes passing between the retinulæ and elsewhere. (3) The name of internal pigment-cells is given to the series which usually rests upon the basilar membrane. This last varies considerably in thickness.

In the historical and critical portion of his paper, Dr. Hickson deals only with what has been published since 1879, the date of Grenacher's great work. With regard to the view of Mr. Lowne that the retinulæ are not the nerve-end-cells at all, and that the true retina is situated behind the basilar membrane, the author remarks that not only does anatomy teach us that the optic nerve-fibrils end in the retinulæ, but morphology teaches us that they are homologous with the nerve-end-cells of other animals, while the few physiological experiments yet made show that they are eminently adapted for light-perceiving purposes. These considerations are clenched by Leydig's discovery of a true retina-purple in the retinula.

The view of Ciaccio, Berger, and others, that the layer of retinulæ and rhabdoms cannot be considered as the equivalent of the retina of other animals is accepted; it is only part of the retina, or that which bears the nerve-end-cells, and corresponds functionally to the layer of rods and cones in the eyes of Vertebrates. We cannot compare layer for layer the different strata of eyes in different animals; all we can say is that in all animals with highly organized eyes, there are certain complicated nervous structures, between the nerve-end-cells and the brain, which have probably the function of elaborating and combining the sensations received by the end-cells. The author thinks that all the nerve-structure lying between the crystalline cone-layer and the optic nerve is analogous with the retina of other animals; in other words, the retina of insects consists of the retinulæ, peri-opticon, epi-opticon, opticon, and all the intermediate nerve-tracts.

The best method of making sections through the eye of *Musca vomitoria* is to expose it to the fumes of 1 per cent. osmic acid solution for 40 minutes, then to wash for a few minutes in 60 per cent. spirit, and finally to harden in absolute alcohol. When the hardness of the chitin prevents the use of the automatic microtome, a Jung's microtome with the razor set so as to give a long sweep at each stroke may be used. The best method of depigmenting the eye, is to expose the sections to the action of nitrous fumes; for teasing the best solution is chloral hydrate.

**Tracks of Insects resembling the Impressions of Plants.***—M. R. Zeiller describes the burrows made by *Gryllotalpa vulgaris* in the clay soil at the bottom of a little pool of water, that was sometimes nearly dry. These tracks, owing to their arrangement and the marks made on their surface by the insect in traversing its burrow, bear a striking resemblance to the impressions of certain fossil plants. They suggest a comparison with *Phymatoderma liasicum* and present at the same time an analogy to certain impressions of conifers belonging to the genus *Brachyphyllum*, notably *B. Desnoyersi* Brgt. from the oolite.

**Morphology of the Lepidoptera.**†—Dr. A. Walter finds that the views of Savigny as to the morphology of the gnathites of the Lepidoptera must now be definitely given up; the parts which he regarded as mandibles are the projecting angles of a labrum, and the plate which he regarded as the labrum is an epipharynx. True and functional mandibles in the form of toothed appendages are found only in some of the lower Micropteryginæ, such as *Aruncella*, and *Anderschella*. True mandibles without denticulations are to be found in the higher Micropteryginæ, such as *Micropteryx*, *Purpurella*, and *Semipurpurella*. Various stages of reduction are to be observed in various forms, and it is possible that remnants of mandibles are to be made out in all the Microlepidoptera. There can be no doubt that the lower Micropteryginæ exhibit the most primitive form of gnathites found among the Lepidoptera.

There are two maxillary palps, the outer of which forms the most primitive rudiments of a proboscis, while the inner forms a groove-like horny plate which affords a lateral support for the labium. The Lepidopterous proboscis is to be regarded as being primitively derived from the outer palp of the maxilla; in the higher forms the inner palps are reduced.

In the lower Micropteryginæ the labium has the free palps and typical ligula of lower insects, the latter being formed by the fusion of the inner palps into a short tubule, which is open externally; a short hypopharynx is to be detected on the soft inner or hinder wall of this ligula.

In the higher Micropteryginæ the mandibles lose their teeth, and the maxillæ the inner palp; the halves of the proboscis are applied to

* Bull. Soc. Geol. France, xii. p. 676. See transl. by Prof. J. F. James in Journ. Cincinnati Soc. Nat. Hist., viii. (1885) pp. 49–52.

† Jenaisch. Zeitschr. f. Naturwiss., xviii. (1885) pp. 751–807 (2 pls.).

one another to form the typical sucking tube, and the short organ is already capable of being rolled up; the labium is elongated, has no free outer palps, and the hypopharynx is still discernible at its base.

The author inclines to the view that the nearest relatives of the Lepidoptera are, among other insects, the Hymenoptera.

**Number of Abdominal Segments in Lepidopterous Larvæ.***—Dr. A. S. Packard finds that no caterpillars known to him have less than ten abdominal segments. The ninth segment, however, is liable to be much reduced in size and to more or less coalesce with the tenth or anal segment. The ninth segment is most rudimentary in the Sphinges. In the larval butterflies it is rather more distinct; whilst the tenth segment is, as in all caterpillars, represented by the supra-anal plate and anal legs.

In the Ægerians, Zigænidæ, and Bombycidæ (the latter especially), the ninth segment is very distinct. In Halesidota the ninth segment is quite long, forming an entire segment. In Datana it is longer than the supra-anal plate. In *Limacodes scapula* and *P. pithecium* there are no traces of legs; the number of abdominal segments appears to be ten. In the Noctuidæ the ninth segment is distinct. In the Geometers it is distinct above, but below is merged into the infra-anal plate. In the Pyralid caterpillars, as well as the Tortricids and Tineids, the ninth segment is longer and more distinct than in the higher families.

The Bombycidæ seem to be the oldest, most generalized group of Lepidoptera, and it is a question whether the Pyralids, Tortricids, and Tineids are not degenerate forms which have descended from the Noctuidæ and ultimately from the Bombycidæ; there are indications that the Noctuidæ have descended from the Geometers. At any rate the primitive caterpillar had ten pairs of abdominal legs. The saw-fly larvæ (*Lophyrus*) have eight pairs of abdominal legs, while the embryo honey-bee has ten pairs of temporary abdominal appendages.

**Structure of the Halteres of Diptera.**†—Mr. A. B. Lee contributes some further details to our knowledge of these organs, which were believed by Leydig to be auditory in function. It appears that there are two distinct organs contained in each of these structures: one an auditory organ, the other an organ of problematical function, which may be olfactory; the structural details, which are briefly mentioned, will no doubt be published by the author in an illustrated form.

**Movement of Flies on Smooth Surfaces.**‡—Dr. J. E. Rombouts supports, as against the observations of Dewitz, his former conclusions on this subject already noticed in this Journal.§ It will be remembered that it was then established that flies attached themselves to smooth surfaces by the help of a liquid secretion from the feet; this liquid, however, is not sticky, but the attachment is brought about by capillary attraction; this conclusion is strengthened by another

* Amer. Natural., xix. (1885) pp. 307–8.
† Arch. Sci. Phys. et Nat., xiii. (1885) pp. 1–3.
‡ Zool. Anzeig., vii. (1884) pp. 619–23.
§ See this Journal, iv. (1884) p. 737.

experiment described in the paper before us. Several flies are confined on to a glass plate by strips of paper, and the liquid that accumulates is sufficient to be perceptible to the naked eye; by the help of experiments with glass balls, detailed in the former paper, it was ascertained that the adhesive power of the liquid was less than that of water, and about equal to olive oil; hence capillary attraction is obviously the only force which could bring about the required result.

**Circulation in Ephemera Larvæ.***—M. N. Creutzburg finds that in the larvæ of certain Ephemerida—contrary to the statements of Verloren—the vascular ampulla which supplies the caudal setæ is in communication with the dorsal vessel, and not with the body-cavity; this portion of the vascular system is, however, separated from the dorsal vessel by a pair of valves.

**Macrotoma plumbea.**†—Dr. A. Sommer gives a detailed account of this Podurid, a member of a group the anatomy of which has long required revision. As in most insects the integument consists of three layers—the cuticle is transparent, thin, and flexible; the subjacent matrix varies considerably in thickness in different parts of the body, and its cells appear to be devoid of distinct boundaries; the basal membrane is structureless.

The excretory organs are rounded in form and extend through the whole of the abdomen; the concretions are dirty white with reflected, and pale green with transparent light; they vary somewhat considerably in form and size, but generally exhibit a distinct concentric striation, like starch-granules; they are insoluble in water and alcohol, but are, when fresh, dissolved by acetic acid. The simplest muscles consist of a single muscular fibre; the muscles are not inserted directly but by a tendon formed by the cuticle; they have a finely granular perimysium, in which a number of small round nuclei are imbedded; their substance exhibits transverse striation and appears to be well adapted for the study of this curious phenomenon.

The most interesting appendage of the body is the ventral tube; the numerous cells found in it are elongated oviform in shape, are limited externally by a distinct membrane, and have a very finely granulated protoplasm. The cuticular tubules formed by the cells open to the exterior by rounded orifices, and it is clear that we have here to do with unicellular glands; their close connection with the muscles of the ventral tube, leads us to suppose that when the latter is put into function there is an evagination of the connected pouches, owing to the pressure of the secretion which flows out from the gland-cells. If the ventral tube really serves as an organ of attachment we may suppose that the secretion is a material which acts as an adhesive agent.

After describing in detail the structure of the digestive tract, the author passes to the dorsal vessel and the blood; the former is a tube which extends from the eighth abdominal segment into the thorax, and passes between the dorsal longitudinal muscles; it is continued

* Zool. Anzeig., viii. (1885) pp. 246–8.

† Zeitschr. f. Wiss. Zool., xli. (1885) pp. 683–718 (2 pls.).

forwards into an aorta; posteriorly it is attached by fine fibrils to the tergal region of the body; no posterior orifice was to be detected; there are five pairs of ostia, and five pairs of alary muscles. The cardiac tube consists of a plexiform nucleated tissue, broken through at various points; then follows a well-developed muscular layer which forms the chief part of the tube, and internally to it there is a delicate, hyaline, and structureless layer. The blood is of a yellowish-red colour, and contains a fairly large number of blood-corpuscles. They have a clear, homogeneous ground-substance with dark refractive granules, and no investing membrane; they exhibit amœboid movements.

The author was unable to find any traces of a visceral nervous system or of nervi transversi; the absence of the latter may be associated with that of a tracheal system. Sensory setæ are to be observed on the legs, palps, and labium and labrum.

The generative organs are carefully described, and there are some remarks on ecdysis; the author found that Gregarines, *Cysticerci*, and a number of Nematoid worms lived parasitically in *Macrotoma*.

### β. Myriopoda.

**Latzel's Myriopods of Austria.***—The first volume of Dr. R. Latzel's work dealt with the Chilopoda, while the second includes the Symphyla, Pauropoda, and Diplopoda. Nine years of close attention to the study of the Myriopods have enabled Dr. Latzel not merely to complete a monograph of the species inhabiting his native country, but to complete it in such a manner that he has written a book which must be useful to the student of the Myriopoda of any country. Minute descriptions of some 170 species are given, and also tables which make it a matter of ease to determine the genus of any Myriopod.

Where possible, full descriptions are given of the young stages of each species, and the results of all recent researches into the minute anatomy of the Myriopods are embodied. Embryology, indeed, has not received a very large share of attention, but references are given to all writings on the subject. Dr. Latzel differs from some American authorities in looking on *Scolopendrella* as a true Myriopod, and places its order Symphyla as intermediate between the Chilopoda and the Pauropoda. Dr. Latzel agrees with Menge in considering those organs which Ryder has described as tracheæ in *Scolopendrella*, as being merely chitinous supports for muscle-attachment. These are the same organs which Wood-Mason considers to be of the nature of segmental organs.

Dr. Latzel looks on *Peripatus* as forming an order equivalent to other orders, the Chilopoda, the Symphyla, and the Diplopoda.

A most useful bibliography, brought down to the date of publication, is comprised in the work. †

* Latzel, K., 'Die Myriopoden der Oesterreichisch-Ungarischen Monarchie,' 2te Hälfte, xii. and 413 pp. and 16 pls., 8vo., Vienna, 1884.

† See Nature, xxxi. (1885) p. 526.

δ. Arachnida.

**New Hypothesis as to the Relationship of the Lung-book of Scorpio to the Gill-book of Limulus.***—Prof. E. Ray Lankester withdraws his suggestion that by the enlargement of the hollow stigmata connected with the thoracobranchial muscles of an ancestral scorpion the branchigerous appendage might come to lie in the pit of the tendon of the muscle, and that eventually the hollow might inclose it, and replaces it by a more simple explanation. He was led to give up his earlier view by finding that the veno-pericardiac muscle attached to the apex of each lung-sinus in *Scorpio* had no relation to the thoraco-branchial muscles of *Limulus*, but was represented in it by exactly similar veno-pericardiac muscles.

In *Limulus*, as in *Scorpio*, there is on each side of the sternal surface a great blood-sinus in free communication with the lamelligerous organs. If we suppose the mesosomatic appendages in the Scorpion branch of the family to grow relatively smaller and smaller, and to be purely respiratory in function, and to be aerial rather than aquatic; we have only further to imagine the four hinder pairs to have taken on in the embryonic condition a very common trick of growth, viz. an inward growth of invagination, to have the exact condition of the modern scorpion's lung-book.

The best known example of such inward growth is seen in the hydatid-stage of *Tænia solium*, and the introversion is probably due to external pressure. Now, it is to be borne in mind that in the modern scorpion development goes on within the ovary; the pressure of the ovarian tunic must be considerable, and is at any rate a possible cause of the invagination.

**Coxal Glands of Mygale.**†—Dr. P. Pelseneer describes the coxal glands in a large South American *Mygale* (*Theraphosa*). The two glands, which are quite separate, are placed on each side of the cephalothorax, at the side of the entosternite (enthodère of Dugès) between the lower plate and the upward prolongations of it, to which latter they are intimately related in position, size, and form.

As surmised by Prof. Lankester, this gland is not a simple ovoid glandular body, as in *Scorpio*, but is furnished with lobes corresponding to the coxæ of the cephalothoracic appendages, as in *Limulus*. In addition to these four coxal prolongations, the gland has two internal projections near its middle third, corresponding to two slight excavations of the entosternite, between its lower plate and its upper prolongations. The colour of the gland is uniform, a brownish-yellow, not unlike that of the stomach and its lateral diverticula. Its appearance is coarsely cellular, showing distinctly the groups of cells of which it is made up. No efferent duct, either passing to the exterior, or to any internal organ, was seen. The gland in *Mygale*, like that of the adult *Limulus* and *Scorpio*, is therefore a closed gland.

* Quart. Journ. Micr. Sci., xxv. (1885) pp. 339-42.
† Proc. Zool. Soc. Lond., 1885, pp. 3-6 (1 pl.).

**Anatomy of Spiders.***—Dr. F. Dahl reviews certain statements of Bertkau with respect to the anatomy of spiders. This observer has mentioned that salivary glands have not been figured; Dahl calls attention to the fact that he has himself observed and figured them in *Epeira cornuta*, in the males of which species they are far better developed than in the females; this may be accounted for by the fact that the mature male takes little or no nourishment while the female after depositing her eggs spins a web and catches and devours insects. The paper contains rectifications of a few other statements made by Bertkau which are believed by Dahl to be erroneous.

**Hibernation and Winter Habits of Spiders.**†—The Rev. Dr. McCook describes some observations on this subject. In the case of *Theridion tepedariorum* it would seem that the hibernation is not accompanied with a great degree of torpidity; that the spiders preserve their activity and spinning habit while exposed to cold ranging from freezing point to zero (Fahr.); that after long and severe exposure, the recovery of complete activity when they are brought into a warm temperature is very rapid, almost immediate; and that on the return of spring, even after a prolonged and severe winter, they at once resume their habits.

In all the specimens experimented on the abdomens were full, indicating perfect health. Other spiders hung upon their webs with shrivelled abdomens, quite dead; but the author could not determine that they perished by the cold. There appeared to be no growth during hibernation. The same facts hold good as to the winter habits of orb-weavers. The young survive in the cocoons provided by maternal instinct. But early in the spring many adults of both sexes are found, who have also safely weathered the cold months. Many specimens of *Epeira vulgaris* shelter within a thick tubular or arched screen, open at both ends, which is bent in the angles of woodwork, or beneath an irregular rectangular silken patch stretched across a corner. Many others burrow behind cocoons, and are quite covered up by the thick flossy fibre of which these are composed. Examples of *E. strix* were found blanketed in precisely the same way during the winter months.

### ε. Crustacea.

**Urinary Organs of Amphipoda.**‡—Mr. W. Baldwin Spencer finds that little is stated in the text-books as to the presence in certain Crustacea of small but well-defined appendages which open into the posterior part of the alimentary canal; the best method of examining these tubes is to cut sections through the whole of the body, when the course that they take and their relation to the neighbouring organs can be easily made out.

The author has carefully investigated the tubes of *Talitrus locusta*; the walls were found to be cellular in nature, and within these were

* Zool. Anzeig., viii. (1885) pp. 241–3.
† Proc. Acad. Nat. Sci. Philad., 1885, pp. 102–4.
‡ Quart. Journ. Micr. Sci., xxv. (1885) pp. 183–92 (1 pl.).

very definite concretions, but in no case could any sign of a concretion be detected within or between the cells. The presence of these bodies, which are extremely minute, may be associated with the process of ecdysis; phosphoric acid was found in them, whereas Nibeski found carbonate of lime in *Orchestia cavimana*. We must wait for a knowledge of their developmental history before we can say definitely whether or no they are homologous with the Malpighian tubes of the Tracheata.

**Development of the Egg and Formation of the Primitive Layers in Cuma Rathkii.***—Dr. H. Blanc's researches on this subject, of which mention has already been made,† are now published *in extenso*.

**Development of Cyclops.**‡—The development of *Cyclops* has been studied by a great many authors, but little is known concerning the origin of the body-cavity and most of the internal organs. M. F. Urbanovics has addressed himself to solve these questions, and has arrived at the following results:—

A dorsal organ is formed as in the Isopoda, which is composed of a single layer of cylindrical cells. The body-cavity is formed by paired excavations of a mesoblast band; each pair of cavities corresponds to a segment and the dissepiments dividing them from each other only disappear very late; the dorsal and ventral mesenteries persist throughout life; the dorsal mesentery contains a space which is a remnant of the blastocœl and plays an important part in the circulation in the absence of a heart. It is obvious that these facts indicate a far closer similarity with the Tracheata and Annelida than is admitted by Balfour in his 'Comparative Embryology.'

**Anatomy of the Cirripedia.**§—Dr. P. P. C. Hoek has issued a supplementary memoir on the Cirripedes of the "Challenger," which, as we have already stated,‖ he promised to prepare.

The complementary male of *Scalpellum* has never been described since the time of Darwin's first notice of it; Dr. Hoek found this male in 19 out of 41 new species, and always at about the same place, that is, a little above the musculus adductor scutorum; in 18 of the species the testes were mature; in thirteen cases the male was more degenerated than in *S. vulgare*. The 24 forms whose males are now known have either a special capitulum and a stalk, as in three species; or there is no division of the body, but there are rudimentary shell-valves, as in eight species; or there is no division of the body and no valves, as in thirteen species. The first of these are littoral in habitat; the second live at depths of at least 700 fathoms; and the third (with three exceptions) live at depths greater than 1000 fathoms. Two of the three exceptions belong to the arctic fauna, where, as is now well known, deep-sea forms of other latitudes are found living at lesser depths.

* Rec. Zool. Suisse, ii. (1885) pp. 253–75 (1 pl.).
† See this Journal, *ante*, p. 238.
‡ Zool. Anzeig., vii. (1884) pp. 615–9.
§ Tijdschr. Nederl. Dierk. Vereen., vi. (1882–5) pp. 64–142 (6 pls.).
‖ See this Journal, iv. (1884) p. 891.

After describing the *Cypris*-larval forms, the author passes to the male of *Scalpellum regium*, where the microscopic body consists of an elongated sac, closed on all sides; there is only a very small cleft between the two scuta; the tentacles are the only appendages which still show their primitive form; the feet are functionless and straight, and the gnathites have disappeared. In young males the cement-apparatus is well developed, but in mature forms it is not so distinct; the enteron is aborted and functionless, and no signs of circulatory or respiratory organs are to be detected. The nervous system consists of a rather small cerebral ganglion, a comparatively feeble œsophageal ring, and a large ventral ganglion; the peripheral nerves are not well developed, and there do not seem to be any eyes, or other sensory organs. The generative system is the only one which is well developed, and of it only the male organs; even these are much more concentrated than in ordinary hermaphrodite Cirripeds; there is only one testis, which has the form of a compressed gland, and the seminal vesicle is single, instead of being double. In all these points the small males of other deep-sea species agree with *S. regium*.

In the genus *Scalpellum* Dr. Hoek distinguishes three stages of sexual differentiation.

I. True hermaphrodite species, all members of which have both female and male genital products; they are probably self-fecundating. Ex. *S. balanoides*.

II. Species with large hermaphrodite members, and small males; the latter may (*S. villosum*), or may not (*S. vulgare*) have a stalk, a mouth and a stomach.

III. Species with the sexes separate; the females large, the males small, and, probably, short-lived; e. g. *S. regium*.

The Cirripedes are rich in organs of an unknown, or at least problematical function, and those first discussed are the "Segmental organs"; these were regarded by Darwin as being sensory in function, but Hoek ascribes to them the duty of excretory organs; he is supported in this view by the presence of muscular fibres connected with the numerous lacunæ, similar to those seen by Grobben in the region of the antennary gland of the Decapoda.

The cement-glands are next discussed; and then the "true ovaries" of Darwin, which Hoek looks upon as having a function in relation to the digestive tract, though it is clear that they are not salivary glands; they probably approximate to pancreatic or hepatic cells.

The eye of a Cirriped was first seen by Leidy, who described the two small lateral eyes of *Balanus;* Dr. Hoek describes the eye of *Lepas*, and points out that there are certain points of resemblance to what Leydig has described in insects.

The paper concludes with an account of the female generative organs; the apparatus which is found at the end of the oviduct possibly represents a second segmental organ; the sac is regarded as representing the infundibulum of the primitive segmental organ, and it is no objection against this homology that it serves for the

evacuation of genital products, or that its cells, in place of being excretory, have the function of providing a cementing mass for the ova.

**Embryology of Balanus.***—According to M. N. Nassonow the ovum divides vertically into two sub-equal segments, of which the anterior forms the later ectoderm, whilst from the posterior and granular segment is exclusively derived entoderm and mesoderm. An *amphigastrula* is formed, the blastopore closes, and the entoderm divides, beginning ventrally, to form a symmetrical plate of mesoderm. The chief part of the mesoderm goes to form the three pairs of ventral projections which are the rudiments of the limbs of the nauplius, and does not take any share in the formation of the muscular system. The anus is formed at the spot where the blastopore originally occurred.

## Vermes.

**Oogenesis and Spermatogenesis in Branchiobdella.**†—Dr. W. Voigt finds that the reproductive organs of *Branchiobdella* are formed on the type of the Oligochæta; the two ovaries are in the eighth segment, and, even in living forms, are distinguishable by their whitish coloration; each consists of a compact mass of cells attached to the septum by a muscular stalk; the testes are found in the sixth segment, but their stalk of attachment is not provided with muscular tissue. During its development the cells of the ovary exhibit great powers of multiplication; the ova derive their nourishment from a pair of vascular loops which extend from the dorsal to the ventral trunk.

In treating of spermatogenesis, the author makes use of the terminology of La Valette St. George, who recognizes five stages—those of the sexual cells, spermatogonia, spermatocytes, spermatids, and spermatosomata. What Mr. Blomfield called the blastophor is here called the cytophor. The sexual cells give rise to spermatogonia in the ordinary way, and by indirect division of the latter to spermatogerms. The author has been able to observe in both testes and ovaries degenerated cells, the cause of which is often due to the taking in of a large quantity of fluid.

**New Parasitic Leech.**‡—Dr. J. Leidy describes a new parasitic leech infesting the mouth of the so-called Colorado pike (*Ptychochilus lucius*). From its conspicuous gland-like organs and habit, Dr. Leidy proposes to name it *Adenobdella oricola*.

**Archenchytræus Möbii.**§—The structure of this new species is briefly described by M. W. Michaelsen. The worm has about sixty setæ-bearing segments, and the setæ are aggregated in bundles of three to five. The testes are developed on the mesentery, separating segments 10 and 11, the ovaries on the succeeding mesentery. The

* Zool. Anzeig., viii. (1885) pp. 193–5.
† Arbeit. Zool. Zoot. Inst. Würzburg, vii. (1885) pp. 300–68 (3 pls.).
‡ Science, v. (1885) pp. 434–5 (1 fig.).
§ Zool. Anzeig., viii. (1885) pp. 237–9.

vasa deferentia open on to segment 12; the oviducts on to segment 13. The spermathecæ are in segments 4 and 5; each is furnished with a pair of diverticula. During sexual maturity the spermathecæ communicate with the lumen of the intestine; in the neighbourhood of the spermathecal apertures are peculiar aggregations of cells connected with nerves and apparently sensory; the buccal cavity contains a projecting process of the mucous membrane, similar to what has been described by Vejdovsky in *Anachæta bohemica;* it appears, however not to be a gustatory organ but a sucker.

**Nervous System of Polychætous Annelids.***—M. G. Pruvot finds that the nervous system of Annelids is always, even when it is more deeply situated, continuous with the hypodermis by at least part of the surface of its ganglia; it is always composed of a cortical substance which encloses nerve-cells in a stroma of anastomosing fibres, and of a medullary substance which consists of peripheral nerve-cells in a central dotted substance; this last is to be regarded as the true centre, and all the nerves really arise from it. The medullary substance forms four longitudinal trunks in the ventral chain, and of these the two external do not communicate directly with one another, but only with the two internal.

The ganglia which are sometimes found on the œsophageal connectives are only the first ventral ganglia which have ascended, and have lost their transverse commissure. The stomatogastric has sometimes a double (cerebral and sub-œsophageal), sometimes only sub-œsophageal or a cerebral origin; when well developed it may, as in the Euniceidæ, reveal the characters of the general nervous system, by forming a small ventral ganglionic chain, and an œsophageal collar; or, as in the Nepthydeæ and Phyllodoceidæ its elongated roots may terminate in a small peri-proboscideal ring formed by a large number of small similar ganglia.

In each segment the pedal nerve arises from the two ventral cords by two roots; it follows the integument for the whole of its course, and divides into two branches, which again divide into two trunks for the setigerous bulb and the pedal cirrus. All the appendages of the somites are to be regarded as more or less modified feet; the author points out the differences which are to be found in different appendages of various parts of the antennæ, especially with regard to their nervous supply. As the investigation of this necessitates the destruction of the animal, he points out that palpi may always be distinguished from antennæ by their insertion in the ventral surface of the body, and by their form or size.

**Larval forms of Spirorbis borealis.**†—Mr. J. W. Fewkes gives a detailed description of the larval forms of *Spirorbis borealis* Dandin.

The ova are in bead-like strings, composed of from one to four rows with ten to fifteen or more eggs each. The later stages in the segmentation of the egg resemble those of other chætopod eggs: the younger stages were not found.

* Arch. Zool. Expér. et Gén., iii. (1885) pp. 211–336 (6 pls.).
† Amer. Natural., xix. (1885) pp. 247–57 (2 pls.).

The larvæ described differ in some particulars from those of *S. spirillum* Gould, described by A. Agassiz, and even more widely from the young of *S. spirillum*, described by Pagenstecher; but are considered by the author to be of the same species as that described as *S. spirillum* by A. A. Gould.

On escaping from the egg capsule, the young larva swims about in the water with considerable activity, and is often captured with the dip-net in surface fishing. The free larva often does not immediately settle to the bottom prior to the secretion of the case in which it lives, but passes through the preliminary stages while floating on the water, until the increasing specific gravity of its body sinks it. The case or shell is not at first coiled, but horn-shaped. The most prominent structure about the body of the larva at this stage is an oblong mass of cells of brick-red colour seen through the transparent walls of the shell, but of their probable function nothing is said.

**Skin and Nervous System of Priapulus and Halicryptus.***—Dr. R. Scharff finds in the skin of these Gephyrea a third layer, or one additional to the cuticle and hypodermis described by Ehlers; this is extremely thin, and consists of connective tissue; it is well developed in *Sipunculus nudus*, where it is the seat of secreting glands and of accumulations of pigment; the cuticle lines the interior of the œsophagus; around the anus of *P. caudatus* the hypodermis is curiously modified, its cells being much elongated, and at the same time expanded so as to form a compact mass, to which the author is inclined to ascribe an excretory function.

The proboscis of both *Priapulus* and *Halicryptus* is provided with small dermal projections arranged in numerous longitudinal rows; on the body there are circular rows. In *Priapulus caudatus* the spikes have the form of small truncated cones, just visible to the naked eye; through the circular opening at their top there project a number of delicate hairs; the spikes appear to be retractile. The most striking analogy between these and sensory organs in other animals is to be found by comparing them with the organs of the lateral line in fishes.

As to the nervous system, the author's results agree generally with those of Horst; in both genera examined the system lies entirely in the ectoderm; the position of the cord is marked externally by a shallow groove on the ventral surface; the apparent swellings seen at regular distances along the nerve-cord seem to be due to the powerful contractions of the annular muscles, by means of which the cord is found to bulge out in the intervening spaces. Dr. Scharff differs from all his predecessors in stating that the nervous system lies not immediately under the hypodermis, but within it. The ganglionic are merely modified hypodermic cells. Unlike Saenger, he was unable to detect lateral nerves given off from the main trunk and surrounding the body as in *Sipunculus nudus;* though thinking it rash to deny the presence of peripheral nerves, the author inclines to the view that the whole of the hypodermis acts as a kind of nervous

* Quart. Journ. Micr. Sci., xxv. (1885) pp. 193-213 (1 pl.).

layer; at the same time he recognises that the well-developed sensory organs and the organisation of the nerve-cord hardly support this idea.

**Development of Sphærularia bombi.***—M. L. Joliet has a note on Schneider's account of his recent observations on the development of this parasite. Female *Bombi*, infested by *Sphærularia*, do not prosper, but die at the beginning of June, when the embryos of the parasite are set at liberty. These require a damp, well-aerated, and non-putrefying situation; after two successive moults they acquire their sexual characters. During the free stage they take no food, and do not copulate. If they succeed in introducing themselves into the intestine of a larval *Bombus* they continue their development.

**New Nematoid from Merlangus.**†—M. L. Ferument describes a new nematoid from the intestines of *Merlangus vulgaris*, for which he proposes the name of *Spinitectus oviflagellis;* it is very delicate in form, and has its integument completely covered by an armature of spines arranged in transverse rings, by means of which it is enabled to fix itself firmly to the mucous membrane of its host. The head is unarmed. There is no swelling of the digestive tube. The eggs are proportionately large, being one-fifth of the width of their parent; they are characterised by having at either pole a small appendage in the form of a flattened button; at its circumference there are, at definite distances from one another, three very fine filaments which, when unrolled, are fourteen or fifteen times as long as the egg.

The new genus appears to belong to the family of the Filaridæ and to stand nearest to the genus *Hystrichis*.

**Nervous System of Bothriocephalidæ.**‡—M. J. Niemiec has investigated the nervous system of *Bothriocephalus latus*, and of a species of the same genus which is parasitic in the dog. The lateral nerve-cords ascend into the scolex where they continue their original direction; there are no ganglia or any commissures in the hinder part of the scolex, as has been asserted by some previous observers. It is only in the anterior extremity of the scolex that the lateral cords turn towards one another, and, after an inconsiderable enlargement, unite by a well-developed commissure; this last contains ganglionic cells, and may be called the central ganglion, though it is not so sharply delimited as in *Tænia*. The lateral cords give rise, just below the commissure, to four nerves on either side, which spread out radially, and then curve backwards to accompany the principal cords. The latter give off a series of short nervous filaments which pass to the epithelium. The author points out the value of the study of the nervous system of *Bothriocephalus* as explaining that of *Tænia;* it is simpler and more primitive in character.

* Arch. Zool. Expér. et Gén., iii. (1885) p. lxxii.
† Ann. Sci. Nat.—Zool., xvii. (1885) 8 pp. and 1 pl.
‡ Comptes Rendus, c. (1885) pp. 1013–5.

**Parasites of Fresh-water Fishes.***—M. F. Zschokke has been investigating the organization and zoological distribution of the parasitic worms of fresh-water fishes. He has examined twelve species from the Lake of Geneva, among which are *Perca fluviatilis*, *Cyprinus carpio*, *Trutta variabilis*, *Salmo umbla*, and *Esox lucius*. The first result of these studies is to demonstrate the presence of 37 species of parasitic worms; three at least of these are new species; they are found in nearly all the organs of the body; six of the eleven species of Cestoda were found in the strobila-stage, two in the scolex, and three in both. Only three of the species had no special parasite (namely, *Coregonus*, *Trutta*, and *Cyprinus carpio*). A table of distribution shows that the rapacious fishes (Salmonidæ, Gadidæ, Esocidæ) are the richest in different species of parasites. The genera of parasites have a close relation to the food of their host; thus the carnivorous forms have a very remarkable preponderance of adult Cestoids; on the other hand, the *Cyprinidæ*, which are herbivorous, are rich in Acanthocephali, for with their vegetable nutriment they take in a number of small Crustacea. The Trematoda are very regularly distributed; Nematoids are found in nearly all.

The author further directed particular attention to the difficult question of whether the parasites are the same throughout the year, or vary with different seasons, and, so far as he was able to judge, he found that the number of parasites does not vary considerably during the year. He notes, lastly, what must have struck other observers, that the number of female Ascarids is excessively large in proportion to the males.

The preceding introduction to the paper is amply supplied with very valuable tables of statistics.

Dealing with the species in detail, the author gives notes on the various forms: *Tænia salmonis umblæ* is a new species found in the intestines of *Salmo umbla;* it is from three to five centimetres long, the jointing is only feebly indicated, and the head has, on its anterior surface, a slight depression, which has the appearance of being a large but very shallow sucker. The genital orifices are placed in pits, and alternately, though not regularly, on either side. No ripe proglottids were detected. The author proposes to unite the species distinguished by Rudolphi as *Bothriocephalus infundibuliformis* and *B. proboscideus*.

Nothing is to be added to the excellent account given by Pintner of the excretory system of *Triænophorus*.

*Distoma nodulosum* was found in eight of the twelve hosts examined, and *D. globiporum* is very widely distributed; *D. tereticolle* is most common in the trout. With some hesitation, *Diplozoon paradoxum*, in its *Diporpa*-stage, is reported from the gills of *Lota vulgaris* and *Cottus gobio*.

*Sporocystis cotti* n. sp. was very frequently found in the muscles of *Cottus gobio*, under the form of small, whitish, elongated cysts, but the *Distomum* to which they belong has not yet been discovered.

* Arch. de Biol., v. (1884) pp. 153–241 (2 pls.).

*Echinorhynchus proteus* and *E. angustatus* are very common, but *E. clavæceps* was only found once in the rectum of *Leuciscus rutilus*.

With a good deal of hesitation, a specimen found in the intestine of *Thymallus vulgaris* is regarded as being a young form of *Gordius aquaticus;* such characters as were to be detected seem to justify the author's view, but they are hardly sufficient for certainty.

In an appendix a report is made on certain psorosperms which were found under the skin of *Coregonus fera*, and appear to be the cause of an affection to which this fish is subject, especially in the spring; agreeing generally with the piscine psorosperms described by Balbiani, they do not exactly resemble those seen by Lunel and described by Claparède; they have two vesicles at the end opposite to the "tails," whereas, in all species, according to Balbiani, they are found near the tails; as, however, these vesicles give off an extremely fine canal, which passes to the base of the tail, it is probable that, as in others, they serve as a sheath for these processes.

**Free-swimming Sporocyst.***—Prof. R. Ramsay-Wright records the existence of a hitherto unknown form of sporocyst, one specimen of which he observed recently swimming very actively in an aquarium containing a few water-plants and fresh-water mollusca. In form and size it recalls the larger *Cercariæ* with forked tails, and contains a single tailless *Cercaria* or larval Distome. In accordance with its free life, the muscular system is much better developed than usual, and the same is true of the water-vascular system. Of special interest are tactile papillæ, which beset the surface, and which obviously enable the sporocyst to find the definitive host for its contained larva.

**Development of Turbellaria.**†—Mlle. S. Pereyaslawzew communicates a short abstract of her results obtained by studying the development of the Turbellaria Acœla. The ovum divides into two equal halves, from each of which a small cell is detached; the further processes of cell-division are detailed; they result in the formation of a gastrula, the smaller cells becoming the ectoderm; the larger cells form the endoderm, and also give rise to the mesoderm; as development advances the embryo takes on an angulated contour such as has been figured by Metschnikoff; when it reaches the gastrula stage it becomes again rounded and clothed externally with cilia.

**Fresh-water Turbellaria of North America.**‡—Mr. W. A. Silliman has been engaged in studying the fresh-water Turbellaria of Monroe County (State of New York), and as the area is rather limited, he thinks it probable that he has found all the forms that live there. A comparatively large number of new species are described.

*Macrostoma sensitivum* n. sp. has generative organs of much the same character as those of *M. hystrix*, but the male orifice is not at the end of the penis, but some distance behind it. The author finds that forms with no schizocœl have a more richly branched water-vascular system, while *Microstoma* and others which have a well-

* Amer. Natural., xix. (1885) pp. 310–1.
† Zool. Anzeig., viii. (1885) pp. 269–71.
‡ Zeitschr. f. Wiss. Zool., xli. (1884) pp. 48–78 (2 pls.).

developed cœlom have a proportionally smaller number of vascular branches; the physiological cause of this appears to be that, in the latter, the ciliated funnels are nearer to a larger quantity of lymphatic fluid, and so are more easily able to conduct it into the capillaries of the water-vascular system. The integument of Platyhelminths appears to be capable of endosmosis but not adapted to exosmosis; in consequence of this the received water has to make its way out by special efferent canals. The two species of *Microstoma* described are *M. lineare* of Oersted, and *M. caudatum* of Leidy.

*Stenostoma agile* is a new species, in which the ciliated pits lie far forwards, and are innervated by nerves from the anterior lobes of the cerebral mass. There are four new species of *Mesostoma*. *M. gonocephalum*, in which the eyes are reniform and appear to have small lenses, which are not, however, highly refractive. *M. cœcum*, which has no eyes, is without true pigment, and is only occasionally coloured by its food; there are no flagella or other tactile hairs; it was found in mud, under stones. *M. pattersoni* has a number of cells and cell-spheres in its perienteric fluid, and these are driven about by every contraction of the body-wall; the water-vascular system is particularly easy to detect, and the ciliated lobes are most numerous in the cephalic region. The interesting peculiarity of *M. viviparum* is denoted by its specific name; there appears to be no vitellarium, the ovary is not well defined in area, the ova lying in the parenchyma, near the genital orifice. There is no sign of any bursa copulatrix or receptaculum seminis. All the embryos of one mother appear to be at about the same stage in development. The author hopes to describe the developmental history at a future time. True viviparous Turbellaria are extremely rare, none being known in Europe, though two have been described by Girard from North America. Chlorophyll-bodies are richly developed, and the author refers them to the presence of algæ; he goes so far as to correlate with their presence the absence of a vitellarium, and the habit of viviparity, thinking that the embryos find the maternal body a suitable place for development in consequence of the abundance of food and oxygen.

*Gyrator* (?) *albus* n. sp. is the name given to a sexually immature species.

In *Vortex pinguis* n. sp. the testes are irregular sacs, and the penis is completely separated from the seminal vesicle; the spermatophores are fairly simple in structure; the vestibule of the generative organs is so spacious as to serve for a uterus, in which the ova are invested by yolk after fertilization. *V. blodgetti* n. sp. has the copulatory organ provided with six spines.

*Plagiostoma* (?) *planum* is the name of a new species which is founded on a single example, with an extensile terminal mouth, and with a spacious intestine which is provided with a pair of diverticula; these are not mere constrictions as in some species. Spaces or lacunæ in the body-parenchyma are very rare.

The author takes the opportunity of describing *Tetrastemma aquarum dulcium* to express his belief that the four groups of Rhabdocœla, Triclada, Polyclada, and Nemertinea are of the same

classificatory value, and are four orders of the class Turbellaria. He enumerates in all twenty-one species, and expresses his opinion that a considerable proportion will be found to be common to North America and Europe; into the interesting remarks that he makes on already known species our space forbids us to enter.

**Later Stages in the Development of Balanoglossus.***—Mr. W. Bateson gives an account of his observations on the later developmental stages of *Balanoglossus Kowalevskii*, and makes a suggestion as to the affinities of the Enteropneusta. A notice of Mr. Bateson's work on the earlier stages of the species has been already given.†

As the cilia of the larva disappear a peculiar organ, in the form of a small papilla, bearing long cilia and mucous glands, appears on the central part of the posterior surface; this serves as a sucker, and then entirely disappears; it is essentially similar to the larval suckers of Tunicates, Ganoids, and Amphibians, but it is not, apparently, an ancestral character.

Owing to the transparency of the body at an early stage the alimentary canal may be easily seen to consist of an anterior branchial tract, a middle digestive, and a posterior intestinal portion. As the animal loses its cilia and before the second pair of gill-slits become developed it creeps into the upper layer of mud, its mouth comes to be directed forwards, a notochord becomes distinctly visible, and the opercular fold appears in the form of a circular thickening.

As the body increases in size it becomes more and more transparent, but this phenomenon is, possibly, of no real significance, being due merely to the rapid growth of the animal. As the body grows, the number of gill-slits increases; it seems probable that they go on increasing during the greater part, if not the whole, of the life of the animal; the largest number of pairs of slits observed was fifty-seven. As the gills appear in greater number the distinction between the digestive and intestinal regions of the animal becomes better marked.

*Balanoglossus* appears to have a very peculiar odour, which is described by Mr. Bateson as being "very penetrating and persistent, resembling that of chloride of lime with a fœcal admixture." In a new and as yet undescribed species—*B. Brooksii*—the smell, which is strongly suggestive of iodoform, is very distinct after some months' preservation in spirit (often changed), and is "a considerable drawback to investigating the species."

There appears in the anterior dorsal wall of the gut, a most remarkable structure which is regarded by Mr. Bateson as the notochord; it first arises by a forward growth of the anterior dorsal wall of the pharynx, which thus shuts off a short diverticulum of hypoblast; this is aided by a longitudinal constriction of the dorsal region of the pharynx which gradually travels backwards, separating a hollow hypoblastic tube, which remains open to the gut behind, and by a forward growth from the point of junction with the gut.

The skeletal rods first appear as two short rods of a deeply stained, structureless substance which lie in the angles between the

* Quart. Journ. Micr. Sci. Supplement (1885) pp. 81–122.

† See this Journal, *ante*, p. 461.

notochord and the dorsal wall of the pharynx; they appear to be of hypoblastic origin, and it is possible that they are formed at the expense of the notochord. Later on, the notochord increases greatly in size, and becomes vacuolated just like the notochord of young Lampreys and Elasmobranchs; the skeletal rods, becoming of considerable size, unite anteriorly to form a single bar, while the whole structure forms the support of the proboscis.

"From its development, position, relations to surrounding parts, histology, and function," Mr. Bateson says, "it appears to me to be comparable with the notochord of the Chordata, and this name is strictly appropriate to it. Even if the suggestions which will be made hereafter as to its phylogenetic significance be not accepted, this rejection would in no way militate against the fact that this structure is to all intents and purposes a notochord, which can only be designated as a longitudinal dorsal supporting rod, derived from the hypoblast."

Particular attention is given to the resemblances between the Enteropneusta and *Amphioxus;* as to the position and mode of origin of the central nervous system there is great similarity, the only important point of difference being that the invagination of the dorsal cord is only partial in *Balanoglossus*, but is complete in *Amphioxus.*

## Echinodermata.

**Phylogeny of Echinoderms.***—Mr. H. F. Nachtrieb records some observations made on the development of many of the Echinodermata of Beaufort, and concludes with some remarks on the phylogeny of Echinoderms. If we compare the origin of the body-cavity and water-vascular system in the different classes, we see that in the Holothurians we have one median pouch given off from the enteron, and that it, by division, gives rise to the body-cavity and water-system. In the Echinoids there is a two-horned pouch given off. In the star-fish there are two separate lateral pouches given off, of which the left gives rise anteriorly to the water-system, and the right and the posterior part of the left become the body-cavity. In Ophiurids so far as known, there are two separate pouches, both of which divide, the anterior part of the left becoming the water-system, the anterior of the right atrophying, and the posterior parts of the right and left becoming the body-cavity. In the Crinoids there are first given off two separate pouches, which become the body-cavity, and then a single one, that becomes the water-system. Assuming that the story of the Ophiurids and Crinoids is correct, we have here a rising scale, in which the Holothurians occupy the lowest, the star-fish the middle, and the Crinoids the highest position. In favour of this there are some anatomical facts.

The objections of palæontology are not very difficult to answer. In assuming the Holothurians as the primitive forms it is not necessarily implied that the line of development is a straight one, as it is represented above. It is quite probable that the line began to break with the appearance of the star-fish.

* Johns-Hopkins Univ. Circ., iv. (1885) pp. 67-8.

**Arbaciadæ.***—In this first part of their paper on the family *Arbaciadæ* Gray, Dr. P. Martin Duncan and Mr. W. P. Sladen treat of the morphology of the test in the genera *Cœlopleurus* and *Arbacia*. These two forms, as is shown by a minute study of the fossil and recent species, have a great similarity of structure. In all (for *Arbacia nigra* belongs to a different genus) the compound plates of the ambulacra are formed of an adoral and an aboral demi-plate with a large central primary plate. In all forms the optic pores are double, and the perforation is in the adoral edge of the plate, a process separating the pores. In all the forms the median or vertical sutures of the interradia are marked with knobs or ridges, which correspond with sockets or short grooves on the opposed plate edges. This kind of dowelling is even seen in the ambulacra of *Arbacia* and along the transverse interradial sutural edges of *Cœlopleurus*.

*Cœlopleurus* is the oldest of the two genera: there are species with the peculiar ambulacra in the Eocene, Oligocene, and Miocene. The recent species from the Indian Seas only differs from the Miocene form in having high and not oblique interradial plates. All the species of *Arbacia*, which are recent forms, that were examined present no greater differences than can be accounted for on the theory of descent.

**Histology of Asterida.**†—Dr. O. Hamann has a preliminary notice on the histology of star-fishes, in which he points out that the body-wall consists of an epithelium, which is followed by a layer of connective tissue, in which the calcareous structures are developed. Internally to it are a layer of circular and a layer of longitudinal muscles; the latter was described by Ludwig as the lamella of supporting substance; in it the so-called ossicles are developed. In the layer of supporting substance which lies on the muscular layers we find the canal-system of the body-wall, which is invested by an epithelium. Muscular bundles, passing off from the circular layer, traverse the lumen of the canals, and end or branch at definite points in the layer of supporting substance. The muscular layers may be traced to the ossicles; and it is pointed out that the discovery of these muscles enables us to explain the movement of a star-fish and its arms. The ambulacral gills are to be regarded as evaginations of the dorsal wall, and have the same structure as it; their protrusion and retraction is to be explained by their possession of a similar system of muscles.

In addition to the well-known oral nerve-ring the author was able to detect a nerve-plexus in the oral disk; this consists of nerve-fibrils with scattered ganglionic cells, which pass into the epithelial cells of the disk. It is pointed out that we have here an arrangement which is comparable to that which Dr. Hamann has already described as obtaining in Holothurians. In the dorsal integument there are nerve-trunks which are ordinarily set at right angles to the long axis of the arm. The dorsal epithelium consists of simple supporting

* Journ. Linn. Soc. Lond. (Zool.), xix. (1885) pp. 25-57 (2 pls.).
† Nachr. K. Gesell. Wiss. Göttingen, 1884, pp. 385-6.

cells among the basal prolongations of which we find nerve-fibrils, of sensory, and of goblet-shaped glandular cells.

**Stalked Crinoids of the 'Challenger' Expedition.*** — Dr. P. Herbert Carpenter has published in the 'Challenger' reports a very full monograph of the morphology of Crinoids generally, and an extensive account of the stalked forms.

The first, or morphological, portion deals with the skeleton generally, and the mode of union of its component joints; in the second chapter the stem and its appendages as seen in the Pentacrinidæ, Bourgueticrinidæ, and Hyocrinidæ are considered, and the differences in the three groups are pointed out; the author thinks that "the resemblance and 'probable homology' which Prof. Perrier sees between the arms and the root of a Crinoid are . . . . forced in the extreme"; for the former are merely extensions of the body, while the branches of the root have a very different structure, or, in other words, that of the stem, as is indeed allowed by Perrier himself. The terminal faces of the stem-joints of *Hyocrinus* are interesting as being of the same nature as those of the Apiocrinidæ and many of the Palæocrinoids.

In the third chapter the calyx, and in the fourth the rays are dealt with; the characters of the pinnules of Palæocrinoids are discussed, and the view of Wachsmuth and Springer that the alternate plates of *Cyathocrinus* are rudimentary pinnulæ is objected to, analogy being apparently confused by them with homology. The three functions of pinnules are, it is pointed out, that of protecting the fertile portions of the genital glands, of serving as respiratory organs, and of aiding in alimentation; in *Cyathocrinus* all these functions might have been performed by the branching arms.

The division by Ludwig of the cœlom into an intervisceral and circumvisceral portion is regarded as convenient, but it is pointed out that in some species—such, for example, as *Antedon eschrichti* among the Comatulids, and in the stalked Crinoids—it is difficult to fix a definite boundary between them. The oral plates which, formed in Pentacrinoid larvæ, are absorbed during development, are retained throughout life by *Holopus*, *Hyocrinus*, *Rhizocrinus*, and *Thaumatocrinus*. Wyville Thomson's name of perisomatic skeleton is adopted for "the basal and oral plates, the anal plate, the interradial plates, and any other plates or spicules which may be developed in the perisome of the cup or disk," while that of "visceral skeleton" is used to denote the "numerous spicules and networks of limestone which occur more or less plentifully in the bands of connective tissue that traverse the visceral mass of the Comatulæ" and the more or less regular plates which are found *within* the disk of *Pentacrinus;* these are formed of a calcareous network interpenetrated by an organic basis, which is of the same nature as in the joints and arms.

In the sixth chapter the minute anatomy of the disk and arms is dealt with, and the author states that his extended observations on

* Report of the Voyage of H.M.S. 'Challenger'—Zoology, xxxii. (1884) 440 pp. and 69 pls.

Comatulæ and on *Pentacrinus, Bathycrinus*, and *Rhizocrinus*, enable him to confirm in almost every respect the investigations of Ludwig on *Antedon rosacea;* especial attention is, as may be supposed, given to the nervous system. In the discussion on the characters of the colouring matter, it is interesting to observe that pentacrinin was found in *Holopus;* one species of the new genus *Metacrinus* has a different colouring matter, which is light pink when fresh.

The seventh chapter deals with the habits of Crinoids and their parasites; the eighth with their geographical and bathymetrical distribution, the results of which are usefully arranged in tabular form.

A characteristic of the work is the attention which is given to palæontological discoveries, and the relations of the Neocrinoids to the Palæocrinoids. The following table shows the mutual homologies of the principal plates in the actinal and abactinal systems of Echinoderms.

| | Urchins. | Ophiurids. | | Crinoids. | | |
|---|---|---|---|---|---|---|
| | Abactinal | Abactinal | Actinal | Abactinal | Actinal | |
| | | | | | Symbatho-crinus | Actino-crinus |
| 1. Central plate | Dorso-central | Dorso-central | .. | Terminal plate at base of larval stem | Oro-central | Oro-central |
| 2. First series, radial | .. | Under-basals (variable) | .. | Under-basals variable. | .. | .. |
| 3. Second series, interradial | Genitals | Basals | Mouth-shields | Basals | Orals | Proximal dome-plates |
| 4. Third series, radial | Oculars | Radials | .. | Primary calyx radials. | .. | Primary dome-radials. |
| .. | .. | .. | .. | Orders of calyx radials. | | Orders of radials. |
| .. | .. | .. | .. | Calyx interradials | | Dome interradials |

The following is the classification adopted:—

*Phylum.* Echinodermata.
*Branch.* Pelmatozoa.
Class 1. Crinoidea.
„ 2. Cystidea.
„ 3. Blastoidea.

In the order Neocrinoidea we have descriptions of the several

forms; the first family is that of the Holopidæ, under which *Holopus* is very fully described; the second family, that of the Hyocrinidæ, is new, the character of *Hyocrinus* being sufficient to distinguish it from the Apiocrinidæ; de Loriol's family name of Bourgueticrinidæ (1882) is accepted for *Bathycrinus* and *Rhizocrinus*, the characters of which are emended. In the Pentacrinidæ there is the new genus *Metacrinus* for forms which appear to be confined to the Eastern seas. Various problems are discussed in an appendix, and the whole work concludes with a full bibliography of the Neocrinoids and an excellent index.

**Development of Comatula.***—Professor E. Perrier in a preliminary notice brings forward the following facts concerning the organogeny of *Comatula*.

From the archenteron are developed three diverticula; two form the general body-cavity, while the third gives rise to the ambulacral ring; directly the latter is formed it communicates with the exterior by a single "stone canal." The rudiment of the structure termed by Ludwig the dorsal organ arises by a columnar thickening of one of the layers of the right peritoneal sac; round the prolongation of the right peritoneal sac into the axis of the peduncle the mesodermic tissue becomes differentiated into the chambered organ; a similar differentiation takes place in the walls of the calyx to form five cords, which pass to the septum, separating the two halves of the body-cavity; these cords as well as the two peritoneal sacs and the ambulacral sac share in producing the rudiments of the arms, which thus contain (1) an ambulacral canal, (2) a subambulacral cavity continuous with the left peritoneal sac, and (3) a much smaller cavity connected with the right peritoneal sac; later this cavity enlarges and a new cavity—the genital space—appears between it and the subambulacral cavity. The young *Comatula* is set free at the period when each arm has only a single pair of pinnules; there are at that time five "stone canals" which open directly on to the exterior; these tubes generally rupture at the point where they enter the body-walls, and appear therefore to open into the body-cavity, which they never do in reality, even in the adult. At the same period of development a number of fibro-cellular cords appear around the œsophagus and along the dorsal organ, which form a plexus of vessels which send off branches, some opening on to the exterior of the body, and some into the body-cavity and into the ambulacral vessels; a plexus of these vessels envelope the dorsal organ, and has been compared by Claus with the heart of sea-urchins and star-fishes. The ambulacral system, therefore, together with these vessels, forms a single vascular system functionally one, though developmentally composed of two distinct and separate systems. The dorsal organ is prolonged into the arms and into the pinnules, and forms the genital rachis; the dorsal organ itself consists of pyriform cells which come to be grouped round a central cavity; this gives off short diverticula, and transverse

* Zool. Anzeig., viii. (1885) pp. 261–9.

sections of the whole organ occasionally present the appearance of a glandular organ like the salivary glands; it is these numerous cavities, no doubt, which led Ludwig to describe the dorsal organ as a plexus of blood-vessels.

## Cœlenterata.

**Australian Hydroid Zoophytes.***—Mr. W. M. Bale has compiled a catalogue of the Australian hydroid zoophytes, with a view not only of affording a guide to the collections in the Sydney Museum, but of providing students of natural history with a compact account of all that has been done in the description and illustration of the Australian representatives of this group. A general introduction on the morphology of the Hydroida is prefixed to the systematic portion of the catalogue, which contains a large amount of new and valuable matter, including descriptions of 23 new species:—*Pennaria* (1), *Campanularia* (3), *Lineolaria* (1), *Sertularia* (7), *Thuiaria* (2), *Plumularia* (4), *Antennularia* (1), *Halicornaria* (4).

**Cœlenterates of the Southern Seas.**†—Dr. R. von Lendenfeld, in his fifth communication, deals with the Australian Hydromedusæ; in his introduction he notes the great abundance of marine animals in Port Jackson, and states that his investigations have been greatly aided by the liberality of Mr. W. Mackay. The list of species amounts to no less than two hundred and forty-one.

In his sixth communication ‡ the author deals with *Neis cordigera* of Lesson, a Beroid which was first discovered in 1824; from *Beroe* the species differs by having high lobes which project far above the sensory poles, and by not having the vascular system of the gelatinous tissue of one-half of the body separated from that of the other. In form, *Neis* is intermediate between *Beroe* and the Lobatæ; four of the ctenophores are longer than the other four; the sensory organ at the aboral pole has no special peculiarities; the generative products appear to be confined to the parts of the vascular plexus which are widely separated by the meridional canals, and in this point this Australian species differs essentially from *Beroe*.

**Chromatology of Actiniæ.**§ — Dr. C. A. MacMunn finds that *Actinia mesembryanthemum* contains a colouring matter which can be changed into *hæmochromogen* and *hæmatoporphyrin*; this is present in other species, and from its characters it is provisionally named *actiniohæmatin*. It is not actiniochrome (a pigment found by Prof. Moseley in the tentacles of *Bunodes crassicornis*), as its band occurs nearer the violet than that of actiniochrome. Moreover, both actiniochrome and actiniohæmatin can be extracted with glycerin, in which the latter is convertible into hæmochromogen, but the former remains unchanged. Actiniochrome is generally confined to the

* Bale, W. M., 'Catalogue of the Australian Hydroid Zoophytes,' 8vo, Sydney, 1884, 198 pp. (19 pls.).

† Zeitschr. f. Wiss. Zool., xli. (1885) pp. 616–72.

‡ Tom. cit., pp. 673–82 (1 pl.).

§ Proc. Roy. Soc., xxxviii. (1885) pp. 85–7. See this Journal, *ante*, p. 464.

tentacles, and is not respiratory; actiniohæmatin occurs in the ectoderm and endoderm, and is respiratory.

A special colouring matter is found in *Sagartia parasitica*, different from either of the above, and this too exists in different states of oxidation. It is not apparently identical with that obtained by Heider from *Cerianthus membranaceus*.

In the mesoderm and elsewhere in *Actinia mesembryanthemum* and other species, a green pigment occurs which alone and in solution gives all the reactions of biliverdin.

*Anthea cereus*, *Bunodes ballii*, and *Sagartia bellis*, yield to solvents a colouring matter resembling chlorofucin, and all the colouring matter, which in them shows this spectrum, is derived from the "yellow cells" (= symbiotic algæ) which are abundantly present in their tentacles and elsewhere. It is not identical with any animal or plant chlorophyll, as is proved by adding reagents to its alcoholic solution.

When "yellow cells" are present, there appears to be a suppression of those colouring matters which in other species are of respiratory use.

### Porifera.

**Relationship of Sponges to Choano-flagellata.***—Dr. F. E. Schulze criticizes the views held by Saville Kent and others, respecting the systematic position of the sponge; the so-called collared cells are closely similar to certain flagellate Infusoria; and this resemblance was held by these authors as a proof of the close affinity between the two groups. Saville Kent has brought forward other reasons in support of this opinion; in the first place he has studied the larvæ of certain sponges, and has inferred from their development and structure that they do not correspond in any sense to a gastrula, but are to be interpreted as simple colonies of Choano-flagellata; a mature sponge larva consists of a hollow sphere surrounded by a single layer of collared cells, and those cases where the larva consists of simple flagellate cells in one half of the sphere and granular non-ciliated cells in the other half are believed by him to be later developmental stages. Schulze points out that Saville Kent's statements have not been borne out by other investigators, and that no one but himself has seen the collared cells in the larvæ; he suggests further that the so-called "larvæ" are in reality nothing more than portions of sponge tissue separated by teasing, which would account for the appearances observed and described by Saville Kent. Even if Kent's observations are correct, the fact of the development of the sponge gemmule from an ovum fertilized by true spermatozoa at once sets aside any possibility of a comparison with a colony of Choano-flagellata. The discovery of a Choano-flagellate (*Protospongia*) consisting of numerous collared cells imbedded in a common gelatinous matrix is not, as Saville Kent thought, an argument in favour of his hypothesis, since in sponges the gelatinous tissue compared by him

* SB. K. Preuss. Akad. Wiss. Berlin, 1885, pp. 179–91. See Ann. and Mag. Nat. Hist., xv. (1885) pp. 365–77.

to this matrix is a true connective-tissue and has indeed been recently shown by Von Lendenfeld to contain nervous and sensory cells; it is true that in the Choano-flagellate amœboid cells wander into the gelatinous matrix, but this is connected with spore formation, and "no fixed connective-tissue cells at all are formed," not to mention the nervous structure already referred to.

**New Variety of Meyenia fluviatilis.*** — Mr. H. J. Carter describes a new variety of *Meyenia fluviatilis*, for which he proposes the varietal name of *angustibirotulata*. The specimens were obtained near Brentwood in Essex, and from the Calumet River, U.S.A. The distinguishing features of this new variety are the length and hour-glass shape of the birotules, and the *smooth* skeletal spicule. The only variety of *M. fluviatilis* with which it can be confounded is that of Bombay. In this last, however, the shaft of the birotule is equal in thickness throughout, and the skeletal spicule may be spiniferous as well as smooth.

**New Fresh-water Sponge.†**—Mr. E. Potts describes a new fresh-water sponge, *Heteromeyenia Pictouensis* n. sp., from Pictou, Nova Scotia. It is near *H. Ryderi*, but the peculiarities of its birotulates distinguish it from that or any other species. It appears to be an "evergreen," continuing its life in the normal state throughout the year, and for this reason seems not to form "protected gemmules" in such abundance as do other species.

**Sponges of the Norwegian North Sea Expedition.‡**—Dr. G. A. Hansen gives an account of forty-five species of sponges collected during the Norwegian North Sea Expedition of 1876–8; there is one new genus *Clavellomorpha*, which is placed next to *Thenea*. There is a new species of *Hyalonema*, *H. arcticum*, many of the long spicules of which are enlarged in the middle, where the axial canal is divided. Twelve new species are placed in the genus *Reniera*, five with Suberites, four with *Myxilla*, and two with *Sclerilla*; there are four new species of *Desmacidon*, and one of *Gerodia*. The five calcareous sponges have all been described, and the nomenclature of Häckel is adopted. Many of the specimens were incompletely preserved owing to the evaporation of the alcohol, and the author was unable to trace out the canal system; the species are, therefore, discriminated by their spicules, in the description of which the stenographic system of Vosmaer is made use of.

### Protozoa.

**Further Experiments on the Artificial Division of Infusoria.§**—Herr A. Gruber has been making some further observations on *Stentor cæruleus*. An example *a* was cut transversely into two pieces; on the next day both had become perfect organisms *a'*; one was again

* Ann. and Mag. Nat. Hist., xv. (1885) pp. 453–6.

† Proc. Acad. Nat. Sci. Philad., 1885, pp. 28–9 (1 fig.).

‡ Hansen, G. A., 'Den Norske Nordhavs-Expedition, 1876–8, xiii., Spongiadæ,' fol. Christiania, 1885, 25 pp., 7 pls. and 1 map.

§ Biol. Centralbl., v. (1885) p. 137. See Naturforscher, xviii. (1885) p. 204.

divided into two, and on the next day there were two complete $a''$; one of these was again cut with the same result, and one of the $a'''$ in a similar way, with the like result. Further experiments have strengthened the belief of the author in the value of the nucleus in regeneration; pieces without a nucleus did well, but never grew up into complete animals.

**Vorticellæ with Two Contractile Vesicles.***—Dr. A. C. Stokes points out that besides *Vorticella Lockwoodii* Stokes, and *V. monilata* Tatem, the following species of the genus possess *two* pulsating vacuoles, a point in their structure which has been overlooked, viz.:—*V. vestita* Stokes, and *V. rhabdophora* Stokes. The presence of double vesicles has so far been observed only in such members of the genus as possess some form of cuticular investment or of surface ornamentation rather than transverse striæ. As these species are apparently more highly organized, and presumably somewhat higher in the scale than are the smooth or simply striated forms, so are they slightly more complex in structure.

**New Fresh-water Infusoria.**†—Dr. A. C. Stokes describes some new fresh-water Infusoria from shallow ponds in central New Jersey.

*Heteromita mutabilis* n. sp. is remarkable for the presence and variety of the posterior protrusions of the body-sarcode. From *H. lens* (Müll.) S.K., it can be distinguished by its normally ovate or subpyriform contour, but chiefly, apart from the posterior changes of shape, by the diverse length and thickness of the flagella.

*Petalomonas carinata* n. sp. seems to combine the characters of *P. abscissa* (Duj.) Stein and of *P. mediocanellata* Stein, the former bearing one or two dorsal keel-like elevations, and the latter having a groove traversing its ventral surface, while *P. carinata* possesses both in a marked degree. It is much the smallest member of the genus hitherto observed. *Zygoselmis acus* n. sp. has its favourite haunt in dead and partially empty algal cells. *Anisonema emarginatum* n. sp. *Entosiphon ovatus* n. sp. is much larger than *E. sulcatus* (Duj.) Stein. *Tillina flavicans* n. sp. somewhat closely resembles *T. inflata* Stokes, which is here diagnosed and figured for comparison. *Lacrymaria truncata* n. sp. is the only fresh-water member of the genus thus far observed. It is remarkable for the very long and band-like nucleus, and especially for the capacious conical pharyngeal passage which has hitherto not been recorded as appearing in any of the several marine species. *Colpidium truncatum* n. sp. differs from the hitherto single known member of the genus in the oblique truncation of the frontal border, the single nucleus, and the position of the contractile vesicle. *Vorticella octava* n. sp. is characterized by the peculiar twisted appearance of the sheath about the pedicle; in none of the previously described *Vorticellæ* has such an appearance been noted. *Urostyla trichogaster* n. sp. was for some time the prevailing form in a vegetable infusion, gliding over the fungoid slime on the surface as visible whitish spots. By transmitted light it is

* Amer. Mon. Micr. Journ., vi. (1885) pp. 52–3.
† Ann. and Mag. Nat. Hist., xv. (1885) pp. 437–49 (1 pl.).

brown and semi-opaque. *Opisthotricha emarginata* n. sp. in its movements is rapid and erratic. The contractile vesicle expels its contents through the dorsal surface, forming there at complete systole a conspicuously projecting elevation of the cuticular surface. *Stylonychia notophora* n. sp. differs from *S. mytilus* Ehr., which it most resembles, in that the extremities are subequal in width, in the rounded posterior margin beyond which project three instead of two anal styles, in the possession of motionless bristle-like hairs on the dorsal surface, and especially in having the opening of the anal orifice on the superior or dorsal aspect. *Podophrya brachypoda* n. sp. may be recognized by the foot-stalk being very short and inconspicuous; unless seen in profile or side view, or in longitudinal optic section and attached to the supporting object from which it is readily separated, it bears a not remote resemblance to *Sphærophrya*. Dr. Stokes suggests that *P. Buckei* S.K. is probably an immature form of an unobserved, more distinctly pedicellate member of the present genus, and not, as Kent thought, likely hereafter to become the type of a new genus. In *Solenophrya inclusa* n. sp. the frontal convexity or roof is so hyaline that its existence can be satisfactorily observed only by the use of some chemical means of removing the enclosed zooid. This is readily accomplished by a drop or two of caustic potash in solution. Dr. Stokes has been unable to detect openings in the upper surface or dome-like roof of the lorica. *S. pera* n. sp. The form of this lorica is so much like that of the ordinary hand-satchel now popular among ladies that it suggested the specific name. *Acineta urceolata* n. sp. is the last species described.

Dr. A. C. Stokes also describes * some new fresh-water Infusoria from the shallow ponds and streams of New Jersey.

*Physomonas vestita* n. sp. differs from the hitherto single known member of the genus in the absence of the truncated anterior border, and in the presence of a linear, dark-bordered band or depression near the frontal margin, as exists in *Spumella*.

*Bicosœca lepteca* n. sp. is among the largest, if not the largest of the genus. It differs widely from the only fresh-water species, *B. lacustris* J.-Clk., hitherto observed in American lakes. *B. leptostoma* n. sp. most closely resembles the salt-water *B. tenuis* S.K., and may be considered its fresh-water representative. *B. longipes* n. sp. *Stylobryon Abbotti* n. sp. This polythecium, unlike that of *S. petiolatum* (Duj.) S.K., which it most resembles, is subject to but little variation in its mode of colony-building. *Tillina helia* n. sp. has the nucleus placed subcentrally, but its position in reference to any special region is not constant.

*Derepyxis* n. gen. is near Stein's *Chrysopyxis*, but differs in the constantly pedicellate character of the lorica. Two new species, *D. amphora* and *D. ollula*, are described. *Chilomonas ovata* n. sp. is the most minute fresh-water species yet recorded. *Loxophyllum flexilis* n. sp. is remarkably irregular in outline, and this peculiarity is increased by the presence of two little projections, on the posterior

* Amer. Journ. Sci., xxix. (1885) pp. 313-28 (1 pl.).

part of the dorso-lateral border, that are constantly present but which vary somewhat in size and form. *Spirostomum loxodes* n. sp. in external contour bears a striking resemblance to *Loxodes;* it approaches nearest to *S. teres* C. & L. The lorica of *Vaginicola leptosoma* n. sp. resembles in form *V. attenuata* (From.) S.K., but is just twice as large, besides differing in the proportion borne by the length to the width. In *Cothurnia annulata* n. sp. the enclosed animalcule differs from all hitherto known species in the possession of a transversely striated cuticular surface, and the ridge-like elevation encircling the central portion of the body; the lorica also differs in form from that of other species. *Litonotus vesiculosus* n. sp. resembles *L. Wrzesniowskii* S.K. Its chief diagnostic characters, in the internal structure, are the presence of very many minute, quickly and irregularly pulsating contractile vesicles scattered about the cortex, while in the animalcule most resembling it the pulsating vacuole is large, single, and located near the origin of the caudal extremity. *Litonotus carinatus* n. sp. cannot easily be mistaken for any other species of the genus. *Litonotus trichocystus* n. sp. to a certain extent resembles *L. fasciola* (Ehr.) S.K. It is, however, easily distinguishable by its shorter and less conspicuously flattened neck-like part, and especially by the number and arrangement of the trichocysts, which are constant. *Chilodon fluviatilis* n. sp. differs from all other forms in its shape, and its preference for water not entirely still. *Chilodon caudatus* n. sp. has the postero-terminal border of the dorsum continued as an acuminate and rigid spur which, with the prominent anterior lip, renders this infusorian readily recognizable. *Dexiotricha* n. gen. approaches nearest to the Bursariadæ of Stein; but diverges widely from the members of that family in the absence of the conspicuous, excavate peristome field, and especially in the presence of the row of adoral cilia on the right-hand side instead of the left, and in the presence of a ciliated pharynx, a feature to be distinguished only under high amplification and the most favourable position of the infusorian and the direction of the illuminating ray. One species, *D. plagia* n. sp. is described.

Dr. A. C. Stokes also describes and figures * the following.

*Atractonema tortuosa* n. sp. differs from the hitherto only known species, *A. teres* Stein, in being less fusiform. The single flagellum arises within the pharyngeal passage, a point on the wall, presumably the roof, serving as the basis of attachment. In *Notosolenus*, primarily described by the author as *Solenotus*, although an oral aperture has not been actually discerned, yet the appearance of what seems to be a short pharyngeal tract is so constantly present that an oral orifice probably exists and the animalcules must be removed from the neighbourhood of Stein's *Colponema* and placed near Dujardin's *Anisonema*. In *N. sinuatus* n. sp. the appearance of a pharyngeal tract is more clearly defined than in the other species, and the infusorian is by far the largest of those hitherto observed. *Paramœcium trichium* n. sp. is nearest to *P. bursaria* (Ehr.) S.K.,

* Amer. Natural., xix. (1885) pp. 433-43 (10 figs.).

but differs from it conspicuously in form, especially in the apparently oblique curvature of the anterior extremity, in the absence of the truncation of the same part, the absence of the rapid and continuous circulation of the endoplasmic contents, and particularly the green coloration of the cortex and sarcode. Trichocysts are very abundant. *Cyrtolophosis* n. gen. forms and inhabits singly or several in company a very soft, shapeless, coarsely granular zoocytium. This sheath or zoocytium appears to be formed primarily by a thin exudation from the creature's body, that would be nearly invisible were it not for the extraneous particles that adhere to the surface, and especially for the zooid's excrementitious matter which seems to be the principal building material, and the cause of the coarsely granular aspect. The infusoria are ovate in form and entirely ciliated. One species, *C. mucicola*, is described. *Euplotes carinata* n. sp. differs from all other species in the number of the frontal styles, the character and arrangement of the anal styles and caudal setæ, and in the shape of the carapace, which has a very conspicuous keel or high acute ridge traversing the dorsum from the frontal to the posterior borders. In conclusion, a corrected drawing of *E. plumipes* Stokes is given and the species described.

**Infusorial Parasites of the Tasmanian White Ant.*** — Mr. W. Saville Kent describes the parasitic Infusoria from the intestine of the Tasmanian white ant.

Like the types described by Dr. J. Leidy, from the North American white ant, they belong to three distinct varieties.

*Trichonympha Leidyi* n. sp. differs from Dr. Leidy's *T. agilis* in the relative shortness of the hair-like cilia which clothe the entire surface of the body. The mouth of *Trichonympha*, left undetermined by Dr. Leidy, is shown by Mr. Saville Kent to take the form of a transverse slit developed upon one side of the body at a short distance only from the apical extremity. It is followed by a narrow œsophageal track which opens into the capacious digestive cavity that occupies one-half or two-thirds of the posterior region of the body. When placed in diluted milk the adult and immature forms of both the American and Tasmanian species, have a habit of anchoring themselves by means of the long fascicle of hair-like cilia that are produced from their posterior extremity.

Of the two remaining Infusoria, the one is apparently referable to Leidy's genus *Pyrsonympha*, while the other belongs to Stein's *Lophomonas*, so far recorded as a parasite only of *Blatta* and *Gryllotalpa*.

**Unstalked Variety of Podophrya fixa.**†—Dr. E. Buck describes the form of the unstalked variety of *Podophrya fixa* as being rounded; four phases in its life-history were observed. In the first or swarming stage the plastids consist of a finely granular parenchyma, the body is rounded at either end, somewhat constricted in the middle, and has a round projecting nucleus. In the second or *Sphærophrya-*

* Papers and Proc. Roy. Soc. Tasmania, 1884 (1885) pp. 270–3. See also Ann. and Mag. Nat. Hist., xv. (1885) pp. 450–3.

† Ber. Senck. Naturf. Gesell., 1884, pp. 298–314.

stage the tentacles developed from, as it seemed, the middle of the ventral surface; food was taken in abundantly, but there did not seem to be any parasitic habit. The third stage is that of the free *Podophrya*, in which the body forms an elongated ellipse, and has the two tufts of tentacles carried to either end of the body, the form of which varies with the amount of food ingested. The fourth phase is that of the fixed or *Acineta* condition, which is entered upon by the organism surrounding its hinder end with a kind of gelatinous material, which gradually elongates into a more or less tail-like process. The gelatinous material gradually increases in consistency, and takes on a cup-shaped or infundibular form.

**Pseudo-cyclosis.***—Under this heading Dr. S. Lockwood describes the movement of the food-particles (green unicellular algæ) that he witnessed in a specimen of *Amœba diffluens*, and which at first sight he mistook for the phenomenon of cyclosis.

"As the *Amœba* advances, the green bodies are left in a cluster at its hinder part. Now the *Amœba's* movement stops, and now the little spheroids begin rushing in a well-defined stream towards the advanced portion of the protoplasm. . . . Again the containing body advances, and those contained recede—that is, are left at the hinder part of the protoplasm. We notice also a resting of the host, and the rush forward of the smaller bodies. The *Amœba* again advances, this time but a very little. It seems even to recede. Really it contracts, then spreads out unsymmetrically on two sides, producing an object not unlike the ankle and foot. Now comes the usual rest succeeded by the movement of the contained bodies, which this time start in two streams, the smaller group towards the heel and the larger to the toes of the so-called foot. This alternating of the two kinds of activities is quite interesting to witness: the streaming inner movement always obeying two facts—following a rest of its own, and taking the occasion of a rest of the *Amœba*."

In every instance the food-propulsion was a movement in the direction of the outward or forward flow or progression of a part of the *Amœba*, and this was always followed by an illusory recession, that is a seeming stream of the little algæ backward caused by the advancing protoplasm leaving these objects behind until the new pseudopodium rested, when the trend of the little bodies immediately advanced.

The object of this movement is to bring the food into actual contact with every molecule of the gelatin body, thus making the entire body take part in the process of digestion, and securing to the whole an equal alimentary distribution.

**New Protozoon.**†—Mr. T. Deecke describes an unnamed protozoon which produced perforations in the plates at the bottom of a water-tank made of tinned copper. Furrows radiated irregularly from these perforations as if excavated by a graving tool. The holes and furrows were filled out with an earthy material, consisting mostly of carbonate of copper. When a small piece, still moist, was placed in

* Amer. Mon. Micr. Journ., vi. (1885) pp. 46-7.
† Scientific American, ii. (1884) p. 136.

the centre of a drop of water on a life-slide provided with a circular air space, and covered with a cover-glass, the clear water surrounding the opaque mass was filled in a short time with a protozoon belonging to the Protamœbæ. It was not difficult to see them, in all possible shapes and sizes, creep out from the dark mass and wander slowly toward the margin of the drop bordering the air space, and the more numerous they were the more the air contained in the water was consumed. This is a very convenient method, the author adds, to which he has often resorted for bringing micro-organisms, which live in hiding places, into view. It is air that they, like all living beings, need for their existence, and the scarcer this becomes in the isolated drop of water the more they approach from the centre of the drop to its margin, which remains in contact with the air.

The protamœbæ observed differ from the ordinary species, not so much in the peculiar shapes they assume as in the dark colour of their contents, or rather in the presence of a dark, finely divided substance imbedded in the otherwise transparent and colourless gelatinous little mass. By the action of dilute hydrochloric acid, under the development of a gaseous product (carbonic acid) the dark contents are dissolved into a colourless fluid, while the bodies of the protamœbæ mostly assume more or less spherical forms, resembling drops of oil.

"Considering the great numbers in which these micro-organisms are present, their peculiar mode of life by adhering to, and of locomotion by slowly creeping over a surface, their feeding by the simple extension of their sarcode body over any material in their way, a process very likely associated with some secretory function, it seems quite probable that they exert an observable influence wherever they happen to locate. This influence is probably of a mechanical as well as of a chemical nature. When the material which fills out the furrows is removed, the perfectly pure metallic surface of the copper is brought to view, as if acted upon by the use of an acid. Thus, at first, as it seems, the copper is dissolved in minute quantities, which afterwards, by the interchange of the acid with the carbonic acid of the lime salt contained in the water, forms a soluble organic lime compound and carbonate of copper, the latter of which is deposited in the furrows. That a portion of this as a comparatively indifferent material is taken by the protamœbæ is not surprising. They certainly do not feed on the copper. Its presence is merely accidental, and the whole phenomena, as I believe, should be looked upon from this point of view. The species, even if brought into existence only by this peculiar combination of circumstances, may be regarded as distinct, since it has developed peculiar qualities and a mode of life of its own. The origin of the protozoon is easily explained, and must be sought in the rain-water which occasionally flows into the tank, carrying down from the roof of the buildings microscopic forms of life."

The author suggests that perhaps in other similar cases hitherto ascribed to galvanic action or that of air and water, processes associated with micro-organic life are of greater importance than has been recognized.

**Development of Monocystid Gregarines.***—Herr G. Ruschhaupt has been closely studying the Gregarine which is found in the testicles of *Lumbricus agricola;* the species of Gregarines found in earthworms are *Zygocystis cometa*, *Monocystis magna*, *M. cristata*, *M. porrecta*, *M. cuneiformis*, *M. agilis*, and *M. minuta*, the characters of which are described by the author.

Encystation of solitary forms was very frequently observed, the cuticle of the Gregarine forming the outer envelope of the cyst, while the subcuticular sarcocyst formed a second inner envelope; *M. porrecta* frequently, and *M. cuneiformis* sometimes complete their development within the sperm-mother-cells of the *Lumbricus*. Observations made on *M. magna* showed that the sporoblasts were formed in the neighbourhood of the nucleus, and afforded *pro tanto* evidence against the formation of sporoblasts by budding at the periphery of the cyst. Attention is directed to the presence of macrospores and microspores within one and the same cyst; the "restmasse" of the spore or nucléus de relicat is seen to represent the true germ, and may be compared to what is to be seen in the ova of more highly differentiated animals. The author was on three occasions able to observe the entrance of spores into the sperm-mother-cell; within it there occurred the following set of changes: the rapidity of these changes were, it may be premised, dependent on the state of maturation of the spore; the spore filled its shell as a homogeneous and clear mass of protoplasm which was inclosed by a quite fine envelope; changes began to be apparent in the shell itself, which were similar to those observed in degenerating spores; at last the contents were naked. Later on these exhibited amœboid movements of a highly differentiated character.

In conclusion the author discusses the connection between the Gregarines and the generative products of the earthworm, the infection of earthworms with Gregarines and the relations between these parasites and coccidia.

## BOTANY.

### A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

#### *a.* Anatomy.†

**Circulation and Rotation of Protoplasm as a means of Transport of Food-material.**‡—Dr. H. de Vries points out that the process of diffusion acts so slowly that it can be of no practical importance in determining the transport of food-material from one part

* Jenaisch. Zeitschr. f. Naturwiss., xviii. (1885) pp. 713–50 (1 pl.).

† This subdivision contains (1) Cell-structure and Protoplasm (including the Nucleus and Cell-division); (2) Other Cell-contents (including the Cell-sap and Chlorophyll); (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ Bot. Ztg., xliii. (1885) pp. 1–6, 17–26.

of the plant to another. During the brief duration of a summer night the whole of the starch accumulated during the day in the large leaves of *Helianthus* and *Cucurbita* passes through the leaf-stalk into the stem. Researches into the rapidity of diffusion show that if this process were the sole cause of the movement it would take months or even several years to accomplish. The author is of opinion that it is effected mainly by the rotation and circulation of the protoplasm.

In order to determine the wide distribution of these phenomena, the author subjected a number of plants to examination. In *Tradescantia rosea* he found these movements in the conducting cells of the phloëm of the vascular bundles; in this instance a true rotation passed up one longitudinal wall of the cell and down the other wall, the movement being at the rate of 0·2–0·4 mm. per minute. The movement was observed in the young half-developed branches, in all the internodes of the stem, in the central veins of the leaves and of the leaf-sheath, and in the rhizome and roots, always in the parenchymatous cells, the rotation of the protoplasm carrying with it the microsomes, chlorophyll-granules, and starch-grains. A movement of circulation was equally universal in the epidermal cells of all organs, and one of rotation in the xylem-cells and in the young, thin-walled, but very elongated elements of the stiffening-ring.

Similar phenomena were observed in *Tropœoleum majus*, *Cucurbita Pepo*, *Elodea canadensis*, *Hydrocharis morsus-ranæ*, and *Limnocharis Humboldtii*, in some cases also in the young bast-fibres, the wood-cells, and the epidermal cells; all intermediate stages being noted between typical rotation and circulation. The movement is, however, most easily seen in the conducting-cells of the phloëm.

The author concludes that movement of the protoplasm is a universal phenomenon in tissues adapted for the accumulation and conduction of food-material; and that the protoplasm, not only in special cases or during particular periods of life, but everywhere and so long as it is active, has portions which are in motion.

**Division of the Cell-nucleus in Plants and Animals.***—M. L. Guignard continues his researches on this subject, and has further established the identity of the process of indirect division in the two kingdoms. He finds the highest of the vegetable types, and the one which displays most completely the analogy with the animal kingdom, in the nucleus of the embryo-sac of *Lilium candidum*.

The nucleus is composed of a single filament, the folds of which frequently anastomose to form a network; and the author considers that the difference on this point between the views of Prof. Strasburger and M. Flemming is apparent rather than real. The granulations or chromatic microsomes are arranged in a single row in the hyaloplasm of the filament. Their size varies not only in different filaments, but even in the same.

The nucleoli, from their first appearance, present distinct reactions, showing that their chemical composition differs from that

* Ann. Sci. Nat.—Bot., xx. (1885) pp. 310–72 (4 pls.). See this Journal, iii. (1883) p. 864; iv. (1884) p. 915.

of the chromatic granulations; they are not really comprised in the hyaloplasm, but probably contain a certain quantity of the chromatin of the nuclear filament. On attaining a certain size they detach themselves from the folds of the filament; their presence can only be detected with certainty when their volume considerably exceeds that of the largest of the chromatic granulations. Their function in the life of the nucleus is at present unknown.

The nuclear membrane is sometimes extremely delicate, as in the endosperm, sometimes thicker, as in the large nucleus of the embryo-sac. It is composed of a single layer of granulations, which may be isolated from the cytoplasm. The currents between the nucleus and the cytoplasm are the result of osmosis; the cytoplasmic reticulum and the framework of the nucleus are both in intimate connection with this membrane. It is achromatic and derived from the cytoplasm.

As regards the chemical composition of the different parts of the nucleus, they may be divided into two groups, although their exact nature cannot at present be determined. The chromatic granulations of the filament, which alone enter into the constitution of the nuclear plate, contain the nuclein of Zaccharias, or the soluble nuclein (in caustic soda) of Miescher. The hyaloplasm and nucleoli are composed, according to Zaccharias, of insoluble nuclein or plastin.

In the process of indirect division of the nucleus, Strasburger has adopted a distinction into three phases:—prophasis, metaphasis, and anaphasis; Guignard prefers to admit simply progressive and regressive phases, with the separation of the elements of the nuclear plate as the culminating point.

The first change is usually to be observed in the nucleus itself; this is much less often preceded by a striation of the surrounding cytoplasm. This change consists in the formation of the knot (*peloton*), the folds of which gradually contract and thicken. The nuclear membrane becomes more visible; and towards the end of this stage two rows of chromatic granulations are sometimes seen in the hyaloplasm of the filament.

The segmentation of the filament takes place most often before, less often after, the disappearance of the membrane. As soon as the segments are formed, the doubling of the chromatic granulations in the hyaloplasm makes itself manifest. At whatever time this doubling takes place, the segments have always the form of a ribbon at the moment when their longitudinal fission is about to take place in the nuclear plate. In pollen-mother-cells and in the embryo-sac their halves remain recognizable after the formation of the two rows of chromatic granulations.

When the nuclear membrane is resorbed, the cytoplasm penetrates into the nuclear fluid. The achromatic threads of the spindle are then formed at the same time as the poles, which always appear as if situated, not in the interior of the nucleus, but in the cytoplasm itself. The threads, which are continuous from one pole to the other, are derived entirely from the cytoplasm in all cases in the vegetable kingdom which have yet been observed; while in the salamander and

hydra, the nuclear hyaloplasm takes part in their formation. In the embryo-sac of *Lilium* the amphiaster is visible before the poles act as centres of attraction ; in other cases it originates later.

When once the nuclear plate is completely formed, the longitudinal fission of the chromatic elements commences at the extremity nearest to the centre; the two halves, separating more and more, glide in the direction of the poles. With complete separation the progressive phases of the division end. This is the stage designated by Flemming metakinesis.

The regressive phases commence with the movement of the two chromatic groups towards the poles, between which remain the threads of the spindle. In each group the rods form together a radiate figure, the star (*étoile*) of the daughter-nucleus. Arrived at the poles, the rods contract and curve in various directions, so as to bring their free ends into contact, which then unite so as to form a continuous filament from one pole to the other. Finally, the contraction and reconstitution of the filament is succeeded by the separation of the folds, accompanied by the formation of the nuclear fluid and membrane. The chromatic granulations become distinct in the hyaloplasm, at the same time that the nucleoli make their appearance in contact with the folds. The filaments may now remain as such, or may be converted into a new network resembling that of the parent nucleus.

**Changes in the Cell-walls of Epidermal Cells and in the Hairs of Pelargonium zonale.***—In the course of an article on this subject containing a very large amount of detailed observation, Dr. C. Frommann makes the following statements with regard to the intercellular protoplasm :—Many intercellular spaces, together with the cleft-like prolongations into which they run out, are so densely and uniformly filled up by granular protoplasm throughout their entire contents, and are, as it were, thus stopped up, that it is impossible to make them absorb water. In cases where the cell-walls are penetrated by threads which connect the parietal intracellular protoplasm with that contained in the intercellular spaces, it is impossible to doubt that the latter has pre-existed as such. There are sometimes small intercellular cavities filled with protoplasm and situated beneath the cut surface, completely surrounded and isolated by cellulose, where there is no possibility of the protoplasm being detached portions which have forced their way in. The granules and threads inclosed in a slightly refractive layer of cellulose by the solidification of the intercellular spaces, which are yet distinctly differentiated, show the same properties as those which still lie free in the intercellular spaces. Even after the intercellular spaces have become completely solidified, chlorophyll-bodies and denser protoplasm-granules can sometimes be distinguished in them, even when the fine granules and filaments have completely disappeared or become indistinguishable. It is evident that in these cases also the protoplasm imbedded in the cellulose must have previously existed free in the intercellular spaces.

* Jenaisch. Zeitschr. f. Naturwiss., xviii. (1885) pp. 597–665 (2 pls.).

**Carnoy's Biology of the Cell.***—In this work Prof. J. B. Carnoy arranges his account of the structure of the cell under three heads :—The protoplasm and its contents; the cell-membrane; and a general account of the entire cell. The book on the nucleus consists of three chapters, treating of the chemistry of the nucleus, its structure when at rest, and its morphography. The nucleus consists, according to the author, of a membrane, a protoplasmic portion (reticulum and echylema) and a nuclein-filament, which contains the nuclein, and forms, in typical nuclei, a continuous thread, but may break up into pieces of various form, or may become absorbed and disappear altogether. In his account of the structure of the nucleus, the author differs in some essential points from that of Strasburger. He maintains that outside the nuclein-filament is a protoplasmic network, out of which the spindle-threads are produced by division. He states also that the nucleoli are sharply differentiated from the nuclein-elements by containing no nuclein. The nucleolus forms a kind of reserve of nuclear protoplasm, and disappears altogether when the nucleus divides. The "para-nucleolus" of Strasburger is the nucleolus itself.

**Decomposition of Solutions of Chlorophyll by Light.**†—Dr. J. Reinke describes a series of experiments on this subject, from which he derives the general conclusion that the groups of rays of the solar spectrum may be arranged in the following series according to their power of decomposing chlorophyll :—red, orange, violet, yellow, blue, dark red, green. This series shows further that the power of any given rays to decompose chlorophyll is a function of the degree of their absorption in a solution of chlorophyll. The absolute maximum of the curve of this power coincides with the maximum absorption between the lines B and C; from here the curve falls rapidly to the ultra-red, more slowly through the orange and yellow to the green, where its minimum again coincides with the minimum absorption, rising then, through the blue, to a second smaller maximum in the violet. The separate values obtained by observation for alcohol-chlorophyll and benzol-chlorophyll nearly agree; alcohol-chlorophyll does not show any stronger decomposibility in the blue and violet than benzol-chlorophyll does, which might have been expected, because in the former the absorption between F and G is increased by the greater proportion of xanthophyll.

The curve of the action of the colours of the spectrum is perhaps a function of the absorption in pure chlorophyll; xanthophyll does not appear to act as a sensitizer in this process. The author claims to have shown that the decomposition of chlorophyll by the rays of the sun is in proportion to the absorption of the latter; and chlorophyll no longer furnishes an exception to the general law with regard to substances sensitive to light.

* Carnoy, J. B., 'La Biologie Cellulaire : Etude comparée de la cellule dans les deux règnes. Fasc. 1. Technique microscopique.' 8vo, Lierre, 1884, 271 pp. and 141 figs.

† Bot. Ztg., xliii. (1885) pp. 65–70, 81–9, 97–101, 113–7, 129–37.

**Spectra of the Pigments of Green Leaves and their Derivatives.***—Herr R. Wegscheider gives particulars, in the form of comparative tables, of the position of the bands and the maximum of absorption in the cases of the spectra of (1) the living leaf; (2) tincture of chlorophyll; (3) alcoholic solution of the crystallized chlorophyllan obtained by Tschirch; (4) the pure chlorophyll of Tschirch; (5) the alkali-chlorophyll of Tschirch; (6) the $\gamma$-xanthophyll of Tschirch in etherial solution.

**Red Pigment in Flowering Plants.**†—Dr. J. Wortmann replies to the statements on this subject by Dr. H. Pick, many of which he considers to rest on erroneous observation. Especially he objects to Pick's view on the influence of the red pigment in the transport of starch, in which he neglects the fact of the difference in the objective intensity of rays of the same wave-length which have passed through media of different colours.

**Identity of the Orange-red Colouring Matter of Leaves with Carotine.**‡—M. Arnaud has prepared from the leaves of the spinach the orange-red colouring matter called by Bougarel erythrophyll. After purifying by repeated distillations in benzine it appears in small flattened rhombic crystals, dichroic, and with the iridescence of certain anilin colours. He finds this substance to be identical in its crystalline form, its solubility, its fusing point (168° C.) and in other characters, with carotine, the red colouring matter of the carrot, to which Husemann gives the formula $C_{18}H_{24}O$. The same substance occurs also in the leaves of the mulberry, the peach, the sycamore, and the ivy, and in the fruit of the gourd.

**Formation of Starch in the Leaves of the Vine.**§—In pursuance of the experiments of Prof. Sachs‖ on the formation of starch in leaves, Sig. G. Cuboni has made a series of observations on its presence in the leaves of the vine. In March and April, when the leaves are first formed, starch was never found, even in bright sunshine. It first made its appearance in May, and the quantity increased continually till July. This is not solely dependent on difference in temperature, since starch is still formed in the leaves at the end of October and in November; while even in the height of summer the young leaves and shoots are not able to form starch until they are at least a month old. It depends, however, to a certain extent on the maturity of the chlorophyll-grains. In a leaf containing no starch at the outset, abundance was found after an hour's exposure to the direct action of the sunlight; and the maximum quantity was obtained by two hours' intense sunshine. Four hours of complete darkness is sufficient to cause the whole of the starch to become absorbed.

Although the youngest leaves are unable to form starch, the

* Ber. Deutsch. Bot. Gesell., ii. (1885) pp. 494–502.

† Bot. Ztg., xliii. (1885) pp. 39–43. See this Journal, iv. (1884) p. 257.

‡ Comptes Rendus, c. (1885) pp. 751–3

§ Rivista di Viticoltura ed Enologia Italiana, ix. (1885) p. 13. See Naturforscher, xviii. (1885) p. 224.

‖ See this Journal, iv. (1884) p. 589.

maximum development is not obtained by the lowest leaves on a branch, but by those on the middlemost nodes; on a branch containing sixteen leaves by those from the seventh to the eleventh, the lowest showing less than half the maximum power of production.

If an annular incision is made above and below a leaf, separating the elements of the soft bast, the starch in the leaf is not absorbed and transformed in the dark; but if a similar incision is made only below or only above the leaf, the ordinary process is not disturbed; and this is also the case if a leaf separated by an incision on both sides has a panicle of fruit or flowers opposite it on the same node. No starch is formed if the leaves are etiolated or attacked by *Peronospora viticola.*

**Starch in Vessels.***—Dr. A. Fischer records the abnormal occurrence of starch in vessels in the leaves of *Plantago major.* He found them only in the vessels of the leaf-stalk, not in those of the veins of the leaf itself, and mostly only in the spiral vessels of the stronger bundles. Portions of these vessels were filled with starch-grains, while in other parts they were entirely wanting.

**Presence of Manganese in Plants.†**—According to M. E. J. Maumene, manganese occurs in small quantities in most vegetables. Tea is particularly rich in manganese, from 0·5 to 0·6 p. c.; so also is tobacco, especially the Kentucky variety, which contains from 1·5 to 1·6 p. c. Both yellow and red cinchona bark appear to contain more than traces of manganese.

**Nutritive Properties of the various portions of the Grain of Wheat.‡**—M. A. Girard states that of the three parts of which the grain of wheat may be said to consist, viz. (1) the integument, including the outer envelope of the endosperm, (2) the endosperm, and (3) the embryo, the value for nutritive purposes resides almost exclusively in the second. Both the integument and the embryo contain a considerable proportion of nitrogenous substance; but this is chiefly in the form of cerealin, a substance almost valueless for nutritive purposes from its insolubility. Its fermenting properties render cerealin absolutely injurious in the making of bread. The embryo contains in addition an easily oxidizable oil, which has a very prejudicial effect in promoting the rapid decomposition of the bread.

**Assimilating Cavities in the interior of Tubers of Bolbophyllum.§**—Prof. E. Pfitzer describes the structure of the remarkable *Bolbophyllum minutissimum,* from Port Jackson, one of the minutest flowering plants. One of the most remarkable features is the occurrence in the disk-shaped tubers of peculiar chambers opening out into the external air only by a narrow cleft, the epidermal layer

* Bot. Ztg., xliii. (1885) pp. 89–95.

† Bull. Soc. Chim., xlii. pp. 305–15. See Journ. Chem. Soc.—Abstr., xlviii. (1885) p. 421.

‡ Ann. Chim. et Phys., iii. (1884) p. 289. See Naturforscher, xviii. (1885) p. 44.

§ Ber. Deutsch. Bot. Gesell., ii. (1885) pp. 472–80 (1 pl.).

of which is abundantly provided with stomata, and which apparently serves for purposes of assimilation. Similar structures were found in a previously undescribed species, *B. Odoardi*, from Borneo.

**Idioblasts containing Albuminoids in some Cruciferæ.***—Herr E. Heinricher describes the structure of peculiar cells found beneath the epidermis in the leaves of *Moricandia arvensis*, not readily distinguishable in the living state from the ordinary assimilating cells, but easily differentiated on treatment with alcohol, when their contents are seen to be chiefly, if not exclusively, of an albuminoid character; they contain neither sugar, starch, nor tannin. In *Moricandia* these peculiar cells occur also in the floral organs with the exception of the petals and stamens; and the author has detected them also in four other species belonging to the tribe Brassicæ of Cruciferæ, viz. *Diplotaxis tenuifolia*, *Sinapis alba* and *nigra*, and *Brassica Rapa*, where they are found within the assimilating parenchyma of the leaf, and in the deeper layers of the cortex of the stem and root; in *Diplotaxis tenuifolia* even in the pith.

These cells are certainly not excretion-receptacles, and it is doubtful whether they serve physiologically for the formation or for the storing-up of albuminoids. Morphologically they appear to be most closely related to laticiferous tubes, and are possibly derived from these organs by degradation, thus indicating a phylogenetic affinity with the allied order of Papaveraceæ.

**Annular and Spiral Cells of Cactaceæ.**†—M. P. van Tieghem describes the structure and arrangement of these cells, the latter of which may be arranged under three types, all found in different species of the genus *Opuntia*. In *O. flavicans* the stem possesses four fibrovascular bundles separated by large rays, and surrounding a small pith. In these rays and pith the spiral and annular cells are found in large numbers, but not in the bundles themselves. After the formation of the secondary tissues the four fibrovascular bundles are very narrow, but strongly elongated radially, and are separated by four large fan-like secondary rays, which are composed exclusively of spiral and annular vessels, the secondary wood being again entirely destitute of them. The same is the case in *O. flavicans* and *cylindrica*. In *O. tunicata*, on the contrary, these cells are localized in the primary and secondary wood, and are wanting in the pith and rays. The same mode of distribution occurs in the genera *Mamillaria*, *Echinocactus*, and *Melocactus*. *O. Salmiana*, *pubescens*, and some other species display a combination of these two arrangements, the spiral and annular cells forming a more or less thick continuous sheath enclosing the wood, and they are also found in the primary and secondary wood. Finally, in *O. Ficus-indica*, *brasiliensis*, and in most species with flattened stem, these elements are altogether wanting.

As far as their structure is concerned, they are living cells, with perfectly closed cell-wall, protoplasmic body, and nucleus. They constitute in fact a remarkable kind of parenchyma.

* Ber. Deutsch. Bot. Gesell., ii. (1885) pp. 463–6 (1 pl.).
† Bull. Soc. Bot. France, xxxii. (1885) pp. 103–5.

**Formation of Secondary Cortex.***—M. E. Heckel describes the peculiar structure of the wood of a young branch of *Sarcocephalus esculentus* from Tropical Africa. During the various stages of development of the primitive cortex to the condition of definite secondary cortex, all the initial layers disappear in succession, either by compression or by giving rise, by cell-division and multiplication, to new zones, two of which have a permanent existence. A cortex is thus again formed, constituted definitely of two tissues of secondary or even tertiary formation, entirely destitute of liber, the place of which is taken, from a physiological point of view, by certain elements which have become sclerotized. The author believes this structure to be not uncommon in tropical woods.

**Pericycle of the Root, Stem, and Leaves.**†—According to M. L. Morot, there exists in all flowering plants, outside the central cylinder of the root, between the endoderm and the outermost part of the fibrovascular bundles, a layer of tissue, of the same origin as the pith and the medullary rays—the pericycle. It is the most important part of the internal conducting system of the root, from the secondary and tertiary formations to which it gives birth, and from the frequent absence of the pith in consequence of the fusion of the primary bundles, and also of the medullary rays. Although most often reduced to a single layer of cells, it sometimes constitutes a layer of considerable thickness. It is usually homogeneous, but sometimes contains secreting canals. It is from the pericycle that the secondary roots always proceed; and it may, by the repeated divisions of its cells, produce cork, secondary parenchyma, and secondary or tertiary fibrovascular bundles.

The presence of the pericycle is nearly as invariable in the stem, where it may also persist in the absence of the pith and medullary rays. The only instances of its being entirely wanting are in certain aquatic plants of degraded structure. Occasionally it forms a separate envelope round each bundle; in the vast majority of cases it constitutes a continuous sheath round the whole of the central cylinder. It usually consists of a number of layers of cells, but is sometimes reduced to only one. Its structure is more complex than in the root. Sometimes it remains entirely parenchymatous; but it is most often partially sclerotized, and then contributes largely to the constitution of the stereome of the stem. In addition it may inclose laticiferous vessels, resiniferous cells, and secreting canals. Like that of the root, the pericycle of the stem may generate new tissues. From it proceed underground or aerial lateral roots; or it may develope intercalary vascular bundles between the primary ones, cork, secondary parenchyma, and centrifugal layers of meristem.

The pericycle occurs equally in the leaves, where it is inclosed, like the endoderm, between the bundles, rarely forming a complete ring round them. Its composition varies greatly as in the stem; it

* Bull. Soc. Bot. France, xxxii. (1884) pp. 95–9 (1 pl.).
† Ann. Sci. Nat.—Bot., xx. (1885) pp. 217–309 (6 pls.).

rarely forms new tissues, but it may be the seat of the formation of adventitious roots.

The recognition of the pericycle as a distinct element in the constitution of the root, stem, and leaves, greatly facilitates the distinction between the central cylinder and the cortex. The innermost layer of the cortex is the endoderm; but this frequently loses the special characters by which it is ordinarily distinguished, and the boundary of the cortex can then be determined by the pericycle, which is always recognizable by the presence of scleric elements and by its generating power. It also serves to define more exactly the position and constitution of the liber. To this latter have frequently been erroneously referred certain lignified elements which really belong to the pericyclic layer between the outermost portion of the bundles and the endoderm. Furthermore the recognition of this structure permits the place of formation to be exactly defined of elements hitherto referred to various anatomical regions. A good illustration of this is afforded by Van Tieghem's observations * that the oleiferous canals of Umbelliferæ, Pittosporeæ, and *Hypericum*, originate in the pericycle, equally in the root, stem, and leaves; while the laticiferous vessels of Cichoriaceæ have their origin in the pericycle in the stem and leaves, in the liber in the root.

**Changes of Structure in Land-Plants when growing submerged.**†—Herr H. Schenck describes these changes, which are especially pronounced in the case of *Cardamine pratensis* when growing entirely submerged in water. They are all in the direction of the structure of the organs and of the tissue in plants which grow ordinarily beneath the surface of the water. The leaves acquire long stalks; the mechanical elements are greatly reduced; the cuticle of the epidermis being thin, and the fibrovascular bundles reduced in size, especially the xylem. On the other hand, the assimilating tissue of the leaves is much more strongly developed, the cells of the mesophyll being rounded and very loosely associated.

**Epidermis of the Leaves of Aquatic Plants.**‡—M. J. Costantin disputes the statement of Brongniart and Jussieu that the leaves of aquatic plants are destitute of an epidermis. This statement rests on the hypothesis that epidermal cells do not contain chlorophyll, and that the leaves of aquatic plants do not possess stomata; but the author points out that both these assertions can only be accepted with a considerable amount of exception. He states also that the number of stomata varies in leaves of precisely the same character in the same species, and that the water surrounding the leaves has a direct influence on the formation of stomata.

**Structure of Ranunculaceæ.**§—M. P. Marié has made a close examination of the structure of the different organs in the various genera and subgenera of Ranunculaceæ, which he describes in detail,

* See this Journal, iv. (1884) pp. 767–70.
† Ber. Deutsch. Bot. Gesell., ii. (1885) pp. 481–6 (1 pl.).
‡ Bull. Soc. Bot. France, xxxii. (1885) pp. 83–92.
§ Ann. Sci. Nat.—Bot., xx. (1885) pp. 5–180 (8 pls.).

giving also a number of characters which are common to the whole order, in the form and arrangement of the stomata, the structure of the tissues, arrangement of the fibrovascular bundles, &c.

**Opening of the Anthers in Ericaceæ.***—Mr. H. H. Rusby describes the position in which the pores are found through which the pollen escapes from the anthers in this order, which differs materially in the different genera. The basal position of the pores in some genera, and their apical position in others, depends on variations in the mode in which the filament is folded in the bud. The "horns" attached to the anthers have an important function in determining the direction in which the pollen is discharged.

**Anatomy of the Leaf in Vismieæ.†**—M. J. Vesque gives details of the anatomical structure of the leaf in the four genera which make up this tribe of Hypericaceæ. They are characterized by the stomata being accompanied by two parallel cells at the mouth, by stellate hairs with conical or cylindrical rays, by rounded schizogenous glands in the mesophyll, canaliform glands in the pericycle and secondary liber, and by agglomerations of crystals.

**Reduced Organ in Campanula.‡**—Dr. E. Heinricher describes a peculiar structure, hitherto unnoticed, in the epidermal cells, most commonly of the upper surface of the leaf, of *Campanula persicifolia*. They consist of protuberances of the cell-wall nearly in the middle of the outer wall of the cells, often projecting considerably into the cell-cavity; corresponding to these were frequently also projections from the outer surface of the cell-wall. This species has two distinctly marked forms, hairy and glabrous; and the author regards these peculiar structures as reduced trichomes. The application of reagents showed that they do not consist of pure cellulose. They were observed in all specimens examined of *C. persicifolia*, also in *C. grandis* and *patula*.

**Hypertrophy of the Bud-cones of the Carob.§**—M. L. Savastano describes an abnormal growth of the singular organs which he terms "bud-cones" in the carob-tree (*Ceratonia siliqua*) in the south of Italy. Ordinary buds appear in the axil of a branch, and develope either into a branch the following year or into one or two inflorescences during the third year, which rarely bear fruit. At the same time is formed the "bud-cone," which will put forth an annual succession of inflorescences for fifteen or twenty years, after which its activity ceases and it disappears. These bud-cones are subject to a disease which causes them to swell to the size of a wen, producing each year an unusual large number of inflorescences which, however, wither without fruiting, and after a time cease to be produced. These wens are found to consist mainly of a uniform tissue of irregular cells of

* Bull. Torrey Bot. Club, xii. (1885) pp. 16–21 (13 figs.). [The author uses the term "anthesis" incorrectly for the bursting of the anther instead of the opening of the flower.—Ed.]

† Comptes Rendus, c. (1885) pp. 1089–92.

‡ Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 4–13 (1 pl.).

§ Comptes Rendus, c. (1885) pp. 131–3.

large size without any woody elements. The malformation is due neither to the attacks of parasites nor to external causes, nor to a formation of gum, but to simple hypertrophy of the tissues.

**Homology of the Floral Envelopes in Gramineæ and Cyperaceæ.***—Mr. F. Townsend seeks to prove that the pale in the floret of grasses is the homologue of the ochrea and utriculus in *Carex*, and that the latter is a single floral envelope; hence the pale is also single.

The author gives notes on several species of the order Cyperaceæ, more particularly with the view of ascertaining the homology of the parts of the inflorescence; and records a few instances of abnormal development in the order Gramineæ which bear on the subject.

The utriculus of *Carex*, like the inner and lower barren glume of grasses, is always next the rachis, and the position of the subtending bract of the female spike of *Carex* is exactly that of the usually suppressed bract at the base of the spikelets of grasses.

The tendency of the utriculus or ochrea is to become divided, and this division occurs in the lower barren glume of *Festuca*, and also in the pale of grasses generally, which is the homologue of the utriculus of *Carex*; as the fertile glume of the spikelet in grasses is the homologue of the subtending bract of the utriculus in *Carex*. The seta, more or less developed in many species of *Carex*, is the rudimentary development of a secondary axis, while the "acicula" of Dumortier is the terminal portion of the spikelet.

**Bulbils of Begonia socotrana.**†—M. P. Duchartre describes the peculiar bulbils of this species, formed in large quantities on the rhizome. They have a peculiar organization which enables them to develope, after a period of repose, into a new plant bearing flowers and bulbils. This organization is extremely complex, each bulbil containing within it a rudimentary branch, consisting of a well-developed axis to which are attached thick fleshy bodies 4–5 mm. in length, the rudiments of leaves. This structure is itself a store of nutriment for the young plant, its envelope consisting simply of two large but very thin leaf-scales, superposed entirely one on the other, except at the base.

**Petalody of Ovules.**‡—Dr. M. T. Masters describes a remarkable case of malformation in *Dianella cærulea*, belonging to the Asparagaceæ, from Australia. The flowers are very much more densely crowded than in the normal form, and in a large number of the flowers a multiplication of perianth-segments has taken place at the expense of the stamens and carpels, but with scarcely any intermediate forms. In other flowers the amount of change has been much less; the perianth retaining its normal condition while the thickened fleshy filament is replaced more or less completely by a slender ribbon-like stalk, to which the anther is dorsifixed instead of basifixed. The ovary is transformed from a trilocular condition with axile to a

* Journ. of Bot., xxiii. (1885) pp. 65–74 (19 figs.).
† Bull. Soc. Bot. France, xxxii. (1885) pp. 58–63.
‡ Nature, xxxi. (1885) pp. 487–8.

unilocular condition with parietal placentation. But the most remarkable changes are in the placenta, consisting in the outgrowth from the ventral suture of two narrow parallel longitudinal plates of a bright blue colour extending the whole length of the carpels. In flowers in which this petalodic condition of the placenta is present, there are no ovules in carpels which are closed and unilocular, while in cases where the ovary is still trilocular ovules in a very rudimentary condition are present, reduced to a funicle and irregular plate of cellular tissue more or less blue in colour, but without any nucellus. This is the first instance recorded of petalody or of any form of phyllody of ovules in Monocotyledons.

**Haberlandt's Physiological Anatomy of Plants.***—The special characteristic of this work is that it brings prominently forward the function of the various kinds of tissue, classifying them as formative, epidermal, mechanical, absorptive, assimilating, conducting, accumulating, aerial, and secreting. It will illustrate the treatment to mention that such terms as bast, cambium, &c., are not used by the author as defining tissues found in special positions, but as tissues performing special functions.

**Behrens's Text-book of General Botany.†**—The speciality of this text-book (translated from the German and revised by Prof. P. Geddes) is the abundant detail in the account of the morphology of the various organs of flowering plants. Under the head of Physiological Botany large space is devoted to the phenomena of pollination and fertilization, and the illustrations are numerous and good.

### β. Physiology.‡

**Production of Male and Female Plants.§**—Dr. H. Hoffmann has attempted to determine the conditions under which male or female individuals are produced in the case of the following dicœcious plants:—*Lychnis diurna* and *vespertina*, *Valeriana dioica*, *Mercurialis annua*, *Rumex Acetosella*, *Spinacia oleracea*, and *Cannabis sativa*. He finds that in most, if not all these cases, dense sowing increases the proportion of male plants produced, and this results from an insufficient supply of nutriment. As a general law, the production of male plants is promoted by the want of an adequate supply of food when in an embryonal condition.

**Fertilization of Naias and Callitriche.‖**—According to Dr. B. Jönsson, the fertilization of the Naiadaceæ is purely hydrophilous, and takes place in the following way. The flowers are either monœcious or dicœcious; in the monœcious species the male flowers are

* Haberlandt, G., 'Physiologische Pflanzen-anatomie im Grundriss dargestellt,' 140 figs. 8vo, Leipzig, 1884.

† Behrens, W. J., 'Text-book of General Botany,' revised by P. Geddes. viii. and 374 pp., 408 figs. 8vo, Edinburgh, 1885.

‡ This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Growth; (4) Respiration; (5) Movement; and (6) Chemical processes (including Fermentation).

§ Bot. Ztg., xliii. (1885) pp. 145-153, 161-9.

‖ Lunds Univ. Ars-skr., xx. (1884) 26 pp. (1 pl.).

seated higher on the axis than the female, which are mature about the same time; the male flowers being very much the more numerous. When the anther is ripe, the pollen-mass, in which the last ordinary stages of development are suppressed, becomes free; and the elliptic-cylindrical pollen-grains, which are completely filled, except at the two polar ends, with starch-grains, sink in the water in consequence of their greater specific gravity, and are caught by the detaining apparatus of the female flowers. In dicœcious species the process varies only in the pollen having to be carried to the stigma of another plant. When once the pollen-grain is detained, the pollen-tube passes into the canal of the style, by the wall of which it is attracted and hindered in its growth, in consequence of which it becomes separated by collenchymatous septa, so that the rapid access of food-material is prevented. From the conducting tissue at the mouth of the canal, the pollen-tubes usually find their way direct to the conducting tissue at the mouth of the micropyle, whence they reach the wall of the embryo-sac.

In *Callitriche autumnalis* the pollen-grains are round, filled with oily protoplasm, and lighter than water. They are carried actively by the water to the stigma, whence they reach the canal of the style. The difference in the mode of fertilization in *Naias* and *Callitriche* corresponds to the difference in their habit, the former preferring still, the latter running water.

**Influence of direct Sunlight on Vegetation.***—M. Buysman calls attention to the influence of direct sunlight on vegetation, tracing in the first place the effect of the sun's rays in the tropical regions and afterwards in the temperate and arctic zones.

The constant high temperature within the tropics is the cause of the plants being less dependent on the direct solar heat than is the case in the greater part of the temperate and cold zones. Plants in the high northern regions when they vegetate receive more warmth by insolation than is often supposed—1st by the direct solar light itself, and 2nd by the heated surface of the ground. The snow and ice being melted by the sun, the necessary water and humid atmosphere never fail; this is the cause of the luxuriant growth of grass on some places of the Tundra. The flowing water gradually communicates its warmth to the soil, and prevents also nightly radiation.

In the temperate regions vegetation commences in spring when the difference in temperature between night and day is greatest; in the high north this difference is often insignificant because the sun remains above the horizon; but the temperature of the soil being at this time very much lower than that of the objects exposed to the sun's rays, even this great difference is the cause of the very rapid vegetation in sheltered localities and under the influence of the solar light.

**Absorption of Oxygen and Evolution of Carbon dioxide in Leaves kept in Darkness.†**—MM. P. P. Dehérain and L. Maquenne, repeating

* Nature, xxxi. (1885) pp. 324–6.

† Comptes Rendus, c. (1885) pp. 1234–6.

the experiments on this subject of MM. Bonnier and Mangin,* have arrived at somewhat different results. They describe the apparatus used, the plant experimented on being *Euonymus*. Instead of the value of $\frac{CO_2}{O}$ being usually less than unity, they found it to vary from 0·96 (in February) to 1·20 (in April), being most often greater than unity. The cause of this difference the authors suggest to be that the carbon dioxide measured by MM. Bonnier and Mangin included a portion of that formed by respiration. They consider the facts observed to show that in the plant examined a portion of the carbon dioxide given off is the result of internal combustion similar to that which takes place in fermentation.

Commenting on this paper, M. Th. Schlœsing † considers the results obtained by MM. Bonnier and Mangin to be very well authenticated, and points out the singular fact, which he does not attempt to explain, that the proportion of hydrogen in the plant is larger than might be expected to result from the fact that it becomes fixed in the plant along with oxygen in the proportion in which the two together constitute water.

**Variation of Respiration with Development.**‡—As the result of further experiments on the relation between the amount of oxygen inhaled and of carbon dioxide exhaled by plants, Messrs. G. Bonnier and L. Mangin state that the value of the fraction $\frac{CO^2}{O}$ is not constant for the same species in different stages of development; but that at the same stage of development it is always constant whatever the temperature. This corresponds to the law already established by the authors for the relationship between the gases absorbed and exhaled by leaves in darkness.

**Thermotropism of Roots.**§—New experiments on the phenomenon to which Dr. J. Wortmann has given this name,‖ made on seedlings of *Ervum lens*, *Pisum sativum*, *Phaseolus multiflorus*, and *Zea Mais*, have led him to the general conclusion that not merely the tip, but the entire growing region of the root, is sensitive to heat striking it on one side. By the application of higher temperatures, decapitated roots displayed the same energy in their thermotropic movements as normal roots. A similar sensitiveness was shown by the secondary roots of the scarlet runner.

**Air in Water-conducting Wood.**¶—Dr. M. Scheit lays down the following propositions on this subject:—So long as the cell-walls are moist, as is the case with living plants under normal conditions, no air can diffuse through the tracheids; for it can be demonstrated that even under pressure, lasting for weeks, greater than that which is

* See this Journal, iv. (1884) p. 591; *ante*, p. 488.
† Comptes Rendus, c. (1885) pp. 1236–8.
‡ Ibid., pp. 1092–5. See this Journal, *ante*, pp. 94, 488.
§ Bot. Ztg., xliii. (1885) pp. 193–200, 209–16, 225–35.
‖ See this Journal, iii. (1883) p. 873; iv. (1884) p. 588.
¶ Jenaisch. Zeitschr. f. Naturwiss., xviii. (1885) pp. 463–78.

exerted on the plant from without, no diffusion takes place. When the consumption of water is greater than the supply, bubbles, not of air, but of aqueous vapour, arise so soon as the conducting elements are protected from the access of the external air. The bubbles which make their appearance in microscopic sections can only be air-bubbles when the making of the section does not prevent the access of the external air. Even with the water of transpiration no air can reach the woody elements in which this takes place. The escape of bubbles of gas from "weeping" rootstocks and other parts of plants, and the mixture of bubbles of aqueous vapour with those of air, can be explained by the access of the external air on making the section, and to the opening of cells or vessels which are filled with aqueous vapour and impermeable to air when closed. The observations of the author confirm the statement that no bubbles of air occur in the conducting organs of growing plants.

**Ammoniacal Ferment.*** — According to M. A. Ladureau, the ferment which transforms urea into ammonium carbonate occurs in the soil, the air, water, rain, &c. It acts in vacuo as under normal pressure, also under the pressure of three atmospheres, and in the presence of oxygen, hydrogen, nitrogen, carbon, &c. Antiseptics act on this ferment only when present in large quantities; of anæsthetics chloroform only modifies its action.

**Source of the Nitrogen of the Leguminosæ.†**—M. B. E. Dietzell has grown clover and peas under conditions as nearly natural as possible, in pots of ordinary garden soil, in the open air, but sheltered from the weather and watered with pure distilled water. The quantity of nitrogen in the soil, the seeds, and the mature plant was determined, and the result arrived at was that peas and clover do not absorb combined nitrogen from the air. In all cases except two there was an actual loss from 5·1 to 15·32 per cent. of the nitrogen in the soil.

**Absorption of Atmospheric Nitrogen by Plants.‡**—Mr. W. O. Atwater describes a series of experiments in growing peas in a nutrient fluid composed of potassium nitrate, calcium nitrate, calcium phosphate, magnesium sulphate, and chloride of iron, and protected from rain and dew. He finds as a uniform result that the mature plant contains much more nitrogen than it could have obtained from the nutrient fluid and from the store of food-material in the seed. The amount of nitrogen thus obtained from the atmosphere increased in proportion to the supply of nutrient material in the root. In some of the experiments from one-third to one-half of the total amount of nitrogen in the plant must have been obtained in this way.

The author is unable to determine in what form and through what organ this nitrogen was absorbed by the plant, whether as free nitrogen, or as ammonia, nitric acid, or any other compound, and

* Comptes Rendus, xcix. (1884) p. 877.

† Ann. Agronomiques, x. pp. 513–4. See Journ. Chem. Soc.—Abstr., xlviii. (1885) p. 418.

‡ Amer. Chem. Journ., vi. (1885) p. 365. See Naturforscher, xviii. (1885) p. 237.

whether through the leaves or in the nutrient solution through the root; any one of these modes being in opposition to well-attested experiments. A possible explanation seems to be that free nitrogen is absorbed by decaying vegetable substances by the assistance of electricity.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Affinities of Laccopteris.***—The genus *Laccopteris* is formed of several species of fossil ferns the remains of which are found in strata from the Rhætian to the Cretacean, and has been referred to the Gleicheniaceæ. This distribution is confirmed by M. R. Zeiller, who points out that the structure of the sporangia is almost identical with that in *Matonia*. The sori are composed of from 5–11 large sporangia, arranged in a stellate manner, differing only from those of *Matonia* in the absence of the membranous indusium, which may not be constant. The sporangia are furnished with a large complete oblique annulus. The spores have the same tetrahedral form.

**Composition of the Ash of Equisetaceæ, and its Bearing on the Formation of Coal.†**—M. Dieulafait has examined 168 samples of the ash of various existing species of Equisetaceæ collected in different localities. Although the ashes of different species vary considerably in composition, they are all characterized by the presence of calcium sulphate in large excess, and the total absence of alkaline carbonates. The proportion of ash varied from 5·2 to 8·3 per cent. of the fresh plant, and the mean amounts of potassium sulphate and calcium sulphate in the ashes were 12·0 per cent. and 14·3 per cent. respectively. The mean percentage of sulphuric acid was 13·91, whilst the amount of this acid in the ashes of other plants collected in the same places was not more than 1 per cent. These latter ashes also contained a large proportion of alkaline carbonates.

The presence of such large quantities of sulphuric acid in the Equisetaceæ is obviously one of the causes of the presence of sulphur in coal.

**Transitional Equisetum.‡**—Herr A. Töpffer describes an *Equisetum* found at Gastein intermediate between *E. variegatum* and *E. scirpoides*, agreeing in all respects with *E. variegatum* var. *anceps*, but possessing the peculiar "root-felt" of *E. scirpoides*.

### Muscineæ.

**Conduction of Water in the Stem of Mosses.§**—Dr. G. Haberlandt replies to the observations of Herr F. Oltmanns ‖ on this subject. He objects to the experiments of the latter on *Mnium* that he allowed the plant to become too dry; and contends that the central bundle is the organ by means of which the plant raises water out of the soil.

* Bull. Soc. Bot. France, xxxii. (1885) pp. 21–5 (1 fig.).
† Comptes Rendus, c. (1885) pp. 284–6.
‡ Oesterr. Bot. Zeitschr., xxxv. (1885) pp. 121–2.
§ Ber. Deutsch. Bot. Gesell., ii. (1885) pp. 467–71.
‖ See this Journal, *ante*, p. 493.

To this critique Herr Oltmanns * again rejoins, maintaining that even in the case of *Polytrichum* and *Mnium* the power of conduction of the stem is so small that only in an atmosphere of at least 90 per cent. relative moisture is it sufficient to meet the consumption. The internal conduction must therefore in any case be of very subordinate importance.

**Pottia Güssfeldti, a new Moss.†** — Under this name, Herr K. Schliephacke describes a new species of moss from the mountains of the Argentine Republic, of interest as belonging to a European type, and replacing in that country the *P. latifolia* of our Alps. The author dissents from Venturi's proposal to establish from *P. latifolia* a new genus *Stegonia* dependent on the peculiar character of the cells and nerve of the leaf; but proposes, on the other hand, to form under the same name a subgenus of *Pottia* which shall comprise the two species *P. latifolia* and *Güssfeldti*.

**Elaters of Hepaticæ.‡**—M. Leclerc du Sablon defines the part played by the elaters in the dissemination of the spores of the Hepaticæ. He points out the resemblance in the structure and the mode of dehiscence of the sporogonium of Hepaticæ and the anther of flowering plants, and describes the former in detail in the case of *Pellia epiphylla*, *Calypogeia Trichomanis*, and *Frullania dilatata*. As the elater dries it contracts considerably, and the coils of the spiral become closer, expanding again on moistening. The intervals between the coils of the spiral contract more than the spirals themselves, which are lignified. In addition to their contraction, the elaters also change their position when the sporogonium dehisces; before dehiscence they are parallel, afterwards divergent; and this last is the chief agency in violently separating and dispersing the spores.

### Algæ.

**Protoplasmic Continuity in the Fucaceæ.§**—In continuation of his previous observations on the continuity of protoplasm from cell to cell in the thallus of the Florideæ, || Mr. T. Hick now describes the same phenomenon in several species of Fucaceæ, especially *Fucus nodosus* (*Ascophyllum nodosum*), *F. vesiculosus*, and *F. serratus*. In the first species named, in the cortical layers and in the filaments of the central tissue, the protoplasm appears to run uninterruptedly from cell to cell in the longitudinal direction.

At the ends of the cells, i. e. at the point where two adjacent cells are united, there is an annular thickening on the internal wall not unlike a strongly developed ring of an annular vessel. The material of which this ring is composed differs from that of the cell-walls in not dissolving or undergoing gelatinization under the influence of reagents. It seems to resist alike the action of the strongest acids

* Op. cit., iii. (1885) pp. 58–62.
† Ber. Deutsch. Bot. Gesell. ii. (1885) pp. 461–2.
‡ Bull. Soc. Bot. France, xxxii. (1885) pp. 30–4.
§ Journ. of Bot., xxiii. (1885) pp. 97–102 (1 pl.).
|| See this Journal, iv. (1884) p. 101.

and the strongest alkalies, as well as the disintegrating action of a solution of bleaching powder. Within this ring the arrangements are not the same in all cases, but for the most part they conform to one of four types.

1. In the first type the ring surrounds a comparatively wide and open pore, through which the protoplasm is continuous in a single thread. This type is not very common, but isolated cases are to be met with here and there.

2. In the second type a delicate diaphragm stretches across the space inclosed by the ring, and through this the protoplasm is continuous, as through a sieve-plate, by a number of delicate threads. This is perhaps the commonest form of continuity, and bears the closest possible resemblance to that met with in the sieve-tubes of higher plants.

3. The third type agrees with the second, except that continuity is effected by a thin and delicate ribbon of protoplasm which passes through a narrow slit in the diaphragm. This form is not abundant, and appears to be intermediate between the second and the fourth.

4. In the fourth type the diaphragm is complete and impervious, except at the centre, where there is an extremely minute pore, through which a single delicate strand of protoplasm maintains the continuity.

The delicate diaphragm met with at the ends of the cells, like the annular thickening which incloses it, does not swell up under the action of reagents, nor does it stain like the rest of the walls.

In *Fucus vesiculosus* and *serratus* the same phenomena of continuity were observed, both in the layers of cortical cells and in the fibres which arise from them and curve inwards to interlace with the central filaments.

**Fertilization of Cryptonemiaceæ.***—Dr. G. Berthold publishes a monograph of the species of this family of Florideæ found in the Bay of Naples, belonging to the genera *Halymenia*, *Grateloupia*, *Cryptonemia*, *Schizymenia*, *Sebdenia*, *Halarachnion*, *Nemastoma*, *Gymnophlœa*, *Calosiphonia*, and *Dudresnaya*. These are classified by the author under four tribes:—Halymenicæ, including *Halymenia*, *Cryptonemia*, *Grateloupia*, and perhaps *Schizymenia*; Nemastomeæ, including *Dudresnaya*, *Calosiphonia*, *Nemastoma*, and *Gymnophlœa*; while *Sebdenia* and *Halarachnion* each constitutes a tribe by itself.

The vegetative structure presents nothing very remarkable. In most forms there are found at the apex several apical cells, from which, lying side by side, the thallus is constructed. *Dudresnaya* and *Calosiphonia* differ from the remaining genera in presenting only a single apical cell. In none of the Cryptonemiaceæ are tetraspores found on the same individual as the sexual organs.

The mode of fertilization presents in all the genera the same essential features as that already known in *Dudresnaya* and *Polyides*. The lower portion of the impregnated trichogyne is separated off by

* Berthold, G., 'Cryptonemiaceen. Fauna u. Flora des Golfes v. Neapel. Monog. xii., 27 pp. (8 pls.). 4to, Leipzig, 1884.

a septum as the carpogonium. The cells with which the trichogyne or tubes which proceed from it, conjugate, the auxiliary cells, are of two kinds:—fertile, those which, after conjugation with the connecting filaments which proceed from the carpogonium, form cystocarps; and sterile, which do not bring about this result. These sterile auxiliary cells occur in *Dudresnaya*, *Calosiphonia*, and *Nemastoma*, but not in the other genera. When present they are always in the immediate vicinity of the carpogonium, while the fertile cells are often at a greater distance from it. In the Halymenieæ (*Halymenia*, *Grateloupia*, and *Cryptonemia*) the auxiliary cell is homologous morphologically with the carpogonium, and is surrounded by a similar group of investing filaments. Each fertilized carpogonium may give birth to a large number of auxiliary cells for the purpose of forming a cystocarp; and this is especially the case in the Halymenieæ and in *Nemastoma*.

The number of species described is twenty, among which are two new ones, *Gymnophlœa pusilla* and *Calosiphonia neapolitana*.

**Sieve-hyphæ in Algæ.***—Dr. N. Wille states that in the stipes of certain Laminariaceæ, a portion of the hyphæ running through it in a longitudinal direction have long narrow cell-cavities, and that the transverse walls of these cells are perforated in the same way as those of the sieve-tubes of Phanerogams. These sieve-hyphæ are also connected with one another transversely by short branched hyphæ, thus causing a complex system of communication of the sieve-hyphæ with one another, and between these and the assimilating system. The sieve-hyphæ occur also as a middle lamella between the two assimilating layers in the leaves of *Laminaria*; and evidently perform a very important function in the conveyance of nutriment from one part of the plant to another.

These sieve-hyphæ were observed in *Laminaria digitata*, *Clustoni* and *saccharina*. A somewhat similar structure occurs in the leaves of Fucaceæ; and in *Chorda filum*, a similar though less developed system; also in *Chordaria flagelliformis*. In the Florideæ conducting hyphæ of various kinds are also found. In *Cystoclonium purpurascens* the entire conducting system is surrounded by a protecting ring of large thick-walled cells.

**Algæ of Bohemia.**†—Dr. A. Hansgirg enumerates the fresh-water algæ found in Bohemia, which have not previously been observed, and describes the following new species:—*Micrococcus ochraceus*, *Glœocapsa salina*, *Nostoc halophilum*.

**Pelagic Algæ.**‡—Dr. R. F. Solla gives a list of twenty-three species of marine algæ (besides four unnamed) obtained from the island of Lampedusa, and eighteen from the island of Linosa, both off the coast of Sicily. They belong to the families Porphyraceæ, Ceramiaceæ, Spyridiaceæ, Rhodymenaceæ, Hypnæaceæ, Gelidiaceæ,

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 29-31 (1 pl.).
† Oesterr. Bot. Zeitschr., xxxv. (1885) pp. 113-7, 161-6.
‡ Ibid., pp. 48-53.

Rhodomelaceæ, Corallinaceæ, Fucaceæ, Dictyoteæ, Scytosiphonaceæ, Ulvaceæ, Confervaceæ, Valoniaceæ, Bryopsideæ, Codiaceæ, Dasycladaceæ, and Nostocaceæ.

**Rabenhorst's Cryptogamic Flora of Germany (Marine Algæ).**—We have now the completion of this, which constitutes the second volume of the entire work. The last two parts (9 and 10) include the completion of the genus *Cladophora*, and the families Anadyomeneæ, Valonieæ, Dasycladeæ, Nostocaceæ, and Chroococcaceæ, including under the Nostocaceæ the genera *Rivularia*, *Lyngbya*, *Oscillaria*, and others. The mode in which this section of Dr. Rabenhorst's great work has been accomplished reflects the greatest credit on Dr. F. Hauck, to whom it has been intrusted.

**Diatoms and Bladderwort.***—Mr. H. Taylor has forwarded to 'Science Gossip' a slide containing a bladder of *Utricularia* upon or within which are to be seen numerous frustules of diatoms, upon the decomposing endochrome of which he thinks the plant may have fed.

He says that Mr. Darwin, who does not, in his work on carnivorous plants, mention Diatomaceæ being found in the bladders of any of the species, "appears to think the taking-in of food by the bladders is not owing to any voluntary act on their part, but that the different things found in them have merely forced their way in; but as many of these diatoms are stipitate and attached forms, having no power of locomotion, like the free frustules, this looks very much like their being seized by the antennæ round the valve of the bladder, and conveyed or swallowed in." Mr. Taylor is not, however, certain whether the diatoms are inside or outside the bladder, and even if they be inside it still remains to be shown that they are utilized as food by the plant.

Mr. F. Kitton has given his opinion as to the position of the diatoms. Speaking about the slide forwarded, Mr. Kitton says: "The diatoms are, I have no doubt, upon the bladder of the *Utricularia* as the species are all parasitic (and no doubt occurred on other parts of the plant); they could not have been injected by the bladder, as it possesses no prehensile organs which would be necessary to detach the diatoms from their stipes. The following are the species attached: *Gomphonema constrictum*, *Synedra capitata*, *Cocconema lanceolatum*, *Diatome vulgare*." The point, however, is one of some interest, and it would be well if it were thoroughly cleared up by means of the examination of fresh specimens, Mr. Taylor's having been a dried one.

**Structure of the Cell-wall of Diatoms.**†—Dr. O. Müller replies to the paper by Dr. J. H. L. Flögel ‡ which has appeared in this Journal.

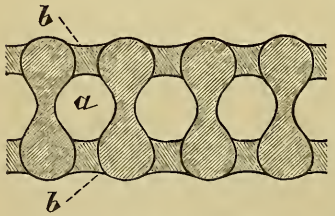
He states the difference between Dr. Flögel's view and his own to be that the former considers he has proved the existence within the cell-wall of *Pleurosigma* of numerous closed cavities corresponding to the well-known polygonal markings on the surface;

* Sci.-Gossip, 1885, p. 164.
† Ber. Deutsch. Bot. Gesell., ii. (1885) pp. 487-94 (1 fig.).
‡ See this Journal, iv. (1884) pp. 505-22, 635-96 (5 pls.).

whilst he objects that these chambers cannot be closed on all sides. This is the kernel of the dispute, everything else is unimportant. Dr. Flögel objects to Dr. Müller's experiments in flooding the walls of the diatoms with fluids of different densities, on the ground that "all the fluids named by him will penetrate the interstitial molecules of thin membranes with the greatest facility"; from this assertion Müller dissents as regards the silicified cell-walls of diatoms, while pointing out the ambiguity of the term "interstitial molecules." He objects also to Dr. Flögel's application of the term endosmose to processes which have not the slightest connection with diosmose, e. g. to the passage of fluid through a porous membrane which is bounded on the other side by air. The fact of the rapid filling up of the chambers and their emptying by evaporation is, according to Dr. Müller, explained in the simplest manner, if the structure of the cell-wall of *Pleurosigma* is regarded as analogous to that of *Triceratium* in this respect, that every chamber is in free communication with the air. This analogy might be carried further, and the author is inclined to assume a double communication, on one side with the outer air or water, on the other side with the cell-cavity. In *Triceratium* this double connection can be proved—outwardly a large circular opening, towards the cell-cavity a number of visible pores; it is very doubtful, however, whether the hypothetical openings in *Pleurosigma* correspond anatomically to those of *Triceratium*.

Dr. Müller considers it most probable that the cell-wall of *Pleurosigma* consists simply of a polygonal network of minute thin bands placed at right angles to the surface, and more strongly thickened at the angles on both sides, inwards and outwards. Both the inner and outer edges of transverse sections would therefore have a moniliform appearance (see fig. 135). A complete separation of the separate "pearls" or transverse sections of the thickened angles can scarcely be expected, since in that case the section must be thinner than the diameter of the openings. In the general way the projections of the margins of the cut openings which lie somewhat higher or lower must unite the separate "pearls" with one another, which will readily give the impression of closed chambers.

Fig. 135.




Diagrammatic representation of *Pleurosigma*. *a*, chambers; *b*, openings.

**Van Heurck's Synopsis of the Diatoms of Belgium.*** — This magnificent work gives a description of every species of diatom as yet gathered in Belgium. The introduction commences with an account of the structure and life-history of diatoms, including their

* Van Heurck, H., 'Synopsis des Diatomées de Belgique.' Texte. 235 pp. 8vo, Anvers, 1885.

mode of reproduction. Then follows a guide to their study, the mode of collection and cleaning, the best instruments to employ in their examination, the most advantageous methods of preparation and media for mounting. A glossary is given of all the terms employed in diatomography, and an account of the best systems of classification, the one followed in the book being that of Prof. H. L. Smith, dependent entirely on the characters of the siliceous envelope, without reference to the endochrome. In the determination of species, since the work is intended for beginners as a guide to the naming of diatoms, the term ("species") is used in its widest significance; a comparatively small number of primitive types being adopted under which the secondary types are ranged. A bibliography is appended; followed by the detailed descriptions of the genera and species.

### Lichenes.

**Structure of Lichens.***—Herr H. Zukal describes the "gonocysts" of *Manzonia Cantiana*, where they occur on the surface of the thallus, and especially on its outer margin. On the blue-green short-celled hyphæ are found globular "capsules" of various sizes, opaque, of a dark colour, and consisting of one, two, four, or more chambers, each containing a green spherical or elliptical cell, or gonidium. Sooner or later the wall of this capsule becomes mucilaginous, and the gonidia are now inclosed by hyphæ from the adjacent thallus, the thallus itself thus increasing in size. In other cases the gonocysts become detached from the thallus, are carried away, and, when reaching a suitable nidus, develope into a new thallus formed from the fragments of hyphæ which remain attached to these. The gonocysts are now formed by gonidia making their appearance on the margin or surface of the thallus, which become enveloped in a thick dark-coloured membrane. The gonidium divides within this "capsule" into a number of daughter-cells, until the wall of the capsule finally becomes absorbed.

The gonangia are roundish bodies, consisting of a brown pseudo-parenchymatous envelope, in connection with a hypha, and containing in their cavity a number of green pleurococcus-like cells, which are not formed either in the envelope or from it. They occur in large quantities in all situations, especially on bark and wood, and are surrounded by the hyphæ, which in the lower cortical layers are colourless and thin-walled, on the surface thicker, brown, and composed of short cells, forming the pseudo-parenchymatous envelope round the gonidia or algal cells. The gonangia apparently assist in the dissemination of the lichens, and are found in those species which inhabit bark, though comparatively rarely.

Many lichens pass, when under certain conditions, into a vegetative condition characterized by peculiar changes in the contents of the hyphal cells. The protoplasm becomes nearly homogeneous, strongly refringent, and has a distinct green tint. It then breaks up readily into regular minute spherical bodies, uniform in size, the

* Denkschr. K. Akad. Wiss. Wien, xlviii. See Hedwigia, xxiv. (1885) p. 13.

microgonidia, arranged in a moniliform manner and filling up the hyphæ. The protoplasmic nature of these bodies can be readily proved; but no cell-wall can be detected nor any green pigment. They may lie for weeks in absolute alcohol or ether without the green colour being removed; this colour depending on a peculiar property of absorption and refraction of these very dense protoplasmic bodies.

In *Verrucaria rupestris* var. *rosea* and *Hymenelia cærulea* the thallus is composed for the most part of branched colourless thin-walled hyphæ, containing a larger or smaller number of bladder-like bodies of roundish, ovoid, pear-shaped, or ellipsoidal form. In the upper zone of the thallus which bears the gonidia, these bladders not unfrequently contain two or four daughter-cells, which are not gonidia although possessing a green tint. With iodine and sulphuric acid the cell-walls of these bladders and of their daughter-cells become yellow, while those of the gonidia turn a beautiful blue.

In *Petractis exanthematica* the alga which forms the gonidia is a *Scytonema*, and the lichen possesses the peculiarity of that genus that the hyphæ are of very different thicknesses. In *Verrucaria fusca* we find also a *Scytonema* in the form of gonidia, and in addition masses of blue-green cells resembling a *Glœocapsa*, and apparently resulting from the breaking up of the *Scytonema*-filaments. The same genetic connection between *Scytonema* and *Glœocapsa* occurs, therefore, within the lichen-thallus as in the free algæ.

The author describes a new genus of lichens, *Eolichen*, with the following characters:—Thallus roundish, gelatinous, pellicular, 1–5 mm. in diameter, adhering to the substratum by the entire surface. The gonidia are species of *Sirosiphon* and *Scytonema;* the hyphæ are segmented in a leptothrix-fashion. Apothecia globular, brownish-red, pellicular, perforated at the apex. Spores in eights, in two indistinct rows, inclosed in a narrow club-shaped ascus. Paraphyses wanting. Three species are described:—*E. Heppii, compactus*, and *clavatus*. In the last species the nutrient alga is a *Scytonema*, in the two others a *Sirosiphon*.

**Algo-Lichen Hypothesis.***—Rev. J. M. Crombie says that "in addition to the various direct and indirect arguments which have been adduced against this theory, another, and in some respects, a still more convincing proof, has quite recently been brought under notice by Dr. Nylander.† In his observations upon *Gyalecta lamprospora* Nyl., a new species from North America, collected by Mr. Willey, of which a full diagnosis is given, he writes: 'Each gonidium of this *Gyalecta* is distinctly seen to emit from its thickish cellular wall (as do also the young gonidia) a firm medullary filament and often two such filaments, characteristic of the nature of lichens. It is most manifest that these licheno-hyphæ are productions, and indeed continuations, of the cellular wall of the gonidium itself.' In the species under notice it may be mentioned that the thallus is not corticated, and that the gonidia are most frequently chroolepoidly

* Journ. of Bot., xxiii. (1885) p. 219.
† Flora, lxviii. (1885) p. 313.

seriated and moderate. Now this very important discovery of the veteran and distinguished lichenist is, beyond all question, sufficient of itself at once to disprove Schwendenerism in all its phases. For if the gonidia thus send forth filaments in the manner stated, then the gonidia clearly cannot be algals; and if licheno-hyphæ are thus produced by gonidia, then these hyphæ as clearly cannot be parasitic fungal mycelia. On these grounds alone (apart from other considerations), this plausible hypothesis necessarily collapses, and 'symbiosis' is seen to be but a mere fable."

## Fungi.

**Classification of Fungi.***—In Cohn's 'Kryptogamen-Flora von Schlesien,' Dr. J. Schröter proposes the division of the Fungi into the three following primary groups:—I. Myxomycetes; II. Schizomycetes (parallel to the Phycochromaceæ); III. Eumycetes, distinguished by their spores being formed by a sexual act. The Eumycetes are again divided into seven families, viz.: 1, Chytridiei; 2, Zygomycetes; 3, Oomycetes (related to the Siphoneæ); 4, Ascomycetes; 5, Uredinei; 6, Auriculariei; and 7, Basidiomycetes. The Basidiomycetes are divided into (1) Tremellinei; (2) Dacryomycetes; and (3) Eubasidiomycetes, which again are made up of (*a*) Hymenomycetes, (*b*) Phalloidei, and (*c*) Gasteromycetes.

**Development of Ascomyces.**†—Herr C. Fisch has studied the structure and development of this genus of Fungi, and especially of a species which he calls *A. endogenus*, formerly known as *A. Tosquinetii* and as *Exoascus Alni*. It is found on the leaves of the alder, but only in the epidermal cells, the formation of asci being usually confined to the under side. The production of asci is preceded by a reticulate condition of the protoplasm, and is first indicated by a slight protuberance in the outer surface of the epidermal cells, which the ascus finally breaks through. The contents of the asci are at first a perfectly homogeneous and finely granular protoplasm, with a moderately large round nucleus, in which, during the formation of the ascospores, the process of nuclear division can be watched with great ease. The commencement is indicated by the appearance of smaller and larger granules in the nucleus, this being immediately followed by the spindle-stage. The number of spindles is always very small; they are thick, and converge strongly at their ends, the whole structure having a barrel-like appearance. In this stage the nucleus differs in nothing except its small size from that in the embryo-sac of flowering plants. In the subsequent stages the processes differ from that in the higher plants, and also from that described by Strasburger in *Trichia*, in the threads which connect the secondary nuclear plates being parallel to one another, and in the invariable absence of a cell-plate. After division, the eight nuclei are distributed nearly uniformly through the ascus, and form the centres of the ascospores.

* Cohn's 'Kryptogamen-Flora von Schlesien. III. Band: Pilze, bearb. v. Dr. J. Schröter. 1 Lieferung. Breslau, 1885.' See Hedwigia, xxiv. (1885) p. 121.

† Bot. Ztg., xliii. (1885) pp. 33-9, 49-59 (1 pl.). See also Bot. Centralbl., xxii. (1885) p. 126.

With regard to the genetic relationship of the genus, the author inclines to the opinion that the three genera *Ascomyces*, *Exoascus*, and *Saccharomyces* should be united together into the group Exoasceæ, the species of which exhibit themselves in three different forms, viz.:—(1) Not parasitic (*Saccharomyces*); (2) growing outside the host-plant, and producing within it asci only (*Ascomyces*, including the species *A. endogenus on Alnus glutinosa*, *A. Tosquinetii* (?), on the same, and *A. polyporus* on *Acer tataricum*); (3) growing outside the host-plant, and producing within it both asci and mycelium (*Exoascus*).

**Nocturnal Spore-formation in Botrytis cinerea.***—Dr. L. Klein records a series of experiments for the purpose of determining why *Botrytis cinerea* (*Peziza Fuckeliana*) forms its spores only in the night-time, under whatever conditions the development takes place. The conclusion arrived at is that the red-yellow half of the solar spectrum promotes, while the blue-violet half acts prejudicially on the formation of spores; and this retardation is sufficiently strong to render the net result in the daytime nil. Lamplight, on the other hand, in which the red-yellow half is stronger, acts as a positive inciter. Darkness favours the formation of spores, as is shown by shutting off the light from young cultures.

**Rabenhorst's Cryptogamic Flora of Germany (Fungi).**—Dr. G. Winter has now (in parts 16 to 18) given a further instalment of Dr. Rabenhorst's important work, still concerned with the Pyrenomycetes (Hypocreaceæ and Sphæriaceæ). This difficult family is being worked out with very great care, the synonymy and literature are referred to, a point of great importance in determining species, and each species is illustrated with well-executed and characteristic woodcuts.

**Zopf's Myxomycetes.**†—Of this most exhaustive account of the structure, development, and affinities of a most difficult group, we can give only the outlines of the classification, viz. A. Monadineæ; mostly hydrophytes, partly parasites; usually with a zoocyst form; plasmodia wanting, or arrested at early stages of development. I. *M. azoosporeæ*. (1. Vampyrelleæ; 2. Bursullineæ; 3. Monocystaceæ.) II. *M. zoosporeæ*. (1. Pseudosporeæ; 2. Gymnococcaceæ; 3. Plasmodiophoræ.) B. Eumycetozoa: aerial organisms, never parasites; plasmodia never wanting, usually highly developed; fructification generally highly developed. I. *Sorophoreæ*. (1. Guttulineæ; 2. Dictyosteliaceæ.) II. *Endosporeæ*. (*a*) *Peritricheæ* (1. Clathroptychiaceæ; 2. Cribrariaceæ); (*b*) *Endotricheæ*; *α*. Stereonemeæ (1. Calcariaceæ; 2. Amaurochætaceæ); *β*. Cœlonemeæ (1. Trichiaceæ; 2. Arcyriaceæ; 3. Reticulariaceæ; 4. Liceaceæ; 5. Perichænaceæ). III. *Exosporeæ*.

Zopf adopts Rostafinski's term, plasmodiocarp, to express sporocysts (or cysts which contain resting reproductive cells) which remain in the condition of plasmodia.

* Bot. Ztg., xliii. (1885) pp. 6–15.

† Zopf, W., 'Die Pilzthiere oder Schleimpilze' (Breslau, 1884) (Schenk's 'Handbuch der Botanik,' in Encyklop. der Naturwissenschaften).

## Protophyta.

**Distribution of Chromatophores and Nuclei in the Schizophyceæ.***—Dr. A. Hansgirg describes a new genus of Cyanophyceæ, *Chroodactylon*, with the following characters:—Thallus small, hemispherical, gelatinous, pale-blue, attached to rocks. Vegetative cells oblong-cylindrical or ellipsoidal, rounded at both ends, united into filiform-cylindrical families more or less irregularly lobed or apparently branched; lobes uniseriate, inclosed in a common colourless gelatinous integument. Cytoplasm homogeneous; chromatophores distinct, star-shaped, central, inclosing globose pyrenoids. Cell-wall colourless, more or less thickened; cell-multiplication by successive transverse bipartition, in one direction only. Spores unknown. The typical species, *C. Wolleanum*, was found on moist siliceous rocks in Bohemia.

*Chroodactylon* is distinguished from most of the blue-green unicellular Algæ by its distinct cell-nucleus, and by the peculiar form of the chromatophores, which inclose moderately large pyrenoids. Both were stated by Schmitz to be wanting in the Phycochromaceæ, but have since been found by Schmitz himself, Zopf, and Lagerheim.

The author claims to have determined that Zopf's *Phragnomena sordidum* is a true Phycochromacea, and connected genetically with other blue-green algæ; also that *Porphyridium cruentum* Näg. (*Palmella cruenta* Ag.) is connected in the same way with *Lyngbya antliaria* Hansg. (*Oscillaria antliaria* Jürg.), and is in reality an *Aphanocapsa*. In both these species are evident nuclei and star-shaped chromatophores inclosing globular pyrenoids. The reason why they have hitherto generally escaped observation is probably that they are to be found only in the living cell, and not in prepared specimens.

It is stated by Hansgirg to be a general rule that in the more highly developed Phycochromaceæ, viz. the Lyngbyaceæ, Calotrichaceæ, and Scytonemaceæ, nuclei, pyrenoids, and chromatophores are not to be found except when they are in a condition of retrogression from the filiform state, and are breaking up into the unicellular condition.

*Chroodactylon* is distinguished from its nearest ally among the Phycochromaceæ, *Chroothece*, by the formation of cell-families branching in an arborescent manner, and by the star-shaped chromatophores with long rays; from *Synechococcus* and *Aphanothece* by the clearly developed cell-wall of the several vegetative cells and by the formation of a common gelatinous envelope which does not deliquesce. Agreeing with all these genera of Schizophyceæ in its cells dividing by transverse septa only, it differs from them not only in the peculiar form of the chromatophores, but also in the cells of successive generations being inclosed in a common branched gelatinous envelope.

With the genus *Chroodactylon* the author unites Thwaites's *Hormospora ramosa* under the name *C. ramosum*.

Chromatophores with inclosed pyrenoids have been detected by

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 14–22 (1 pl.).

Hansgirg also in *Chroothece Richteriana* Hansg., *Chroococcus turgidus* Näg., and *Urococcus insignis* Ktz. (*Chroococcus macrococcus* Rbh.). True chromatophores are not to be found in the filiform conditions of species of *Lyngbya* or *Oscillaria* growing in air or water.

The paper concludes with the description of a new species of *Oscillaria*, *O. leptotrichoides*, found on the walls of hothouses in Prague, associated with *Lyngbya calcicola*.

**Formation of the Spores of Cladothrix.***—M. A. Billet has observed the formation of spores of *Cladothrix dichotoma* in water in which human bones had been macerated. They are formed in the interior of filaments with false ramification, not differing in appearance from the vegetative filaments. When a spore is about to be formed, the protoplasm of the filament, hitherto homogeneous throughout, contracts into a rounded corpuscle of greater refrangibility, resembling a cell-nucleus. This body elongates, contracts in the middle into an hour-glass shape, and then divides transversely into ten cells of rectangular form, each having a nucleus. These rectangular cells round themselves off, and become elliptical sporiferous cells of which the nucleus is the spore with a diameter of 1–1·5 $\mu$. The spores are united together into a zooglœa-like mass, and, on germinating, put out a filament of smaller diameter than that of the spore, which elongates into a new filament.

The reagent used was dilute sulphuric acid (1 part acid to 3 of distilled water); a dilute aqueous solution of methyl-blue and hæmatoxylin being the best staining reagents.

**Aulosira.**†—MM. E. Bornet and C. Flahault describe this genus as forming a remarkable exception to the group of Algæ (or chlorophyllaceous Protophyta) to which it belongs, viz. the Nostocaceæ. While in the other genera, *Anabœna*, *Nodularia*, *Cylindrospermum*, *Sphœrozyga*, and *Nostoc*, the trichomes are naked, or if inclosed in a sheath the latter is soft, gelatinous, and diffluent, the sheath of *Aulosira* is thin, membranous, and dry. The relative position of the spores and heterocysts is not sufficiently constant to be used as a diagnosis of the genera. A new species, *A. implexa*, from Montevideo, is described and figured.

**Microcystis.**‡—Dr. P. Richter gives reasons for suppressing this genus of Kützing, and for regarding it as a resting condition of *Euglena*, which he agrees with Klebs in placing under Algæ (or chlorophyllaceous Protophyta) rather than under Infusoria. Of the four species described by Kützing, *M. Noltii* (red), *olivacea* (olive-brown), and *austriaca* (yellow), may all be determined to be forms of development of *Euglena viridis*, *M. olivacea* agreeing exactly with Klebs's description of the encysted condition of *E. viridis β olivacea*. *M. minor* the author was not able to identify specifically with a corresponding *Euglena*.

* Comptes Rendus, c. (1885) pp. 1251-2.
† Bull. Soc. Bot. France, xxxii. (1885) pp. 119–22 (1 pl.).
‡ Hedwigia, xxiv. (1885) pp. 18–20.

**Degeneration of Yeast.***—M. H. Bungener states that yeast which has been repeatedly employed for fermenting purposes becomes after several generations unfit for further use. This is apparently due to differences in the composition of the wort, especially with reference to its nitrogenous constituents. After each fermentation the quantity of the nitrogen in the yeast increases, as does also its fermenting power; but after a time the fermentation ceases, leaving the cells still suspended in the liquid, and the yeast is no longer fit to use.

**Effect of High Pressures on the Vitality of Ferments and on Fermentation.†**—In continuation of previous experiments on the effect of high pressures on low organisms by M. A. Certes,‡ MM. Certes and D. Cochin state that the vitality of *Torula* is not destroyed by a pressure of 300–400 atmospheres continued for several days. Examination under the Microscope shows no perceptible change in the form or appearance of the cells; and when afterwards brought into contact with saccharine solutions, they multiply and otherwise behave in the normal way. Under the same pressure alcoholic fermentation always takes place after some time. When fermentation occurs under high pressures, the development of carbon dioxide appears to ensue under special conditions of molecular equilibrium.

**Organisms Productive of Zymosis.§**—M. A. Béchamp, *à propos* of communications by MM. Duclaux and Pasteur,‖ claims priority for the discovery of the production of diastases by germs and the *rôle* of these same germs in digestion. He cites passages from the 'Comptes Rendus,' and states that it would be easy to prove by other quotations from the same source that diastase, synaptase, the soluble ferment of the pancreas, pepsine, &c., are equally products of the physiological activity of microzoa, bacteria, or autonomous cells.

**Microbes in the Soil.¶**—Dr. E. Wollny states that the changes, physical and chemical, which take place in earth containing humus, or the organic remains from which it is formed, have important bearings on the fertility of the soil. In well-worked porous and aerated ground the decomposition of organic matter under favourable conditions liberates carbon dioxide, water, ammonia, and a little free nitrogen, some of which combine with the inorganic substances necessary for the growth of the plant. In well-aerated soil little ammonia is formed; it is quickly oxidized to nitric acid. The agent in this nitrification consists of small filiform bodies which are widely diffused in arable soils, but apparently do not exist in the air. If this organism is destroyed by treatment with chloroform or carbon bisulphide, or by heat, the ammonia remains or the nitrites and nitrates are reduced. Heat greatly influences the growth of this ferment; at

* Bull. Soc. Chim., xlii. pp. 567–73. See Journ. Chem. Soc.—Abstr., xlviii. (1885) p. 417.

† Bull. Acad. R. Belg., viii. (1884) pp. 652–4.

‡ See this Journal, iv. (1884) p. 867.

§ Comptes Rendus, c. (1885) pp. 458–61.

‖ See this Journal, *ante*, p. 295.

¶ Bied. Cent., 1884, pp. 796–814. See Journ. Chem. Soc.—Abstr., xlviii. (1885) p. 426.

5° C. the process goes on slowly; at 12° it is clearly perceptible; at 37° it reaches its maximum; at 55° it ceases. Light is unfavourable to their development.

The oxidation of the carbon of organic matter is caused in a similar way by minute organisms, and under conditions very similar to those of nitrification. Treatment with vapour of chloroform, the addition of antiseptics such as carbolic or boric acid or thymol, or a high temperature, very materially retard the production of carbon dioxide. Organic substances used as manures decompose more rapidly in well-aerated sandy or gravelly than in close loamy or argillaceous soil. The reduction of the nitrates already formed must be regarded as a physiological process, dependent on the presence of organisms which do not require oxygen, Pasteur's anaerobes. Deprived of air, the organic matters yield small quantities of carbon dioxide, water, ammonia, free nitrogen, and a carbonaceous black peaty mass, an acid humus difficult of decomposition.

The chemical composition of soils has an important bearing on the decomposition of organic matter; the presence of lime facilitates it greatly. The amount of humus is also a factor; the production of carbonic dioxide does not always proceed at so rapid a rate as at first; and too great a quantity may hinder the activity of the microbes.

**Microbe of Yellow Fever.***—Messrs. D. Freire and Rebourgeon cultivated in bouillon of 38° C. micrococci obtained from the blood of a patient who had died of yellow fever. He found minute hyaline micrococci cells about one-quarter the size of a blood-corpuscle, larger cells of the same kind, and black cells resembling epithelial cells out of which micrococci were produced. Under cultivation the micrococci went through all these stages; the lowermost layers were black, and exhibited, like the black cells found in the dejections, the reaction of ptomain. The dead black remains of these organisms act pathogenetically by the formation of ptomain.

**Micro-organisms as a cause of Diphtheria in Man, Pigeons, and Calves.**†—For demonstrating the presence of micro-organisms in the diphtheritic process, Herr Löffler used the following staining solution:—30 c.c. of a concentrated alcoholic solution of methylen-blue to 100 c.c. of an aqueous solution of caustic potash (1/10,000). It is sufficient to leave sections for only a few minutes in this solution to deeply stain most known bacteria. They are then washed in a 1/2 per cent. solution of acetic acid, dehydrated, clarified in cedar oil, and mounted in balsam.

In twenty-seven cases in which the diphtheritic membrane was examined, two definite species of micro-organism were found—a chain-forming micrococcus and a bacillus. The former was cultivated pure on meat-jelly, blood-serum, and cooked potatoes. It bears a very strong resemblance to the micrococcus of erysipelas, both morphologically and as regards its mode of growth, but is only of secondary importance with respect to the diphtheritic process.

* Comptes Rendus, xcix. (1884) p. 804.
† MT. K. Gesundheitsamte, ii. (1884).

The bacillus could not be grown on meat-jelly or potatoes, but on blood-serum at 37° C. it formed within three days, whitish, opaque colonies, which did not liquefy the serum. The bacilli are of about the same length as the tubercle bacillus, but about twice as thick; they are generally more darkly stained and slightly thickened at the poles. A definite spore-formation was not observed in the cultivations.

A variety of animals were inoculated with the pure cultivation, and in some an appearance was produced at the seat of inoculation, e. g. the formation of a false membrane on the tracheal, conjunctival, and vaginal mucous membrane, which closely resembled the local appearances in man.

Herr Löffler also found on the surface of a condyloma a bacillus which possessed a great resemblance, both morphologically and as regards its pathogenic action, to the bacillus of diphtheria of calves, and gave rise to diphtheritic infection in rabbits.

**Bacteria.***—Herr L. Brieger in a previous paper described the method by which he obtains pure cultures of bacteria from human fæces; the sample was placed in a sterilized half-litre flask in which water had been long boiled, shaken up so as to be finely divided; 20–30 c.cm. of the mixture was then placed in a shallow dish containing 200–300 c.cm. of Koch's peptonized gelatin, slightly warmed, the contents mixed by agitation, the dish covered with another of larger size, but inverted, and so closed as to prevent the entrance of bacteria from the air, and the whole arrangement covered with a bell-glass. The arrangement was kept at ordinary chamber temperature; after a short time micrococci made their appearance in different places, and the species could be isolated. In a previous paper, the author described the bacteria which decompose carbohydrates, and also a coccus which produces ethyl-alcohol from both grape- and cane-sugar, but is not dependent on the last two for its existence, as it also lives on albumen, white of egg, serum-albumen, and fibrin; it has not, however, the power of liquefying those substances, nor does it produce any chemical change in them at any temperature. A bacillus is also described which forms irregular concentric rings on Koch's gelatin, and which, when injected into guinea-pigs, kills them instantaneously; it has not the power of decomposing albumen; it is a remarkable feature of this bacillus, that when left a long time in the nutritive matter its central portions assume a yellowish-white colour caused by an incrustation of salts—no matter whether cultivated on carbohydrates or albumen, at high or low temperatures; when injected into the blood of guinea-pigs it is injurious, but rabbits and mice are not affected; its action on sterilized grape-sugar at 36–38° produces propionic acid.

Other species of bacteria have been obtained by the author from fæces, but are not described.

Experiments were also made with the coccus which has been

* Zeitschr. Physiol. Chem., ix. (1885) pp. 1–7. See Journ. Chem. Soc.—Abstr., xlviii. (1885) pp. 578–80.

described by Friedländer as the excitant of the croupous form of pneumonia; it was cultivated with success in solutions of grape- and cane-sugar neutralized with lime and containing fibrin and nutrient salts, sodium chloride, potassium phosphate, and magnesium sulphate.

The author describes the precautions used in preparing sterilized flasks, &c.

**Bacterium ureæ.***—This microbe, hitherto known only in the micrococcus form, has been observed by M. A. Billet also in the diplococcus, streptococcus, bacterium, diplobacterium, streptobacterium, leptothrix, and vibrio conditions. The different forms may be associated in the same filament, showing that they all belong to a single species. The micrococcus and torula forms occur always in ammoniacal urine; the leptothrix, bacterium, streptobacterium, and vibrio forms are more frequent in acid urine left in contact with the air. In proportion as the acidity diminishes, the elements of a filament divide more and more and separate into elements which are ultimately the micrococcus form.

The most instructive preparations were obtained by the use of methyl-violet B in very dilute aqueous solution, and mounting in Canada balsam or glycerin saturated with tincture of iodine.

**Identity of Bacterium fœtidum (Thin) with Soil Cocci.†**—Mr. Spencer Le M. Moore gives details of experiments affording morphological and chemical proof of the identity of *Bacterium fœtidum* Thin (found on the soles of the feet) with the cocci of surface soil ("corpuscles brillants" of Pasteur). Access of the ferment to the sole of the foot must take place by the penetration of fine dust containing ferment through the seams of boots; for not only is the ferment of universal occurrence in surface soil derived from deposits belonging to all the great geological horizons, but cocci are always to be found upon the feet even under the most cleanly conditions. Whether the ferment has any relation of causation to an abnormal escape of fluid from the soles is a very obscure problem. The soil ferment is possessed of greater chemical energy than is the bacterium.

**Artificial Attenuation of Bacillus anthracis.‡**—Drs. Koch, Gaffky, and Löffler made experiments, as a control of Pasteur's observations, on the attenuation of the virulence of *Bacillus anthracis*, and on inoculation with the attenuated bacilli to confer artificial immunity against the virulent form of splenic fever. The thermostat of Arsonval was used as an incubator. Small pieces of virulent splenic fever material were introduced, with proper precautions, into Erlenmeyer's tubes, and kept at a temperature of 42°–43° C. The alterations in virulence were tested by taking samples of the cultivations, and introducing them directly, or after further cultivation in meat-jelly on glass slides, into mice, guinea-pigs, rabbits, and wethers.

* Comptes Rendus, c. (1885) pp. 1252–3.
† Journ. of Bot., xxiii. (1885) pp. 149–53.
‡ MT. K. Gesundheitsamte, ii. (1884).

Spontaneous attenuation of virulence was only observed in a few cases. Pasteur used as his first vaccine, material which had been kept for 24 days, and as his second, material which had been kept for 12 days at 42°–43° C. The authors used as their first vaccine, material of 24 days, which did not kill rabbits or wethers, but killed mice regularly, and as their second, material which killed mice and guinea-pigs, but did not kill rabbits with certainty, and was quite inert on wethers. Further, a third and fourth vaccine were used. Still two out of five wethers died after inoculation with virulent material; rabbits and guinea-pigs could not, as a rule, be rendered proof against the disease. The authors have arrived at the conclusion that vaccination is only a very doubtful gain as a preventive measure.

**Cholera Bacillus.***—Dr. H. R. Bigelow mentions that out of six guinea-pigs inoculated in the duodenum by Babes, three presented the lesions of cholera; and pure cultivations of the bacillus of Koch were obtained from the intestinal contents. Koch has just introduced a new method of operation without the production of any external lesion, and he reports the cases as completely confirming the view of the pathogenic nature of the bacillus. The method of staining the bacillus in the tissues adopted by Babes consists in cutting thin sections in close proximity to a Peyer's patch, placing them in an aqueous solution of fuchsin for 24 hours, washing in sublimate solution (1–1000), passing rapidly through alcohol and oil of cloves, well drying with blotting-paper, and mounting in Canada balsam.

**Curved Bacilli in Air and Water.†**—In the present state of confusion which exists as to the exact rôle which Koch's comma bacillus plays in cholera, any information on the subject of curved bacilli is of interest.

M. J. Hericourt finds that curved bacilli, some of the same type as the cholera bacillus, are present in all water, no matter what its source. The constant presence of these organisms can only be explained by supposing the existence of their germs in the air, in which they are present in the spore condition. Neutral bouillon and potatoes were sterilized and inoculated with dust from various places, and many curved bacilli developed in all the cultivations. They showed all the described forms, commas, curves, omega, S, spirals, &c. Intestinal dejecta in simple diarrhœa, dysentery, and typhoid fever, broncho-pulmonary secretions in all diseases of the lungs, pus exposed to the air, the saliva of healthy and sick persons, were all found to contain curved bacteria, often in much greater number than other forms of bacteria. Collected first on bouillon or cooked potato, and then cultivated on nutrient jelly, these curved bacilli form rounded colonies with serrated edges, composed of highly refractive granules. These colonies, kept at 20°–22° C., grow in the jelly and liquefy it, producing colonies of the shape of a gloved finger.

* Science, v. (1885) pp. 454–5 (3 figs.).
† Comptes Rendus, c. (1885) pp. 1027-9.

**Woodhead and Hare's 'Pathological Mycology.'***—As in the case of the 'Practical Pathology' of the first-named author, any success which may attend the publication of this work must depend in great measure upon the skill of the artist. Those who visited the Biological Laboratory at the Health Exhibition last year will at once recognize the accuracy of the coloured figures representing the mode of growth of bacteria, most of which were imported from Dr. Koch's laboratory on nutrient jelly, potatoes, and bread-paste. The drawings made from microscopical preparations are artistically executed. In fig. 7 we notice that large numbers of micrococci with capsules stained by gentian violet are represented in sputum from a case of acute pneumonia. A description of the special method, if any, which was used in the staining of this specimen would be interesting as our own experience coincides with that of Friedländer that, though the capsule can be easily demonstrated in the tissues, its presence can hardly be detected in sputum by staining methods.

The description of the processes which are generally useful for staining bacteria is somewhat confused, and we cannot agree with the authors that "Baumgarten's method" (by which the bacteria are examined in an unstained condition) "is undoubtedly one of the most effective, and may be applied to any of the fluids." It must be admitted by any one who has practical experience in the microscopical examination of bacteria, that especially when present in small numbers, they are rendered much more conspicuous when properly stained than when merely treated with a solution of caustic potash. The subject of the cultivation of bacteria leaves much to be desired, as a description of many useful methods of study is omitted. The important question of illumination is dismissed in less than a page. Nevertheless, in spite of its shortcomings, the book will undoubtedly be found a useful guide by those who are unable to refer to foreign literature, and it is probably the best of the very few books on the subject in the English language, though it can hardly pretend to compare with the excellent practical and theoretical works by some of those, such as Hüppe and Pflügge, who have worked under Dr. Koch's guidance for a long time.

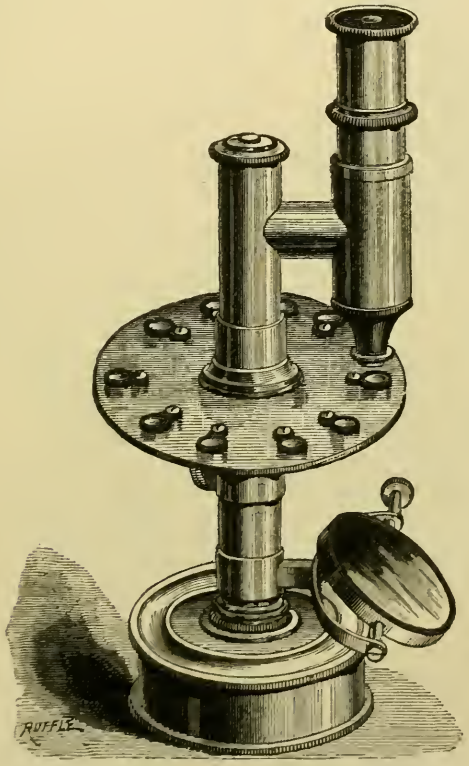
* Woodhead, G. S., and A. W. Hare, 'Pathological Mycology. An inquiry into the Etiology of Infective Diseases.' Sec. I. Methods. x. and 174 pp., 60 figs. 8vo, Edinburgh, 1885.

## MICROSCOPY.

### a. Instruments, Accessories, &c.*

**Revolving Stage Microscope.**—This instrument (fig. 136) appears to have anticipated those of Klönne and Müller and of Mirand figured in this Journal, Vol. III. (1880) p. 144, and Vol. III. (1883) p. 897. No definite date can be assigned to it, but it bears the appearance of

Fig. 136.



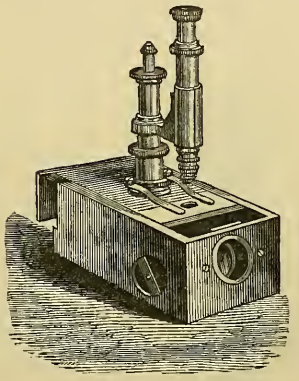

having been made at least twenty-five years ago. It was apparently designed for some special purpose, as the rotating stage is only 4 in. in diameter, and is not adapted to take even the smallest-sized slides. The objects were placed in ten circular apertures (5/16 in. in diameter)

* This subdivision is arranged in the following order:—(1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

in the stage, the bottom of each being closed by a piece of glass. They were protected by a cover-glass, which was held in a pivoted frame, so that it could be turned away from the cell when desired. The instrument is of French workmanship.

The arrangement for focusing is peculiar, the arm carrying the body being raised and lowered by the milled head below the stage at the back.

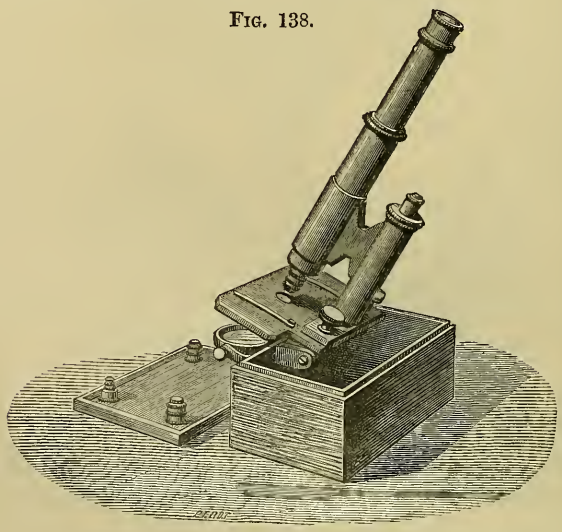
Fig. 137.



**Portable Microscopes.** — The following forms complete, we believe, the history of portable Microscopes, many of which have been already illustrated in the Journal.

*Nachet's Pocket and Portable Microscopes* —The original form of M. Nachet's Pocket Microscope for powers up to 1/8 in., constructed in 1854, is shown in fig. 137. The metal box into which it is packed measures $3\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{5}{8}$ in. In use the Microscope was screwed to the box, as shown in the fig. The mirror is seen through the opening in front, which is closed by a disk of glass. It has a fine adjustment, and for oblique light it is sufficient to slide back the lid of the box as shown in the fig.

Fig. 138.

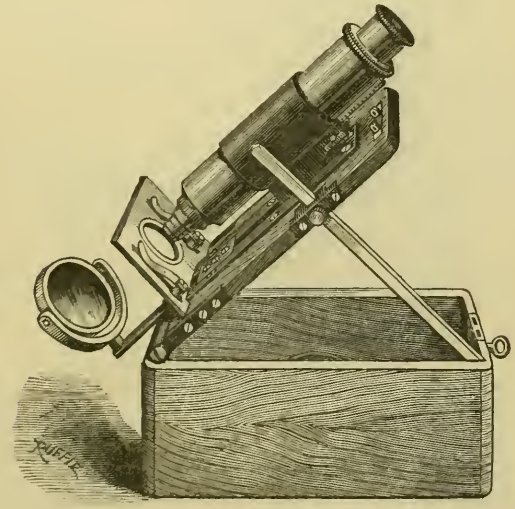


To meet the demand for a portable Microscope of larger size, M. Nachet devised the newer model shown in fig. 138. This when closed

is $5\frac{3}{4} \times 3\frac{1}{4} \times 2\frac{3}{4}$ in. The Microscope is screwed to a metal plate which turns on a hinge joint at the side of the box. This plate forms the stage, and carries a mirror beneath. When the Microscope is removed and placed in the box the plate is turned back on the top of it. A rackwork coarse adjustment has since been added. The Microscope can be inclined, as shown in the figure, or used vertically. To prevent overbalancing, the bottom of the box is provided at each end with a flat brass slide, which can be extended 2 in. in front of the box.

*Collins's Portable Microscope.*—The peculiarity of Mr. C. Collins's portable Microscope (fig. 139) is that it is permanently attached to the

Fig. 139.



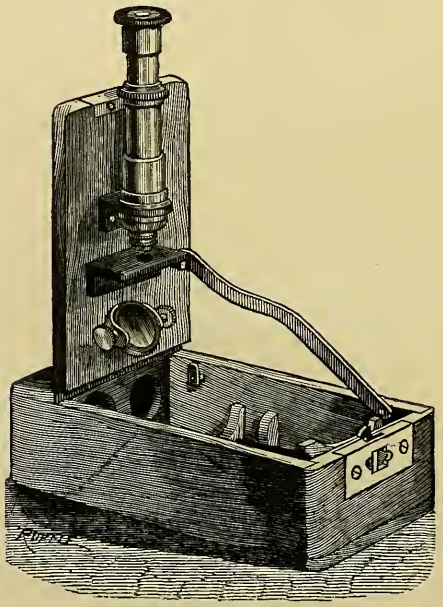
lid of the box, so that no time is lost in screwing it to its support as in other cases. The lid itself is fixed to the box, and has a hinge joint at its lower end by which it can be inclined. A small clamp-screw acting on the brass support fixes the lid, and with it the body-tube, at any desired degree of inclination.

To replace it in the box the mirror is pushed up to meet the stage, the body-tube racked down, and the inclined support withdrawn and allowed to fall into the box. The lid is turned a half-circle on a pivot at the centre of its lower end, so that the Microscope now faces the inside of the box, into which it can then be dropped by means of the hinge on the lid.

*Box Microscope.*—The instrument shown in fig. 140 was purchased in Paris, and was apparently made some twenty-five years ago. Like that of Mr. Collins, the Microscope is fixed to the lid, and when not

in use the body-tube is removed and divided, and the two pieces packed in the box, which can then be closed by the lid. It can only be used upright, as there is no provision for inclining it.

Fig. 140.

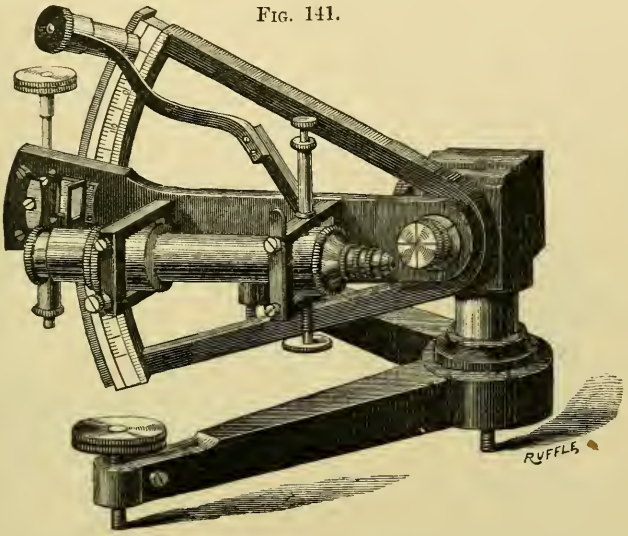


**Pfaff's Microgoniometer.*** — Dr. F. Pfaff's microgoniometer (fig. 141) is practically a theodolite in which the telescope is replaced by a Microscope. A short pillar carries a large block to which the arc, graduated to 58°, is attached. The block has two sockets in faces at right angles to each other, so that the arc can be set vertically, as in the fig., or horizontally. The alhidade can be clamped at any point of the arc by a screw behind the latter, a slight movement being still capable of being imparted to the alhidade by the other milled head. The vernier reads to 4″. The lens is for reading the angles. The Microscope rests in the two frames attached to the alhidade, shown in the fig., and can be depressed or raised at the lower end by a spring screw (so that its axis coincides in direction with a radius of the arc), or moved nearer to or further from the centre of the circle by loosening the side screws in the frames. For microscopic objects a stage (fig. 142) is provided, the bent arm of which

* Pfaff, F., 'Das Mikrogoniometer: ein neues Messinstrument, und die damit bestimmten Ausdehnungscoëfficienten der Metalle,' 20 pp. and 1 pl. 8vo, Erlangen, 1872.

slides in the guides at the top of the block. The milled heads at the end of the feet are for levelling the instrument.

Fig. 141.

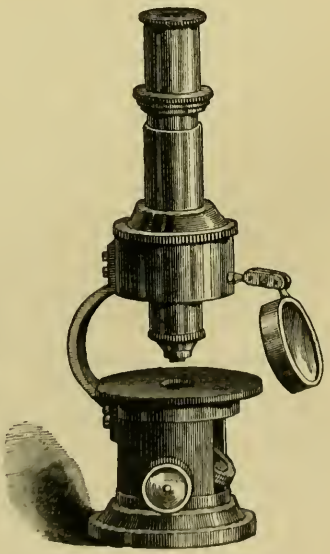



The author claims that the instrument will measure to 1/100,000 of a millimetre, and gives a table showing the dimensions of an object

Fig. 142.

(at a distance of 1 mm. from the centre of the circle) for angles from 4″ to 5°. Directions for use are also given, with remarks on the determination of the coefficients of expansion of the metals.

Fig. 143.



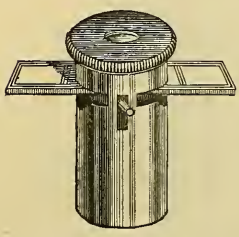
**Double-Drum Microscope.** — In this form (fig. 143), the peculiarity is found of two drums, the one serving as the base of the Microscope, and the other as the support of the

socket for the sliding body-tube. This latter application of the drum has no *raison-d'être* that we can discover, adding nothing to the convenience or stability of the instrument.

**Theiler's "Universal (Achromatic) Pocket Microscope."**—The commendations of Microscopes and microscopic apparatus by what we may term the "lay" press are often very wonderful, and after reading the following descriptions it was not perhaps surprising that we should have become somewhat eager to possess the instrument.

"We have received from Messrs. Theiler and Sons a specimen of their Universal Pocket Microscope, which magnifies 50 diameters. It is a very admirable contrivance, and should be in the hands of all young people."

FIG. 144.



"This instrument is a virtual Microscope, giving beautifully well-defined images, and may be used either by the aid of day- or lamp-light. No one having any interest in microscopy should leave home unaccompanied by such a small and so efficient an instrument. Its cost may be measured in the inverse ratio to its utility and value."

The instrument when received (from Messrs. M. Theiler and Sons, of London) turned out to be the familiar "Taschen-Mikroskop" of the German opticians supplied for many years past. It is shown in fig. 144. The slide is inserted in the slit of the tube by pressing down the spring which keeps it in place. The adjustment of focus is effected by screwing the lens in or out. Some of the German makers supply the instrument to take ordinary 3 × 1 slides.

**Eye-piece Micrometers.***—Mr. H. L. Tolman records that for some months past he and Dr. M. D. Ewell, having been working at micrometry and the relative advantages of the eye-piece and cobweb micrometers, decided to make a series of independent measurements to see which method was superior.

Two slides of fresh blood were prepared under the same circumstances, as nearly as possible, the blood was dried about half an hour in the air of a well-warmed room, and then sealed in a cell, so that the degree of desiccation would be the same, and the measurements were made the same evening, independently. Dr. Ewell used a 1/10 Spencer (homogeneous immersion, N.A. 1·35) with an amplifier and a 1 in. eye-piece, giving a power of about 2000, and Mr. Tolman a 1/10 Spencer (homogeneous immersion, N.A. 1·25) with a 3/4 in. eye-piece, power 1562. The former measured twenty-five corpuscles, the average being 1/3138 in., and the latter measured fifty with an average of 1/3139 in., the difference between the measurements being only 1/985,000, an amount far too little to measure. Mr. Tolman feels pretty well convinced, therefore, that the cobweb micrometer does not offer sufficient advantage in point of accuracy to compensate for its additional cumbersomeness and expensiveness.

* Amer. Mon. Micr. Journ., vi. (1885) pp. 115–6.

In another report* of the measurements the matter is thus dealt with.

"While of course these measurements have no tendency to prove the possibility of identifying blood by the diameter of the corpuscles, they are admissible to show that under exactly the same conditions there is an average diameter of the blood-corpuscles of an individual which varies within exceedingly narrow limits, and that this diameter may be measured with very great accuracy. The limits of error certainly fall within the 1/200,000 in., and probably within the 1/250,000. Whether this average diameter varies from time to time is a question not yet determined."

**Boecker's Holder for Analysing Prism and Goniometer.**—This (fig. 145) serves not only to hold the analysing prism, but can also be used for a Leeson's goniometer.

Fig. 145.

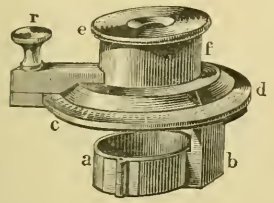
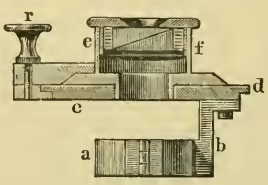



Fig. 146.




The apparatus is attached to the body-tube by the ring *a b*, over which is fixed the divided circle *c d*. Within the latter turns concentrically the tube *e f*, with a bevelled plate on which is the index-mark. This tube receives either an analysing prism or the doubly-refracting achromatic quartz prism of Leeson's goniometer (fig. 146). The rotation of the tube can be prevented when desired by the clamp screw *r*.

**"An Improvement in Objectives."**†—This is another paper by Mr. E. Gundlach, which we reproduce in its original form:—

"Eight years ago I presented to the American Association for the Advancement of Science a description of a new quadruple objective for astronomical telescopes.‡ The general acknowledgment with which the paper was received, and the high estimation of the theoretical principles of the invention by scientific authorities of this country as well as Europe, encourage me to present to this Society a description of another improvement in objectives, which I expect will be of equal value for both the telescope and the Microscope. Although I have unfortunately not had sufficient opportunity for properly executing an objective of the above-mentioned description, and thus practically demonstrating its advantages, I must confess that during the time I have become conscious of a practical defect,

* The Microscope, v. (1885) pp. 113-4, from 'Legal News.'

† Proc. 7th Ann. Meeting Amer. Soc. Microscopists, 1881, pp. 148-52.

‡ See this Journal, ii. (1879) p. 75.

which is, the increased number of lenses. I am now of the opinion that any improvement of objectives which requires additional lenses will always be objectionable, however valuable the improvement may otherwise be.

"The objective which I now wish to describe is free from this defect. It consists of two lenses only, one of crown and one of flint glass, like the ordinary objective. But the formula is based upon a new principle. In my description of the quadruple objective I have spoken of the so-called aberrations of higher order. Let me briefly review this for the better understanding of the following description.

"We know that the flint glass lens of an objective acts merely as a corrector of both the spherical and chromatic aberrations of the crown glass lens; but, owing to this double action, the said correction is, even in its best possible form, imperfect in so far as, when the part or zone lying about midway between the centre and the periphery is just right in correction, then the central part leaves a small remnant uncorrected, while the peripheric zone is already overcorrected. These unremovable remnants or so-called aberrations of higher order are the only cause of those imperfections of the achromatic objective which are dependent on the figure or curvature of the lens, and therefore the best formula for an objective will be that by which these aberrations are mostly reduced. Since the discovery of achromatism nothing has been spared to find by the aid of mathematics the best possible form for the flint glass lens for the correction of the aberrations of the crown glass lens; but for the finding of the proper form, or to better the proportion of curvatures of the crown glass lens itself, there never was a special rule adopted nor theoretical law found after which to obtain the most favorable result. But the calculations were based upon the principle that for any positive crown glass lens a negative flint glass lens can be found, combined with which it will form an achromatic objective in the common sense, and according to this principle no special pains were taken to find the proper form of the crown glass lens.

"My object in this paper is to show that for the best possible construction of an achromatic objective the proper figure or proportion of curvatures of the crown glass lens is an important factor, submitted to a positive theoretical law, and that, as a consequence of the neglect of this law, the present objective is far from having the best possible form. The angular aperture, or, in other words, the proportion of aperture to focal distance of an objective, is limited by the spherical aberration of the crown glass lens, because the latter greatly increases with the increase of the angular aperture, and consequently the aberrations of the higher order are increased. But this limit can be extended, if the spherical aberration of the crown glass lens can be, without change of focal length and diameter, reduced by a mere change of curvature, because this reduction involves a corresponding reduction of the aberrations of higher order. According to this we can imagine two achromatic objectives which are equal in focal distance and aperture, but although the flint glass lens of both have the best possible form for correction of the aberrations of their

respective crown glass lens, one of the lenses is superior to the other in the correction of the aberrations of higher order, because the spherical aberration of the crown glass lens is less than that of the other.

"We now arrive at the question whether the spherical aberration of the crown glass lens of the present achromatic objective can be reduced by a mere change of proportion of curvature, and if so, what is the theoretical law after which this proportion must be found? This law, which I have found by careful study, may be expressed as follows:—The spherical aberration of a lens for rays of given direction will be a minimum if the proportion of the curvatures of the refracting surfaces is such by which the angle of refraction of the medium ray at the interior surface is equal to that at the emerging; or, in other words, by which the angle of the perpendicular inclination of the medium ray at the entering surface is equal to that of the emerging surface. If the rays entering a lens are parallel or nearly so, as is the case with the telescope, then they will, after having passed through the lens, be changed by refraction to a converging direction toward the focal point of the lens, and to be equal in perpendicular inclination upon their respective surfaces. The entering or first surface will certainly have to be of correspondingly shorter curvature than the emerging or second surface. For a lens of a relative focus and diameter, as the crown glass lens of the present telescope, the radius of the curvature of the inner surface will have to be about twice as long as that of the outer surface, to fulfil the condition of minimum spherical aberration. But we are familiar enough with the construction of our present objective to admit that just the contrary is the case, that is, the curvature of the outer surface of the crown glass lens is by far the longest. If the crown glass lens is reversed, so that the inner or shorter curved surface is brought outside, toward the parallel rays of the object, then the form of the lens would much nearer fulfil the conditions of minimum spherical aberration. But then, of course, the flint glass lens will no longer have the proper form as a correcting lens; it would now over-correct the spherical aberration of the crown glass lens, and therefore a more flat long curved form of the same would be required. If the exact form or curvature of minimum aberration of the crown glass lens, as well as that of the correcting flint glass lens, as found by calculation, is compared with the present objective, it will be found that the aberrations of higher order in the new objective are reduced to about one-third of the old one, and a corresponding gain in the definition and reduction of colour, or otherwise an extension of the limit of aperture must be the result. Let me right here mention another idea as a further step for improvement of the objective in the same direction as described, that is, a further reduction of the aberrations of higher order.

"I have in my foregoing description given the law after which a lens of minimum spherical aberration for rays of a given direction has to be constructed, and I will here complete this law by adding that: The absolute minimum of spherical aberration of a lens is

obtained, if the refracting surfaces of the same are equal in curvature, and the rays entering the lens are coming from a certain point of the optical axis, being in distance from the lens a little over twice that of its nominal focus, thus meeting at the other side at an equal distance and forming a cone equal to that at the entering side. Now there is a simple way to give the rays, coming from a distant point or object, before entering the crown glass lens of the telescope, a direction which will be nearly adequate to the first-mentioned condition, namely, if the flint glass lens is placed in front of the crown glass lens. The parallel direction of the rays will then, by the negative flint glass lens, be changed into such diverging direction as would correspond with a cone, being only a little shorter than that required for an equal-sided crown glass lens, and the latter will then for minimum spherical aberration have to be very near equal-sided, thus allowing the aberration of higher order to be in higher degree reduced than in the before described objective. But, however, as an objection to this arrangement, it may be mentioned that the flint glass lens will be directly exposed to the external air and liable to oxidation.

"In my foregoing description I have, for the purpose of avoiding complications and giving a clearer understanding, referred to the telescope only; but as the construction of this instrument is submitted to the same theoretical laws as that of the Microscope, little remains to be said about the application of the described new principle to the Microscope. Our present Microscope objectives are all achromatic in the common sense, but they differ widely in angular aperture, and accordingly in definition and resolving power. But the angular aperture is dependent on the correction of the aberrations of higher order; the latter again on the spherical aberrations of the crown glass lenses of the system. If the crown glass lenses are transformed according to the described principle and law of minimum spherical aberration, and then the flint glass lenses so changed as to properly correct the aberrations of the crown glass lenses, the same result will be obtained as with the telescope objective. The extension of the limit of angular aperture will admit of giving the low power objective with long working distance a definition and quantity of light which at present are united only in considerably higher powers of short working distance."

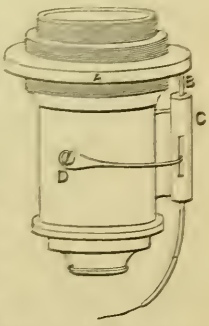
**Care and Use of Objectives.***—Mr. W. Wales uses only an old, soft, silk handkerchief, a small stick of soft wood, a phial of alcohol, and a watchmaker's glass of two powers. A camel's-hair brush can neither completely nor safely remove the film of dust with which the exposed surface of the back combination of an objective is sometimes found to be coated. It will make a series of rings on the surface of the lens, and it may, if grit be present, scratch the glass. Nor should the handkerchief, either wet or dry, be introduced into the tube of any but a low-power objective. The cells must first be unscrewed from their mountings, and then the cleaning can be done properly.

* Journ. N. York Micr. Soc., i. (1885) pp. 113–6.

But an objective ought never to be taken apart by any one but its maker. He has the lathe upon which it was made, and he alone, when the parts have been separated, can replace them in their original adjustment to the optical centre. Any other person will be likely to screw in the cells either too tightly or not tightly enough, and will thus throw the combinations out of their necessarily delicate relations to one another. Besides, unless skill and care be exercised in screwing the parts together, the front and the middle combinations will sometimes be brought in contact, and the flint glass, which is very thin at the centre, will be broken. The screw-thread of the cells is very delicate. Yet some persons, after failing to catch it, apply force enough to break it.

"A large angle oil-immersion lens gets out of order easily. If you find the definition of such objective to have lost its sharpness, you may know that the front lens is out of centre. It has come in contact with the slide. A very slight pressure is sufficient to work the mischief. This susceptibility to injury is unavoidable, as every optician will tell you. It is incident to the requirements of high-angle construction."

Fig. 147.




**Griffith's Mechanical Finger Objective.**—Mr. E. H. Griffith thus describes this apparatus.

The collar A (fig. 147) moves on a fine thread and forces down the bristle-holder B. A slit in C keeps B in position. On turning A back, the spring D lifts the finger. The jacket to which C and D are attached turns on the objective, so that the diatom can be turned as desired. By lifting D the finger can be removed.

The bristle makes a good indicator also.

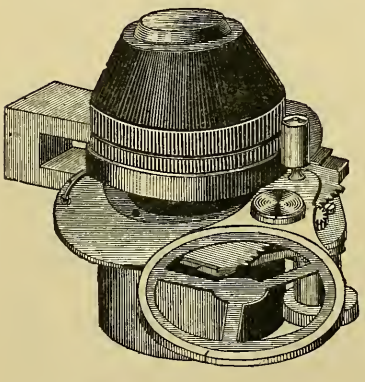
**Right-angled Prism instead of a Plane Mirror.***—Mr. G. Hunt, in reference to Mr. E. M. Nelson's remark †—"Right-angled prisms "are used in telescopes for the purpose of economising every particle "of light; in the Microscope, however, even with a 1/2 in. wick, there "is more light than one knows what to do with"—points out that it is not the *quantity* of the light (which can easily be controlled), but the *quality* which renders the prism preferable. He believes the reflected rays from the posterior silvered surface and from the front unsilvered surface prevent the light from being brought accurately to focus on the object on the stage. This belief is founded on the following experiment.

In the winter time, when the leaves are off the trees, he placed the Microscope with a prism and achromatic condenser at an open window opposite an old oak, about 250 ft. distant. With a little management, the reduced image of the oak formed at the focus of the condenser was viewed by a 1/5 objective. With suitable apertures

* Eng. Mech., xli. (1885) p. 414.
† See this Journal, *ante*, p. 338.

in the diaphragm of the condenser, and in an iris diaphragm fitted on to the lower portion of the condenser between it and the prism, a most exquisite image of the tree was seen. The definition of this was charming, every little twig and incipient bud being distinctly visible. Then, nothing else being altered, a plane mirror was substituted for the prism. "What a change! The larger branches were there indeed, but the slender twigs were involved in hopeless 'fuzz,' which no amount of manipulation could eliminate." The experiment was varied by forming the image of a net window-curtain about three yards distant from the Microscope. With the prism, the picture of the network and pattern was perfect, every detail being exquisitely shown. With the plane mirror, the image was very markedly inferior, though less so than in the former experiment.

Fig. 148.



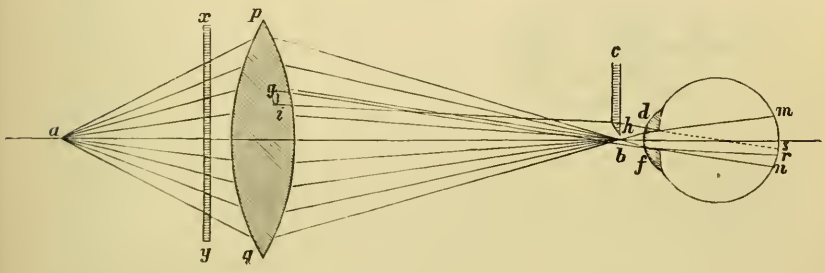
**Zentmayer's Abbe Condenser.***—A simple and inexpensive mounting for the Abbe condenser (shown in fig. 148) has been devised by Mr. Zentmayer, by means of which it can be used with any substage. The milled head, seen below on the right, moves the plate which carries the diaphragms.

**Töpler's Illuminating Apparatus.†**—In the interior of microscopical objects many parts escape observation, not only on account of their small size, but also because very frequently their density differs too little from that of their surroundings, and consequently they influence but slightly the path of the rays. Dr. A. Töpler drew special attention to this subject in 1864,‡ when he described an apparatus called by him "*Schlieren*" (streaks) apparatus, on account of its use for the examination of streaks in glass. *a* (fig. 149) is a point of light sending rays to the lens *p q*; these will be refracted to *b*. To an eye *d f*, which receives all these rays, and is so accommodated that it clearly sees the lens, the latter will appear brightly illuminated. If, however, a diaphragm *c h* is moved towards the point *b*, then at the moment that it passes the point the rays will be entirely shut off and the lens will appear dark. If, however, there is a more strongly refracting point in any part of the lens, e. g. in *g i*, the rays, passing through this point, will not meet the axis at *b*, but nearer to or further from the lens, or will not meet it at all; these rays will then pass by the side of *b*. When the diaphragm is moved forward it will cut off part of the rays before the normal rays are affected, and the spot in question will

* Amer. Mon. Micr. Journ., vi. (1885) p. 84 (1 fig.).
† Zeitschr. f. Instrumentenk., ii. (1882) pp. 92–6 (3 figs.).
‡ 'Beob. nach einer neuen optischen Methode,' Bonn, 1864.

appear somewhat darker than the other portions of the lens; the difference, however, in the intensity of light is so slight, that it would not generally be remarked. At the instant, however, that the diaphragm passes *b* and the lens becomes dark, only those rays remain which in the figure are seen to pass below *b*, and *g i* will appear

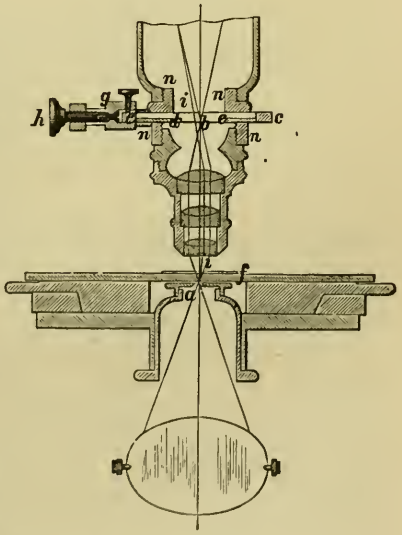
Fig. 149.




brightly illuminated on a dark ground. If *g i* is not in the lens but in a medium before or behind it, as *x y*, the result is precisely similar. The same effect is produced if *g i* has a lower refracting power than the other part of the lens.

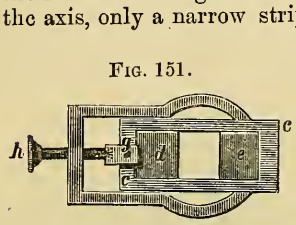
Professor Töpler recently drew Herr W. Seibert's attention to the fact that the same principle might be employed for Microscopes, and the latter has accordingly constructed an apparatus which he says acts admirably with low powers. The semicircular diaphragm *a*, fig. 150 (the straight edge perpendicular to the plane of the paper), is so placed, that its inverted image appears in *b*, at which point a frame *c c* moves in a lateral slit in the nose-piece *n n*. This frame has at *d* a glass plate, unpolished on the under side, and at *e* a thin metal plate with a bevelled edge. The space between *d* and *e* is open, so that in placing the frame in position, as in the figure, all rays proceeding from the object pass without hindrance. The screw *g* holds the frame in position; if it be loosened, the latter can be moved by the hand. The final adjustment is effected (after *g* has been screwed up) by the fine screw *h*. Fig. 151 is a front view of the frame. In ordinary vision through the Microscope the field is brightly illuminated by the rays which,

Fig. 150.



passing the object *f*, reach the objective. All these rays must pass the point at *b* within the diaphragm image. Therefore, by pushing the frame from right to left, when the edge of the plate *e* approaches the axis, only a narrow strip of light from the diaphragm-image will remain, and this will also disappear by a further movement of the frame. At the same instant, the field becomes dark, but the rays remain which deviate in the object towards the left—as in Fig. 150 the ray *i*—and the corresponding points appear bright. Spots in the object are thus easily recognized which would otherwise pass unnoticed in consequence of the brightness of the field. Only those rays are effective which are deflected at right angles to the edge of the frame. The apparatus must therefore be so adjusted that the object can be turned round the optic axis, while all else remains immovable.

Fig. 151.




The manipulation of the apparatus is as follows :—The frame *c c* is placed in a central position so that the open space between *d* and *e* is in the optic axis, and the Microscope is accurately focused on the object. The latter is then pushed aside, so that there is now an open space in the stage under the objective, and the glass plate *d* is brought into the axis. The semicircular diaphragm is now so adjusted that its image appears clearly on the glass, and the straight edge in this image exactly parallel with the edge of the plate *e*, but turned away from it, so that on moving the frame the convex side is first shut off, and finally only a narrow line of light remains. The adjustment of the diaphragm is effected by sliding it up and down. The position of the tube must not be altered, or else, if it is again adjusted to the object, the image of the diaphragm will no longer lie in a plane with *e*, which is an absolute necessity. The frame being now so adjusted that the rays can pass through it unhindered, the instrument is ready for observation. The frame is moved slowly by the screw *h* till the edge *e* meets the optic axis and the direct rays are cut off. The field is now dark, but all points in the object which have a greater or less refractive power are brightly illuminated on the dark ground. If the frame be moved still more, these rays also disappear. The proper moment for observation is, therefore, when all direct light is shut off.

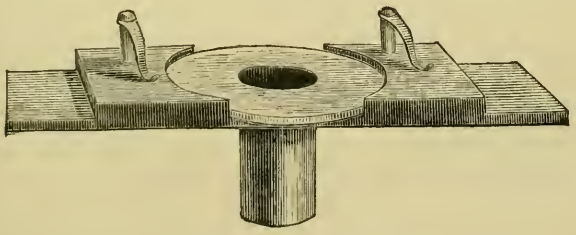
This apparatus is only suitable for low powers ; with high powers many inconveniences arise. The frame must of necessity be brought quite close to the lenses, for if the whole is to be obscured at once, the frame must be exactly at the place where the image of the diaphragm is formed ; if it is further away, only half of the field is effective. The nearer to the lens, however, the greater is the spherical aberration, because the objectives are properly corrected only for an image distance, equal to the length of the tube ; the image of the diaphragm will not be very sharp, and the rays diverted in the object mingle with the indistinct margins of this image. A further inconvenience arises from the fact that in objectives having a focus of 3 mm., the distance between the object and the diaphragm must be so

small, that an ordinary slide cannot be used; and a cover-glass must be used instead. With still higher powers, particularly those with correction, where the frame cannot be brought so near to the lenses, the apparatus is unsuitable. This inconvenience might be avoided by causing a larger, brightly illuminated diaphragm to cast an image and from this to produce a second at *c c*; the first image could then be brought nearer to the object if desired, and the action would be the same as if a real diaphragm were in the place of the image. The author, in order to use the apparatus for higher powers, also describes a modification by which the frame is placed above the eye-piece, where a second image of the diaphragm is formed; but he adds that "this arrangement also is capable of improvement."

In observations with the apparatus, it was remarked that when the field of view was obscured, there was greater penetration. With a bright field, for instance, individual bacteria could only be seen when exactly in the plane of the focus; those in an inclined or perpendicular plane were only seen as points. When, however, the field was darkened by means of the frame, each individual could be followed in its movements.

**Bausch and Lomb Optical Company's "Universal Accessory."**—This (fig. 152) is mainly intended as a remedy for the want of a substage. It consists of a brass base-plate to be laid on the stage,

Fig. 152.



having a central opening surrounded by a countersunk bed, which holds a polarizing prism shown in position in the figure. This can be rotated by the milled edge of its broad circular top. On removing the polariscope a hemispherical lens can be dropped into the opening in the plate, and serves as a condenser or, with a stop placed on it, as a paraboloid. An ingenious arrangement has been adopted to enable the lens to be retained in place. A disk of thin glass of slightly larger diameter than the plane face of the lens is cemented to it (fig. 153) so as to leave a projecting rim. This rim rests on the margin of the opening, and prevents the hemisphere passing through.

Fig. 153.

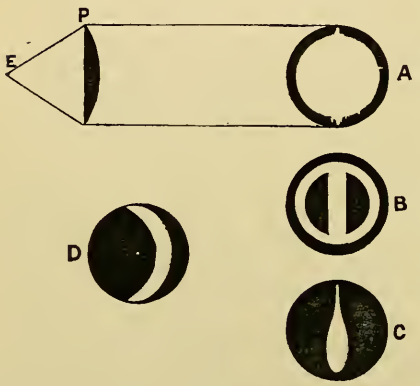
**Illumination.***—Mr. E. M. Nelson writes as follows:—The first step in studying the principles of illumination for the Microscope is to grasp thoroughly the various effects produced by a bull's-eye.

* Engl. Mech., xl. (1884) p. 68 (2 figs.); pp. 157-8 (3 figs.); p. 263 (6 figs.); p. 282 (6 figs.).

A (fig. 154) shows the *effect* produced by centering or placing the edge of a flame (from 1/2-in. paraffin wick) in the exact focus of a plano-convex bull's-eye P.

It is necessary to explain the meaning of the word "effect," for if a piece of card were held in the rays proceeding from P, the picture as shown at A would not be seen; but, instead of it, an enlarged and inverted image of the edge of the flame. Then, one will naturally ask, How do you get the picture A? By simply putting your eye in the rays and looking at the bull's-eye.

Fig. 154.




As this is often disagreeable, by reason of the strength of the light, a more pleasant way of examining the picture is by placing in the rays a condensing lens (the field-glass of a 2-in. eye-piece) and focusing the image on a card. It should be noticed particularly that the *diameter* of the disk A depends on the diameter of the bull's-eye P; but the *intensity* of the light in A on its focal length. The shorter the focus the more intense the light. In making these experiments the condensing lens is presumed to be at a fixed distance from the bull's-eye P.

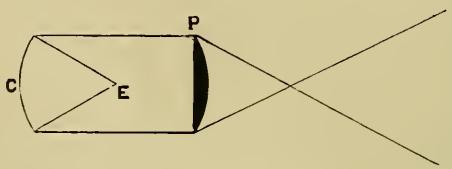
B represents the picture when the edge of the flame E is centered, but *within* the focus of P.

C the picture when E is centered, but *without* the focus of P.

D the picture when E is focused, but *not centered.*

Fig. 155 shows an error often perpetrated, viz. that of putting a

Fig. 155.




concave mirror C at the back of a bull's-eye P, to increase its effect. The rays are brought to a focus and then scattered.

The method of obtaining a critical image with transmitted light by objectives of 1/2-in. focus and less is shown at fig. 156, where E is the edge of the flame from a 1/2-in. paraffin wick, S substage condenser, and P the object. S is centered to, and the image E focused by S on, P. Fig. 157 shows the same thing with the addition

only of the plane mirror *m*. Fig. 157 gives results as critical as fig. 156, it is, however, a little more troublesome to set up, and therefore fig. 156 will be found preferable where the instrument is sufficiently tucked up on its trunnions to permit of its being so used.

Fig. 158 A shows a substage condenser S, and an objective O, focused on the same point; the condenser being of an aperture equal to that of the objective. On removing the eye-piece and looking at the back lens of the objective, it will be seen to be full of light as at C.

Fig. 158 B shows the same thing, but with the aperture of the condenser cut down by a stop. Now only a portion of the back lens of the objective is filled with light. (See D.)

It does not follow that because the back lens of the objective is full of light, as at fig. 158 C, that therefore *the field* ought to be full of light. The field only shows a bright image of the edge of the flame; but it is in the plane of that image where the picture is critical.

If the condenser be racked either within or without the focus, the whole field will become illuminated. At the same time, however, a far smaller portion of the objective will be utilized. On removing the eye-piece, and examining the back lens of the objective, a picture like fig. 154 C, p. 714, will be seen.

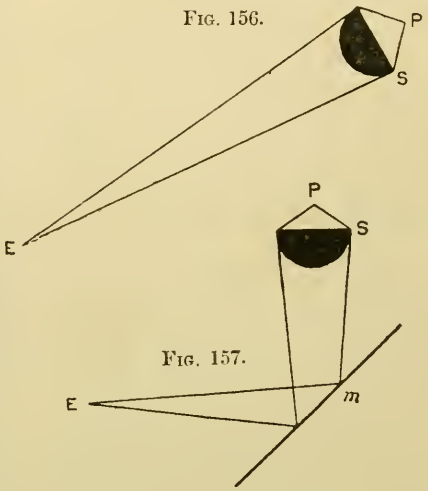



Fig. 156.

Fig. 157.

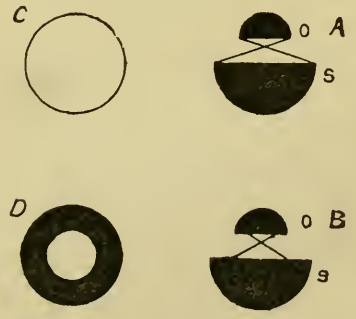



Fig. 158.

Fig. 158 A shows the most severe test that can be applied to a Microscope objective, viz. to fill the whole of the objective with light, and so test the marginal and central portions *at the same time*. Few, indeed, are the objectives that will stand this ordeal. Some fog when half full of light; most when one-third full; and not one in one hundred will bear three-quarter filling.

We now come to some very obvious points—so obvious, indeed,

that one would hesitate to mention them, unless frequently confronted with error.

Fig. 159 shows the correct method of illuminating with diffused day-light, no substage condenser being used. P the plane of the object. C the concave mirror. The mirror is placed at the distance of its principal focus from the object.

Fig. 159.

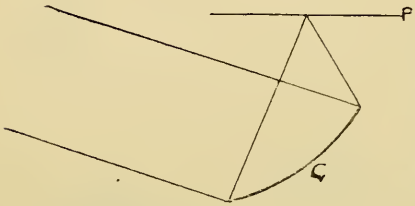



Fig. 160 shows the rough and ready and, I am sorry to say, too often, the usual style.

Fig. 160.

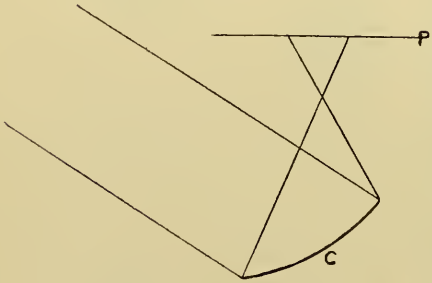



Fig. 161 shows the correct method of illuminating for dark ground, with substage condenser and stops. E, edge of flame; B, bull's-eye; *m*, plane mirror; S, substage condenser.

Fig. 161.

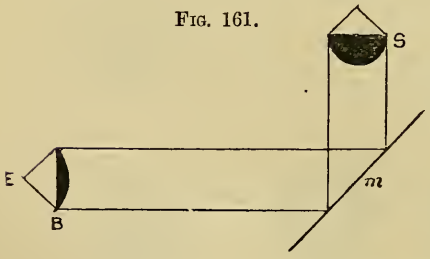
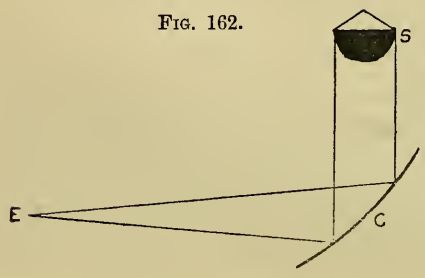



Fig. 162 is another correct method of doing the same thing by using the concave mirror and no bull's-eye. It is seldom used, as it is very difficult to set up.

Fig. 163 shows the error of using the concave mirror with the bull's-eye. Many do it, thinking that they get more light.

Fig. 164 shows the error of not having the edge of the flame E in the principal focus of the bull's-eye B. This teaches how important it is to have the bull's-eye fixed to the lamp, so that both may be moved together, and not independently. The author's own bull's-eye is so made that when it is pushed home in its slot, the lamp flame is in its principal focus.

Fig. 162.




To set up fig. 161 correctly, with a bull's-eye

on a separate stand, would take an experienced microscopist a quarter of an hour or more, an inexperienced one an evening.*

The following are a few hints on dark-ground illumination :— Let us, by way of example, take a definite object, thresh that out thoroughly, then afterwards show what alterations in the method will be required for other objects. The necessary apparatus is an *achromatic* condenser, and a lamp with a bull's-eye *fixed to it*.

Fig. 163.

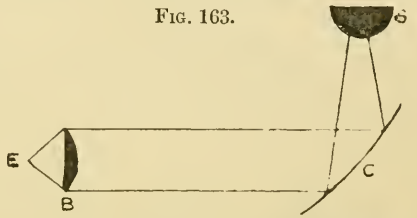
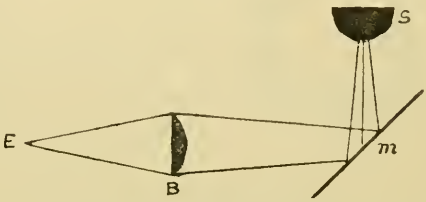



Fig. 164.




It is, in Mr. Nelson's opinion, most important that the condenser should be *achromatic*. It will be urged by many eminent microscopists that an achromatic condenser is quite unnecessary. Also there are those who prefer a paraboloid, spot-lens, &c. He does not, however, go into this question for fear of making his paper too long; the scope of it being a method of showing critical images on a dark ground by means of an achromatic condenser; the test of criticalness being the visibility of the dots in the hexagonal areolation of the larger *Triceratia* with a 2/3 of 0·21 N.A. (= 32½° air angle). Let us, therefore, take this as our experimental object.

We must first adjust our lamp and bull's-eye as described on p. 714 and get the edge of the lamp expanded to a disk as in fig. 165. Place a small aperture in the condenser, and a *Triceratium* on the stage with the 2/3 in. objective on the nose-piece. The Microscope having been put in the proper position, the lamp should be placed on the left-hand side of it. The lamp should now be arranged as to height, so that the rays from the bull's-eye may fall fairly on the plane mirror; the plane mirror being inclined to reflect the beam on the back of the substage condenser.

Now, with any kind of light, focus and centre the *Triceratium* to the field, fig. 166. Then rack the condenser until the small aperture in its diaphragm comes in focus; centre this to the *Triceratium*, fig. 167. Rack the condenser closer up until the bull's-eye is in focus, fig. 168 Here it happens that the bull's-eye is not in centre, and is not uniformly filled with light as in fig. 165, but has instead two crescents of light. This is a case which often occurs; but, of course, it may be more or less filled with light, and may or may not be more nearly centered.

* Mr. Nelson thinks it would be a good plan if microscopists would always use the term "bull's-eye" instead of "condenser," to designate that piece of apparatus; leaving the term condenser for the substage condenser only.

We next have to centre the bull's-eye to the *Triceratium* by moving the *mirror*, fig. 169. It will be noticed that centering the bull's-eye does not put the light right. This must be done by moving the *lamp with its attached bull's-eye*. This movement must be a kind of rotation of the lamp in azimuth round the wick as an ideal axis. The relative positions of the lamp and bull's-eye must on no account be altered. It is taken for granted that the bull's-eye is fixed to the lamp, and was adjusted at the first so that the picture, fig. 165, was obtained by direct inspection without any Microscope.

Fig. 165.

Fig. 166.

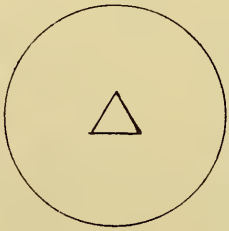


Fig. 167.

Fig. 168.

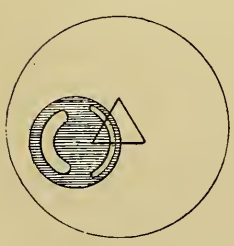


Fig. 169.

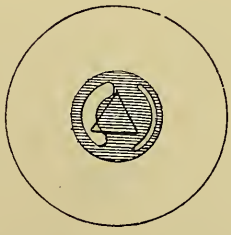
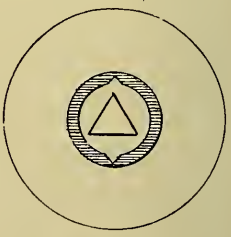


Fig. 170.



This adjustment being satisfactorily carried out at first, is not disturbed. By "moving the lamp round the wick as an axis," is meant the moving of the whole thing as a solid mass. This is a very simple thing to demonstrate practically; but it is not easy to describe even such a simple movement so as to preclude the possibility of error. A very slight movement in the right direction will produce the picture fig. 170.

Any one having the necessary apparatus, by following out precisely this plan, will arrive with very little trouble at fig. 170.

All that need now be done is to open the full aperture of the condenser, and put in the smallest opaque central stop; if this does not stop out all the light in the bull's-eye, then a larger one must be tried. It is of the greatest importance that the stop be as small as possible; a very little difference in the size of the stop makes a great difference in the quality of the picture. Condensers ought, therefore, to be supplied with as many opaque central stops as open apertures.

On account of some residual spherical aberration, the condenser will probably have to be racked up a little to secure the greatest amount of light.

In fig. 170 the expanded edge of the flame covers the *Triceratium*. When the whole aperture of the condenser is opened the size of that disk will not be altered. Its intensity only will be increased. When the central stop is placed at the back of the condenser, only in that part of the field represented by the disk of light will the objects be illuminated on a dark ground. But some will say: Suppose the disk does not cover the object; what is then to be done? Simply this: bring the lamp nearer the mirror.

The size of the disk of light depends on three things.

1. The diameter of the bull's-eye.
2. The length of the path of the rays from the bull's-eye to the substage condenser.
3. The magnifying power of the condenser.

If 1 and 3 are constant; the only way of varying the size of the dark field is by 2, as already stated.

The intensity of the light in the disk depends also on three things.

1. The initial intensity of the illuminant.
2. The angular aperture of the bull's-eye.
3. The angular aperture of the substage condenser.

Mr. Nelson has elsewhere insisted that the power and aperture of the substage condenser should bear some proportion to the power and aperture of the objective used, and does not enlarge upon this, but merely alludes to it, as it does not legitimately come within the range of his paper. Finally, he says he prefers to make the disk of light no larger than necessary. If the whole field is required, he fills it; but if only a portion is wanted, then he reduces the size of the disk accordingly.

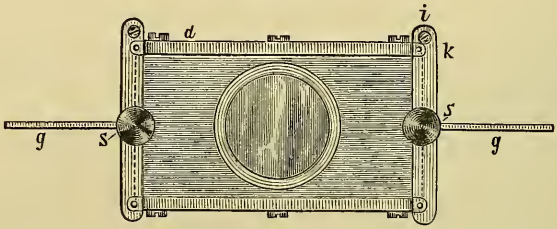
Mr. A. C. Malley* strongly disputes Mr. Nelson's recommendation of a bull's-eye fixed to the lamp, and prefers one mounted on a separate stand, which is easier reached and moved, and by which tremor is avoided. The bull's-eye should be placed about $3\frac{1}{2}$ in. from the centre of the flame, the lamp being surrounded by a tin shade having a small plane mirror behind the flame, and an orifice the size of the bull's-eye in front. The bull's-eye is formed of two plano-convex lenses ($3\frac{1}{2}$ in. focus) with their convex faces together. He also uses a cell of ammonio-sulphate of copper in front of the mirror.

**Hawkins's Observatory Trough.**†—Mr. R. Hawkins suggests an improvement on Dr. Giles's Live-cell,‡ which he thinks will make the apparatus so simple, that any one can make half-a-dozen in an hour or less without extraneous aid. The arrangement consists in the use of clips, to keep the glass cover on, made of a piece of brass wire bent to fit the slide, and so as to have sufficient power to hold the cover well in position.

* Engl. Mech., xl. (1884) p. 299.
† Sci.-Gossip, 1885, p. 135 (1 fig.).
‡ See this Journal, *ante*, p. 135.

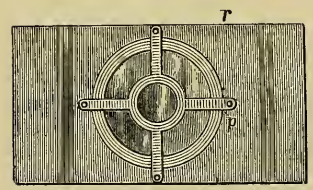
**Pringsheim's Gas Chambers.***—In order to make experiments with different gases, Professor N. Pringsheim had gas chambers constructed by Schmidt and Hänsch, for use with his Photo-chemical Microscope,† which differ from those hitherto used, and which combine great firmness and durability with easy management. As those of glass are very difficult to fix, besides having other disadvantages, the new ones (Figs. 171 and 172) are of metal, and very firm and secure. The base is of strong glass (or metal with an aperture closed with glass), the sides and cover *d* of metal. The latter has a circular

Fig. 171.




aperture in the centre, beneath which a glass cover is cemented for the reception of the hanging drops in which the object is placed. It can be firmly pressed down by the arm *k* (movable at *i*) and the screw *s*. By a mixture of wax and vaseline at the joints and tightening the screws, the chambers can be made completely air-tight, and will even bear a considerable pressure of gas. This is conducted through the tubes *g*. The base of the chamber is kept covered with a thin stratum of water. As the temperature of the drop, particularly in white light, may become higher than the object can endure without injury, it may be cooled by filling the chamber with ice, and by placing on it, instead of *d* (Fig. 171), the cover *r* (Fig. 172), which can then also be covered with ice. In the latter case, a quick conductor of heat from the drop to the ice can be obtained by means of the platinum cross *p*.

Fig. 172.




**Test for the Hand-Lens.**—Mr. J. Deby points out that "while many tests exist for high- and medium-power objectives, none are on record for that most useful instrument to the naturalist, the hand-lens." The best test he considers to be the elytron of *Gyrinus marinus*, a not very rare water-beetle. The lens must not only show the longitudinal rows of large dots, but also the fine intermediate punctations. None but a first-rate lens will show them. The male has finer punctations than the female, and is more difficult of resolution.

* Zeitschr. f. Instrumentenk., i. (1881) pp. 332–3 (3 figs.).

† See this Journal, ii. (1882) p. 395.

**Aperture Puzzle.**—A problem which much troubled the older generations in regard to aperture, was this:—

"Aperture" meaning essentially the "opening" of the objective, or its capacity for transmitting a greater or less amount of light, the following seemed to be paradoxical.

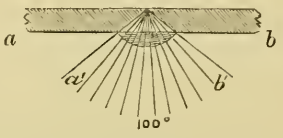
In fig. 173 a dry objective is used, and the object can receive light from the whole hemisphere of 180°. If, for instance (as the matter was put with the view of bringing it within reach of the meanest capacity!), 180 candles were placed in a semicircle *a b*, light from every one of the candles would reach the object.

Suppose now, that instead of a dry objective, whose aperture cannot exceed 180° or 1·0 N.A., an immersion objective is used with an aperture exceeding 1·0 N.A., a hemispherical lens being employed for the illuminator, as in fig. 174.

It is suggested that in this case we have less light reaching the object, for, continuing the example of the candles, only those between

Fig. 173.


Fig. 174.




*a'* and *b'* (or say 100 out of the 180) are effective, none of those between *a* and *a'*, or between *b* and *b'* illuminating the object, and they might as well not be lighted.

The objective which has the smaller aperture, therefore, receives, it is suggested, the light of eighty more candles than the objective which has the larger aperture!

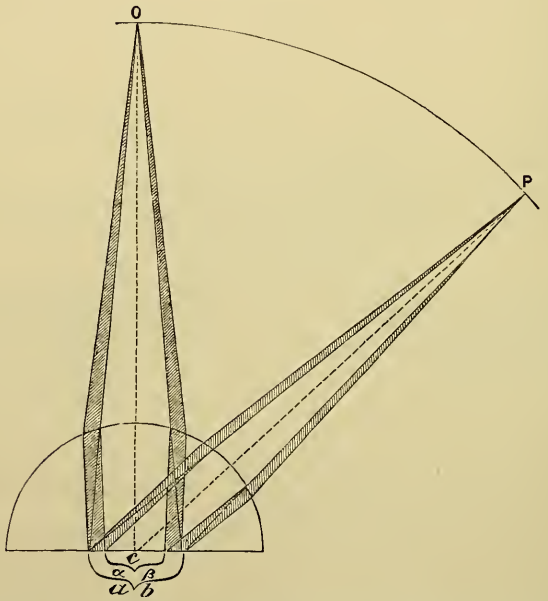
The explanation of the seeming paradox is simply that the effect of the spherical surface in the second case has been disregarded, as was so constantly the case in the old aperture discussions.

The action of the hemisphere in fig. 174 may be illustrated by fig. 175, which shows the course of the rays from a luminous surface O P to a definite surface element *a b*.

Take the inner lines of the fig. as representing the pencil which, in air and without the interposition of the hemisphere, would reach the surface *a b*. If the hemisphere is interposed, the pencil, instead of continuing in a straight line as before, is compressed (refracted), and is now thrown on the smaller surface $a\ \beta$. It is obvious that the two surfaces *a b* (in air) and $a\ \beta$ (in glass) must each receive the same amount of light, for the pencils which reach them are identical in their origin. If now we take within the hemisphere a surface *a b*, which is larger than $a\ \beta$, the former (*a b* in glass), will be illuminated, as the fig. shows, by a pencil which, in its origin, is larger than that illuminating the latter ($a\ \beta$ in glass); and as $a\ \beta$ in glass is, as we have seen, identical in illumination with *a b* in air, *a b* in glass will receive a larger pencil than *a b* in air, the excess

being represented by the shaded space in the fig. In other words, the total quantity of light which in air is thrown upon the element $a\ b$, is by means of the hemisphere condensed upon the *smaller* element $\alpha\ \beta$, so that the hemisphere will admit to the element $a\ b$, *wider* pencils from the points O P than are admitted to it in air. Though the

Fig. 175.




angle O $c$ P is the same in both cases, the quantity of light conveyed within this angle to one and the same surface element is greater in glass than in air.

As to the measure of the increase of light, it may be shown that $\frac{\alpha\ \beta}{a\ b} = \frac{1}{n}$; i. e., if $n = 1{\cdot}5$ (the refractive index of glass), $\frac{\alpha\ \beta}{a\ b} = \frac{2}{3}$, or $a\ b$ is half as large again as $\alpha\ \beta$. The increase of light is therefore as 9 : 4, or $2\frac{1}{4}$ times ($n^2$). This is in agreement with the expression for the numerical aperture in the cases of air and glass, which, for the same angles, are always as 2 : 3.*

**Discovery of Pseudoscopy.**†—Under the title of the "Discoverer of a Singular Optical Illusion," Prof. Govi says, "Of all optical illusions, that is certainly not one of the least remarkable by which, in looking at objects in slight relief or slightly depressed (as coins, seals, &c.) with a compound Microscope or a telescope which reverses the image,

* See also on this subject this Journal, i. (1881) p. 329.

† Atti R. Accad. Lincei—Transunti, vii. (1883) pp. 183-8.

the parts in relief appear hollow, and that which is hollow assumes the appearance of perfect relief. It is indeed true that the illusion is not always, nor with all persons, equally successful, and that sometimes the appearance is alternately that of hollow and of relief to the same eye and with the same object; but, in general, the inversion of form does not lead to deception, not being able to overcome either the knowledge of the object which the observer possesses nor that of the reversal of the image brought about by the instrument. Physicists admit that in this case the illusion proceeds from the observer's knowing the direction from which the light comes, and seeing in the image the lights and shades of the prominences or cavities on the side opposite to that which, having regard to the direction of the light, they ought to occupy; so that, in the absence of any final test of the comparison to aid the judgment, one argues from the position of the lights and shades that what is really hollow is in relief, and *vice versâ*. In fact, if every part of the object is illuminated, or if (as Brewster has suggested) a pin is placed upright by the side of it, and one observes the direction of the shadow which it throws on the object, the illusion suddenly vanishes and the object is seen as it really is, and not as one's erroneous first impression had represented it. Almost all who have written upon the subject of vision, or the illusions of the senses, refer to this curious phenomenon, and attribute its discovery now to one, now to another person, according to the patience, erudition, and perhaps the nationality of the writer; for, with regard to the priority of discoveries, the factors on which the final judgment depends are numerous. Joblot, in 1718, believed himself to have observed it for the first time, not referring to any one who had preceded him. Gmelin does the same in 1745, in a paper on a kindred subject, printed in the 'Philosophical Transactions.'

I do not know the purport of Rittenhouse's communication of 1786, because I have not hitherto succeeded in procuring the 'Transactions of the American Philosophical Society,' which contains a work by that author on some such subject, but it is probable that, like Joblot and Gmelin, he too has believed himself to be the discoverer of the phenomenon. Muncke, in 1828, in the article "Gesicht," in Gehler's 'Dictionary of Natural Philosophy,' attributed the discovery to Joblot (written *Jablot* by him).

David Brewster, in publishing, in 1831, his 'Letters on Natural Magic,' dedicated to Sir Walter Scott, alludes to an observation of this nature made by the members of the Royal Society of London in one of the first and earlier meetings of that society, and perhaps mentions it as well in an article in the 'Edinburgh Scientific Journal,' which I have been unable to consult. In 1838, Charles Wheatstone, in the publication and description of his wonderful 'Stereoscope,' alludes to the Royal Society of London as having first called attention to the strange phenomenon, without, however, giving the year or stating the manner in which it happened. Helmholtz, in his 'Physiological Optics,' reproduces Muncke's citations, and seems to adhere to Joblot as the discoverer of the illusion. Schröder, writing on the subject in 1858, stops at Gmelin, and attributes the discovery to him.

Although there is much disparity in the opinions, it is only the older observers who are really in competition for the honour of the discovery; that is, Joblot and the Royal Society, but it does not appear clearly from the known records which of the two preceded the other.

The 'Philosophical Transactions' do not speak of any such observation, but, consulting the 'History of the Royal Society,' written by Birch, in which are found described with great care almost all the experiments, letters, communications, and discussions which the English *savants* did not think worthy to appear in the volumes of their 'Transactions,' we may read there in the second volume the following passages:—

Under the date of the 11th of February (Thursday), 166$\frac{8}{9}$ (counting *ab incarnatione*, and according to the Julian calendar): 'The operator was ordered to speak to Mr. Hooke, that the great Microscope of Mr. Christopher Cock's making be brought to the Society at the next meeting.' And the 18th of February 166$\frac{8}{9}$ (Thursday), 'Mr. Christopher Cock produced a Microscope which he said he had made for the Society if they liked it, with five glasses, of which the four eye-glasses were plano-convex, two and two so put together as to touch one another in a point of the convex surface. Various observations being made therewith, it appeared to do very well, but there being a guinea put in it and looked upon, some of the members saw the image depressed, others embossed. The workman referred himself to the Society for the price of this Microscope, and the Society referred it to the Council.'

Then the Council decides on the 22nd of February (Monday): 'That the Treasurer pay to Mr. Christopher Cock 8*l.* for a large Microscope made by him for the Society.' It does not appear that the Society or any of its members made any further investigation after this into the singular illusion discovered on the 18th (28th according to Gregorian style) of February 1669, although the 202 Italian lire (8*l.*) paid for the Microscope which had demonstrated it attest the importance attributed to Mr. Christopher Cock's instrument. The date of the first observation of the English academicians being thus established, Joblot's priority disappears, unless it is wished to uphold it on the ground that the discovery remained unpublished in the records of the Royal Society until the time of its publication by Birch (1756).

In any case, even recognizing the priority of the English, we are able justly to claim for an Italian countryman of ours the credit, not only of having anticipated the Royal Society in the discovery of the curious illusion, but of having forestalled those physicists who subsequently endeavoured to explain it. Eustachio Divini, of San Severino (the ancient Septempeda), on the frontier, was the most skilled manufacturer of lenses and glasses of all kinds of his time, and in the year 1649 had conceived the idea of placing in a telescope which he possessed, some fine threads crossed, substituting a convex ocular lens for the concave ocular used by Lippersheim and Galileo, in order to see the network and thus sketch with ease the image of the moon which, with all its markings, was depicted upon it,

thus anticipating the first micrometers of Gascoigne, Montanari, and Huyghens.

Now this same Eustachio Divini, in a letter which has been printed, addressed to Count Carlo Antonio Marozini on the 15th of July, 1663, wrote thus:—'Now that we are upon the subject of telescopes fitted with the single lens, I ought to tell you of a remarkable matter; I have seen strange things. While looking at some object, such as a bas-relief or those arms carved in stone which are commonly put upon walls, their plane parts appeared depressed and level with the wall, while all the rest of the arms were devoid of relief.

But the curious thing is, that the relievos which I have mentioned are seen as if hollowed out, whereas they are really raised up. When I discovered this, I showed it to other persons of enquiring disposition, and by looking several times at the same place, finally convinced myself that I had been deceived by the light which it received from the sun, for in the morning it appeared hollow, in the evening in relief, and in other parts in relief in the morning and hollow in the evening. The Microscopes with two glasses, which also show the objects to me reversed, usually do the same with a difference in the glasses, which I do not as yet understand. They magnify a thousand times, and by the conditions of this power cannot be applied to objects which are rather large; therefore I have sometimes added another lens with a curvature considerably greater than that of the small lens, taking away the latter and inserting the former, which does not magnify so much, but serves for rather large objects, and with them produces a most beautiful effect with the greatest clearness. With this apparatus I have looked at an old coin in order to see letters which could not be read. Sometimes I have seen the places in relief reversed and, changing their position (so to speak), stand on the right-hand side of the Microscope, and if I place myself on the left I see in relief that which when on the right I considered to be hollow. But what seemed to me altogether strange, and has happened to me more than once is, that when looking at another object in relief, I see it hollow, and on changing my position I still see even the part in relief hollow. However, I leave all this to distinguished intellects to speculate upon, and return to our telescope.'

The 15th of July (Gregorian notation), 1663, is earlier by 5 years 7 months and 15 days than the 18th of February (Julian notation), 1669; by this period, therefore, does Divini have precedence of the English academicians in the discovery of the *pseudoscopy* of reliefs, and by a still greater time is he beforehand in the endeavour to explain the phenomenon, for he attributes it to 'deception of the light,' and as his microscopical observations left him somewhat perplexed as to such a reason, he referred the matter to distinguished intellects, which, however, have not known how to find a better one, and repeat (only in a better form and somewhat aided by experiments) the same explanation which Divini had proposed two centuries ago." *

* A Bibliography of eleven of the books and papers referred to is appended.

Abbe, E.—**Ueber optisches Glas.** (On Optical Glass.)
[Title only, with demonstration of Microscopes with lenses made of the new glass.]
*SB. Jenaisch. Gesell. f. Med. u. Naturwiss.* for 1884 (1885) p. 32.

„ „ **Ueber Object und Bild.** (On Object and Image.) [Title only.]
*Ibid.*, p. 34.

**American Society of Microscopists.**—Eighth Annual Meeting at Cleveland, O.
[Circular issued by the Society. Also note by E. H. Griffith.]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 119.
*The Microscope*, V. (1885) pp. 132–3, and 135.

Beckwith, E. F.—**Resolution of Amphipleura.**
["On a slide prepared by H. H. Chase, with a refractive index of 2·42, I have succeeded in clearly resolving *A. pellucida* with a dry 1/5 in. of 135° air angle."]
*The Microscope*, V. (1885) pp. 131–2.

*Behrens, J. W.*—**The Microscope in Botany.** A guide for the microscopical investigation of vegetable substances. Transl. and edited by A. B. Hervey and R. H. Ward. xvi. and 466 pp., 13 pls. and 152 figs., 8vo, Boston, 1885.

„ „ **Observation by Artificial Illumination.**

„ „ **The Ocular Micrometer** (and additions by R. H. Ward).
*Micr. Bulletin* (Queen's) II. (1885) pp. 20–1, from *The Microscope in Botany.*

Carpenter, W. B.—**Wallich Condenser.**
[Remarks on the very great increase of focal depth with the Binocular.
"There was one very curious thing about the Binocular Microscope, that it did increase very greatly the focal depth. He had tried this under every condition, and had always found it to be so. It was to be explained to a certain extent by the binocular prism halving the aperture of the objective. That, however, did not explain it altogether; because having asked a friend to look through the binocular with one eye only, the prism being in its place, and to focus the objective for what he considered to be a medial distance, on then asking him to open the other eye, the difference in the depth of focus had been at once observed; indeed, it was considered that the increase amounted to at least five times. He had talked the matter over with his friend Sir Charles Wheatstone, but they could never come to any satisfactory conclusion."]
*Journ. Quek. Micr. Club*, II. (1885) pp. 145–6.

Chalon, J.—**Note sur l'Objectif 1/16 de pouce de Powell et Lealand.** (Note on the 1/16 in. objective of Powell and Lealand.)
[Description of details of construction.]
*Bull. Soc. Belg. de Micr.*, XI. (1885) pp. 196–8.

Chaney, L. W., jun.—**Microscopical Exhibits at the New Orleans Exposition.**
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 102–4 (2 figs.).

Chun, C.—**Katechismus der Mikroskopie.** (Catechism of Microscopy.)
[Part I. Theory of the Microscope, pp. 3–81. Part II. Use of the Microscope, pp. 82–95. Part III. Methods of Investigation, pp. 96–138.]
viii. and 138 pp. and 97 figs., 8vo, Leipzig, 1885.

Eternod, A.—**Des Illusions d'Optique dans les Observations au Microscope.** (Optical illusions in microscopical observations.) 8 pp., 8vo, Genève, 1885.

Foulerton, J.—**Microphotography.**
[Demonstration to the Western Microscopical Club.]
*Engl. Mech.*, XLI. (1885) pp. 320–1.

GÄRTNER, G.—**Ueber den Nachweis des Wärmetonus der Blutgefässe mittels electrischer Beleuchtung.** (On the detection of the influence of heat on the tonicity of the blood-vessels by electric illumination.)
*Allg. Wiener Med. Ztg.*, 1884, p. 69.

GRIFFITH, E. H.—See American Society of Microscopists.

GUNDLACH, E.—**The Examination of Objectives.** (*Concld.*)
*Micr. Bulletin* (Queen's) II. (1885) pp. 18-9,
from *Amer. Journ. Micr.* for 1867.

HARDY, J. D.—**Microscopical Delineation.**
[Abstract only.]
*8th Ann. Report Hackney Micr. and Nat. Hist. Soc.*, 1885, pp. 28-9.

HAWKINS, R.—**Observatory Trough.**
[*Supra*, p. 719.] *Sci.-Gossip*, 1885, p. 135 (1 fig.).

HERVEY, A. B.—See Behrens, J. W.

[HITCHCOCK, R.]—**Silvering Glass Reflectors.**
[Formula of Mr. J. Browning for silvering glass specula.]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 118-9.

HOLMES, E. A.—**Polarized Light as applied to the Microscope.**
[Paper read before the Hackney Microscopical Society.] 8 pp., 6 figs.

HUNT, G.—**The Right-angled Prism instead of a Plane Mirror in the Microscope.**
[*Supra*, p. 709.] *Engl. Mech.*, XLI. (1885) p. 414.

Hunter's (J. J.) **New form of Graduating Iris Diaphragm.**
[Exhibition only. "Made to go close up under the object."]
*Journ. Quek. Micr. Club*, II. (1885) p. 161.

JADANZA, N.—**Sui punti cardinali di un sistema diottrico centrato e sul cannochiale anallattico.** (On the cardinal points of a centered dioptric system, &c.) *Atti R. Accad. Sci. Torino*, XX. (1885) pp. 917-33 (8 figs.).

KLEIN, C.—**Optische Studien am Leucit.** (Optical studies on Leucite.)
[Contains a description of a new Microscope devised by the author for mineralogical-petrological researches, pp. 436-43. *Post.*]
*Nachr. K. Gesell. Wiss. Göttingen*, 1884, pp. 421-72 (1 pl.).

LÉPINAY, M. DE.—**Méthode optique pour la mesure absolue des petites longueurs.** (Optic method for the absolute measurement of small lengths.) [*Post.*]
*Comptes Rendus*, C. (1885) pp. 1377-9.

LOMMEL, E.—**Bermerkungen zu dem Aufsatz: Ueber einige optische Methoden und Instrumente.** (Remarks on the article "On some optical methods and instruments.")
[Remarks as to the priority of Prof. Abbe and others in regard to the original paper *ante*, p. 532.]
*Zeitschr. f. Instrumentenk.*, V. (1885) p. 200.

M.—**Amateur Lens-making.**
[Directions for making lenses, with description and figures of tools.]
*Engl. Mech.*, XLI. (1885) pp. 424-5 (10 figs.),
from *Scientific American Supplement.*

M'ALLISTER.—**Slide showing Path of Electric Spark.**
[A slide, after being smoked over a small gas-jet, is placed centrally between the terminals of an induction coil, and at right angles to their direction. The terminals are held about 3/8 in. apart. A strong current is required.]
*Journ. N. York Micr. Soc.*, I. (1885) p. 101.

MAYALL, J., jun.—**Nobert's Ruling Machine.** (*Concld.*)
*Knowledge*, VII. (1885) pp. 452-3, 504-5, 523-4,
from *Journ. Soc. Arts.*

MILLER, M. N.—**Theory and Practice of Photomicrography. I., II.**
[Paper read before the Photographic Section of the American Institute. Describes apparatus and gives practical instructions.]
*Engl. Mech.*, XLI. (1885) pp. 298, 359-61.

*Monoyer, M. F.*—**Zur Theorie der Fernrohre. Allgemeine Theorie centrirter dioptrischer Systeme.** (On the theory of the telescope. General theory of centered dioptric systems.) (*In part.*)
*Centr.-Ztg. f. Optik u. Mech.*, VI. (1885) pp. 121–3, 133–6, abstracted by G. Fischer from *Séances de la Soc. Franç. de Physique*, 1883, pp. 148–75.

Moore, A. Y.—**The Microspectroscope.**
*The Microscope*, V. (1885) pp. 101–6 (3 figs. and 1 pl.).

Nelson, E. M.
[Reply to inquiry as to a condenser. Also statement that "the amount of flint in an object-glass depends entirely on the formula by which it is made, i. e. the idiosyncrasy of the maker."]
*Engl. Mech.*, XLI. (1885) p. 283.

„ „ **Stop for an Abbe Achromatic Condenser.**
[Not described.]
*Journ. Quek. Micr. Club.*, II. (1885) p. 148.

„ „ **Rotating Nose-piece Condenser.** [*Ante*, p. 324 and p. 327.]
*Ibid.*, II. (1885) pp. 153–4.

Queen, J. W.—**Remarks on using Oil-immersion Objectives.**
[General instructions sent out with his 1/15 in. objective.]
*Micr. Bulletin* (Queen's) II. (1885) p. 22.

*Queen's (J. W. & Co.)* **New Class Microscope.** [*Post.*]
*Proc. San Francisco Micr. Soc.*, 22nd April, 1885.

"Rob. Crus."—**The Micro-objective. III., IV., V.**
*Engl. Mech.*, XLI. (1885) pp. 302 (3 figs.), 327–8, 413–4.

Scherrer, J.—**Der Angehende Mikroskopiker, oder das Mikroskop im Dienste der Höhern Volks- und Mittelschule.** (The young Microscopist, or the Microscope in the higher, primary and middle schools.)
xv. and 206 pp., 134 figs. 8vo, Speicher, 1885.

**Schoolroom, Microscope in the.**
["No person who has not made the trial can form an adequate conception of the mental quickening occasioned by an exhibition of selected microscopic objects to classes in the schoolroom. The scales on the butterfly's wing, the hexagonal facets of the compound insect-eye, the transformation, as it were, of seemingly shapeless grains of sand into structure of exquisite beauty, the cyclosis of protoplasm in plant cells, and the movement of blood-corpuscles in the foot of the frog—reaching the mind through the eye, make and leave an impression, and give an understanding, which books and diagrams are powerless to produce. The Microscope, frequently and intelligently used, makes nature pellucid. There ought to be an excellent one under skilful manipulation in every school."]
*Journ. N. York Micr. Soc.*, I. (1885) p. 110.

Schott.—**Ueber optisches Glas.** (On optical glass.)
[Title only.]
*SB. Jenaisch. Gesell. f. Med. u. Naturwiss.* for 1884 (1885) p. 32.

Sollas, W. J.—**On the Physical Characters of Calcareous and Siliceous Sponge-spicules and other Structures.**
[Contains description of an arrangement for determining the density of minute objects under the Microscope. *Post.*]
*Scientif. Proc. R. Dublin Soc.*, 1885, pp. 374–92 (7 figs. and 1 pl.).

**Stokes—Watson Spark Apparatus.** [Vol. IV. (1884) p. 964.]
*Nature*, XXXII. (1885) p. 208.

[Stowell, C. H. and L. R.]—**Long Papers v. Short Papers.**
[Advocates papers of not more than twenty minutes in length.]
*The Microscope*, V. (1885) p. 136.

„ „ See Walmsley, W. H.

**Textile Microscopical Association.**
["A National Textile Microscopical Association was formed last Saturday by members of the Corresponding Societies of Boston and New York."]
*Science*, V. (1885) p. 472.

*Theiler and Son's (M.)* **Demonstration Microscope.**
[Same as Waechter's or Engell's, Vol. II. (1882) p. 398.]
*Knowledge*, VII. (1885) p. 491 (1 fig.).
*Nature*, XXXII. (1885) p. 112.

„ „ **Universal Pocket Microscope.** [*Supra*, p. 704.]
*Ibid.*, p. 491. *Ibid.*, p. 112.

Tolman, H. L.—**Eye-piece Micrometers.** [*Supra*, p. 704.]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 115–6.
See also under "Measurements of Blood-corpuscles,"
*The Microscope*, V. (1885) pp. 113–4, from the *Legal News*.

Van Brunt, C.—**Diatoms mounted in Prof. Smith's newest medium—Photographs of same.** *Journ. N. York Micr. Soc.*, I. (1885) pp. 102–3.

Wales, W.—**The proper care and use of Microscope Lenses.** [*Supra*, p. 708.]
*Ibid.*, pp. 113–6 and 123.

Ward, R. H.—**Recent progress in the Improvement of the Microscope.**
from *Annual Cyclopedia for* 1884 (New York, 1885) pp. 499–522 (42 figs.).

„ „ See Behrens, J. W.

Westien, H.—**Apparat zur Vergleichung symmetrischer Stellen der Schwimmhaut des rechten und linken Fusses vom Frosche.** (Apparatus for the comparison of symmetrical parts of the webs of the right and left feet of the frog.)
[*Post.*] *Zeitschr. f. Instrumentenk.*, V. (1885) p. 198 (1 fig.).

### β. Collecting, Mounting and Examining Objects, &c.

**Preparing Embryos.***—The method of examination which Dr. L. Löwe employs is as follows:—The embryos are placed, according to their size, in a 1 per cent. to a saturated solution of bichromate of potash, which is frequently changed. They remain in this for several months or a year. After being thoroughly washed in water they are stained in a 1 per cent. solution of carmine, which is renewed as soon as its ammoniacal odour is lost, then again washed, soaked in glycerin-jelly in an incubator (1–4 weeks), and hardened in alcohol. Sections are then cut with a microtome.

**Methods of Investigating Animal Cells.**†—The methods of examining living animals, e. g. *Amœbæ*, Infusoria, &c., under the Microscope, are first described by Dr. A. Brass. When they have been studied in their natural state, various reagents are applied to the living object; e. g. a mixture of chromic acid, 1; platinum chloride, 1; concentrated acetic acid, 1; water, 400–1000; hyperosmic acid, picro-sulphuric acid, or concentrated solution of corrosive sublimate. Brass believes, however, that better results are obtained by studying protozoa without reagents or staining.

The free cells of the animal body are examined in the living state on a warm stage in lymph fluid, vitreous humour, iodized serum, or 0·6–0·7 per cent. salt solution. The ova of mammalia are examined on a warm stage in lymph, to which a trace of sodium carbonate has been added.

Animal tissues are examined in the fresh state in 0·6–0·7 per cent. salt solution, iodized serum, or lymph fluid. The application of water is to be avoided, as it alters the cells. Tissues, of which the internal structure is to be examined, are washed, after treatment with

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 585–6.
† Ibid., pp. 39–51.

reagents, in water, to which alcohol or a few drops of acid have been added. Small animals, and embryos of higher animals, especially those which have not a strong external skeleton, are put alive into a 1/8-1/2 per cent. solution of chromic acid till they are dead, then treated with several drops of concentrated chromic acid, and finally washed, first in 30 per cent. alcohol, and then in gradually increasing strength up to absolute.

As staining reagents, borax-carmine, ammonia-carmine, and log-wood are used.

By starving or exposing to a low temperature the lower animals, insects, worms, &c., Brass has discovered that the granular substance inside the cells is dissolved and reabsorbed, and that finally the nuclear corpuscles disappear by degrees.

To study this process in the higher Vertebrata—parrots, mice, rabbits, &c.—they were infected with tuberculosis. The chromatic substance of the cells disappeared more or less, especially in those of the ovum, in which the changes were very marked, as ascertained from sections of the ovary.

**Demonstrating the Nuclei in Blood-corpuscles.*** — Herr M. Ladowsky recommends for the demonstration of the nuclei in white blood-corpuscles treatment with solutions of osmic acid (1 per cent.), or weak solutions of picric or chromic acid, and subsequent staining with rosanilin, saffranin, or better methylen-green. The latter is also useful for demonstrating the stroma and nucleus of red corpuscles. The author shows that the white corpuscles are not sticky by injecting watery solutions of indigo-blue, eosin, or even distilled water into the blood, which make the plasma cells aggregate in heaps, whereas the white corpuscles circulate unchanged.

**Demonstration of Karyokinesis in Epithelial Tissues.†**—Signor Tizzoni employs the method of fixing the tissue with Müller's fluid, hardening, preserving in ordinary alcohol, and staining with alum-carmine, which differentiates the chromatic figures of cell-nuclei in a state of division with the same distinctness as logwood and saffranin; the resting nuclei assume a violet colour, those which are dividing a ruby-red colour. This difference of staining points to a difference in chemical composition. The alum-carmine which the author uses is made by adding to Grenacher's formula a trace of sodium sulphate, which increases its staining power.

**Investigating the Structure of the Central Nervous Organs.‡**— Dr. J. Stilling recommends that pieces of brain hardened in chromium salts should be placed, after washing, in red or rectified pyroxylic acid or artificial pyroxylic acid (glac. acet. ac. 100 g.; ordinary water 800 g.; kreasote 30 minims). The connective tissue swells, and is quite macerated, so that the nerve-fibres, which remain intact, can be prepared under water with needles and forceps. The specimens can afterwards be stained with picro-carmine.

* Virchow's Arch. f. Path. Anat., xcvi. (1884) pp. 60-100.
† Bull. Sci. Med. Bologna, 1884, p. 259.
‡ Zeitschr. f. Wiss. Mikr., i. (1884) pp. 586-7.

**Application of Borax-methylen-blue in the Examination of the Central Nervous System.***—Dr. H. Sahli recommends the following formula: Distilled water 40, saturated watery solution of methylen-blue 24, borax solution (5 per cent.) 16. Mix, leave for 24 hours, and then filter. Sections are stained in this solution for 10 minutes to several hours, and then washed in water or alcohol, until the grey substance is clearly distinguished from the deeply blue-stained white substance, dehydrated, clarified in cedar oil, and mounted in balsam, either pure or mixed with cedar oil. The ganglion cells appear pale greenish, and are clearly differentiated from the blue-stained nuclei of the neuroglia. The most delicate nerve-fibres are stained.

The author obtains better results with this solution than with the ordinary alkaline methylen-blue in the examination of the central nervous system for the presence of micro-organisms.

**Preserving Sections of the Nervous System Treated with Bichromate of Potash and Nitrate of Silver.**†—To obviate the difficulty of preserving preparations, Signor C. Golgi places a drop of dammar varnish on the section, and allows it to dry in an even layer. He uses slides which have a square hole in the centre, which is closed below with a cover-glass. The section covered with dammar is placed on this, and when the varnish is dry the specimen can be examined on both sides.

**Study of Fat Absorption in the Small Intestine.**‡—Herr Th. Zawarykin makes use of the following method:—A piece of intestine is treated with hyperosmic acid, washed in water, and placed in spirit for 24 hours. A small portion is then cut between two pieces of elder-pith, in which it is placed in such a way that the villi are turned towards one half and the serous coat towards the other half of the pith. The razor should be wetted with alcohol. The sections can be stained with picro-carmine.

**Preparing the Cloacal Epithelium of Scyllium Canicula.**§—To isolate the goblet-cells, Herr J. H. List uses Müller's fluid and alcohol. The preparations are then imbedded in celloidin, cut, and stained with eosin and methylen-green. The epithelial cells are in this way stained rose-red, the goblet-cells green.

**Preparing Embryos of Amaræcium proliferum.**‖—MM. C. Maurice and A. Schulgin employ the following methods:—The whole, or better pieces, of the Ascidian are laid in water with an equal quantity of picro-sulphuric acid. After half-an-hour they are placed in alcohol, the strength of which is gradually increased. They can be stained whole with alum-carmine, or treated as follows:—The isolated ova or embryos are stained with borax-carmine for 15–18 hours, treated with hydrochloric acid, washed in 70 per cent. alcohol, and transferred to a very weak solution of Lyons blue for 15–20

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 49–51.
† Arch. per le Scienze Mediche, viii. (1884) p. 53.
‡ Arch. f. d. Gesammt. Physiol. (Pflüger) xxxv. (1884) pp. 145–57.
§ SB. K. Akad. Wiss. Wien, xc. (1884).
‖ Ann. Sci. Nat.—Zool., xvii. (1884).

hours. They are then quickly imbedded in paraffin, to which ceresin is added. They are cleared with oil of bergamot or cloves. A long stay in alcohol abstracts the colour. By this method the nuclei are stained red, the plasma blue. The three layers of the embryo are clearly differentiated. The ectoderm is a darker blue than the endoderm. The mesoderm shows the least blue staining, as its cells possess a large (red-stained) nucleus, against which the blue plasma stands out in contrast.

**Mounting Insects without Pressure.***—Mr. R. Gillo describes the process which he uses for this object, and which is a selection and combination of somewhat well-known methods.

"Let us suppose that the object to be mounted is an ordinary ground-beetle, perhaps 1/2 in. long. The first thing to be done is to steep it in liquor potassæ (full strength), and for this purpose I use a test-tube. When the solution becomes dark-coloured, it must be poured away and fresh added. After being in this for ten days or a fortnight, the insect must be transferred to water in a tea-saucer (distilled or soft water should be used), and whilst holding it steady with a camel's-hair brush, gently squeeze the body with another, giving the brush at the same time a kind of rolling motion, thus driving the contents of the abdomen towards the anus, from which it will presently be discharged. The beetle should now be removed to clean water, and left for an hour or so, when the squeezing process with the two brushes must be repeated as before, when more of the abdominal contents will be ejected. Again place the insect in clean water, and in this way, by several soakings and squeezings, the whole of the contents of the viscera will be removed without the least injury to any of the internal organs.

Throughout this process, however, the insect will be seen to be as opaque as it was at first. It is, therefore, necessary to bleach it; and to effect this it must be placed, until sufficiently transparent, which may take a week or more, in the following solution:—A saturated solution of chlorate of potash, to which is added ten or twenty drops or more of strong hydrochloric acid to each ounce of solution. A shallow but large-mouthed corked bottle is best for this purpose. The chlorine, which is slowly liberated in the solution, attacks the chitine, and thus gradually bleaches it and renders it transparent.

It is now necessary to wash all this solution out of the insect, which is best accomplished by placing it in a small pomatum pot filled with *distilled* water, and after an hour or so to change the water, repeating the process four or five times."

"For the next part of the process, a nest of china saucers or palettes, such as are used by water-colour artists (these fit sufficiently accurately one on the other to hold spirit for a day or two without its evaporating), will be required. In an empty palette place the insect on its back, and arrange its legs in the positions they are intended to retain when finished. Now gently pour methylated spirit over it,

* Journ. of Microscopy, iv. (1885) pp. 151-4.

so as completely to cover it, noticing that the legs are not displaced, for if they are right during this part of the process, they will naturally assume the same position in the final stage of the mounting. After several hours, or next day, change the spirit for fresh, and again, after several hours, pass the insect into ether, but as this is such a volatile fluid, it should be used in a test-tube tightly corked. There need be no anxiety about the position of the legs in this stage, as they have been already stiffened by the spirit, and if displaced now will spring back again into their original position. After soaking some hours in ether, pass into turpentine, in which it may be allowed to remain any length of time."

Directions for mounting in a cell with balsam in benzole follow, and for cementing, and it is pointed out that among other advantages insects thus mounted polarize brilliantly, probably owing to the action of the bleaching solution on the different tissues.

**Mounting the Proboscis of the Blow-fly in Biniodide of Mercury.**—Mr. H. Sharp describes his method as follows:—The apparatus necessary consists of two pieces cut from a glass slip, 1 in. by $1\frac{1}{2}$ in., a weak spring clip, and a wide-mouthed bottle containing methylated spirit.

Kill the fly by dropping it into boiling water, cut off the head, place it on one of the pieces of glass, and squeeze it with the finger until the tongue protrudes and the lobes expand. Then gently nip it with the other piece of glass, and put on a weak clip to hold it in position. Place the whole in the methylated spirit, and leave it there for an hour or more. On releasing the proboscis from the glasses the lobes will remain expanded; cut off the proboscis and place it in spirit till all the air is removed. Then put it in water for half-an-hour, and then in weak solution of biniodide of mercury (half water and half saturated solution) for two or three hours; then in the full strength solution for 12 hours.

When the proboscis is put in the weak mercury solution the lobes will most likely curl up, to prevent which place it on a slide when taken from the water, and put on a cover with a weak clip to hold it in position, and then run the weak solution of mercury under the cover. Do the same when transferring from the weak to the full strength solution.

Mount in a shellac cell, and use shellac for securing the cover.

Mr. Sharp finds it safe to use for the final mounting a solution of the biniodide of mercury slightly weaker than saturation, as if of full strength crystals will develope in very cold weather.

**Preparing Luciola italica.***—To investigate the seat of oxidation which produces the light, Dr. C. Emery kills the living animal in a solution of osmic acid, which stains the luminous plates of the still living and light-developing animals brown. The parts which are to be further examined are macerated for a long time in water, the development of fungi in which is prevented by the addition of

* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 338-54.

crystals of thymol. The osmic acid is especially reduced at the bifurcations of the blind ending tracheal capillaries within the luminous plates, and in the tracheal branches before the bifurcation.

Another method of preservation consists in injecting corrosive sublimate solution into the animal, and subsequent treatment with alcohol.

**Preparing Embryo of Peripatus Edwardsii and P. torquatus.*** —To obtain the embryos uninjured, Prof. J. v. Kennel removes them with the uterus from the chloroformed mother-animal, and places them, partly in concentrated solution of corrosive sublimate, partly in 1 per cent. osmic acid solution, and subsequently hardens them in alcohol. Alcohol alone, chromic, picric, or picro-sulphuric acid cannot be used for hardening, as they alter the object. The uterus is rendered transparent by turpentine, and cut with its contents, or the embryo is taken out and cut alone.

**Preparing Diatoms from the Stomachs of Mollusca and Crustacea.†**—Mr. E. S. Courroux recommends that in the case of mussels and cockles, the stomach should be cut out and steeped, or even boiled, in nitric acid until it is dissolved, and the resultant deposit washed and cleaned after one of the methods recommended in the text-books. A little special care, however, in the treatment of shrimps' stomachs will not be thrown away. On removing the shelly skin at the back of the head, the stomach will be seen as a small, dark-coloured body, the size of a small pea. Its position may generally be detected in the perfect shrimp from the dark appearance at the back of the head. The stomachs may be detached with the point of a knife, and when some 12 or 20 or more (as the deposit obtained from them is small) have been collected, they should (taking care that the skin of each stomach is cut or broken) be boiled for a few seconds in a weak solution of washing-soda or ammonia, and then immediately be thrown into a beaker of cold water. By these means we get rid of grease, &c., and render the subsequent treatment by acids more easy. The empty skins of the stomachs will float, and may be picked out of the solution.

The residue which collects after the solution has stood for some time should first be washed free from alkali, and then treated with acids in the usual manner.

The method of separating deposits into different densities is very useful here as with many other gatherings of diatoms, inasmuch as the large forms are then more easily isolated. The often advised whirling in a large evaporating dish in order to separate the diatoms from sand and débris may be frequently practised with success. In the washings of all diatoms, the author has found it of the utmost advantage to perform the later rinsings in distilled water. The diatoms are thus more effectually cleaned from salt, &c., and present less attraction to moisture in the case of dry mounts.

* Arbeit. Zool.-Zoot. Inst. Würzburg, vii. (1884) pp. 1–222.
† Journ. of Microscopy, iv. (1885) pp. 196–8.

The operator may be reminded that the material, even from a considerable number of stomachs, is of course very small in quantity, and must be handled carefully, and, as the most beautiful forms are often the lightest, it is of the utmost importance to let the deposit settle thoroughly in the washings of the lighter portions of the gatherings. The water holding the diatoms in suspension should be allowed to stand at least half-an-hour for every inch of its depth, and hence time will be saved by using watch-glasses and shallow dishes for the purpose.

**Bayberry Tallow for Imbedding.***—This substance is obtained from the ordinary bayberry-bush, and is used by furniture manufacturers for oiling the sliding surfaces of bureau-drawers, &c. It is claimed for the bayberry-tallow that it is cheaper and better than celloidin, and far superior to paraffin and other kinds of wax heretofore used. A special feature claimed for it is non-solubility in alcohol, except when warmed to about the temperature of the body or a little above it, and hence the specimens may be kept indefinitely in alcohol at ordinary temperatures. Another point to the credit of the tallow is that tissues injected with it or imbedded in it can be shaved in thinner sections than those allowed by other materials, and that on account of its firmness it allows of a more even cut. After making a section the tallow may be removed from the specimen by simply placing it for a few minutes in a bath of warm alcohol.

**Imbedding and Examining Trematodes.** — Dr. P. M. Fischer † recommends soap, fifteen parts dissolved in 17·5 parts of alcohol (96 per cent.) as a good imbedding medium for *Opisthotrema cochleare*. Glycerin is used in the examination of the sections. The whole animal can be hardened in absolute alcohol, stained with picro-carmine, logwood, or ammonia-carmine, clarified in oil of cloves, and mounted in Canada balsam in chloroform.

For the investigation of the embryonic sheath of living *Cercariæ* in snails, Dr. J. Bichringer ‡ employs the blood-fluid of the snail itself. Many facts, e. g. the origin of the accessory membrane of the sporocyst, can only be brought to light in this way.

**Hatfield's Rotary Section-cutter.**§ — Rev. J. J. B. Hatfield's section-cutter is rotary in all its moving parts except the specimen-carrier in its approach to the knife, and the horizontal frame A, supported by the standard B, the lower end of which is a clamp C, for fastening on a table near a corner to give the driving-wheel clearance.

D is the circular knife, mounted on the shaft E, which is rotated by the pulley G and belt F, from the driving-wheel H. I is a hollow shaft, and contains the nut and feed-screw. On the free end of the

* Amer. Mon. Micr. Journ., vi. (1885) p. 98 (from 'Louisville Med. News').

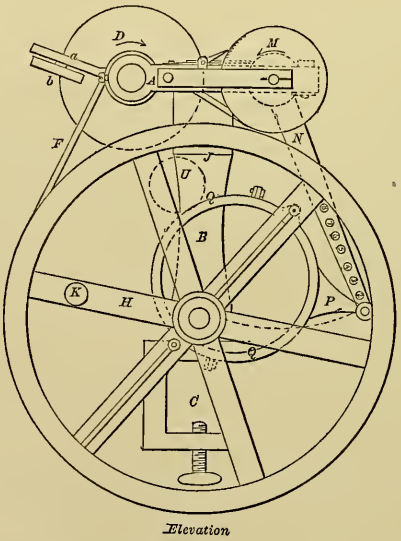
† Zeitschr. f. Wiss. Zool., xl. (1884) pp. 1–41 (1 pl.). See this Journal, iv. (1884) p. 384.

‡ Arbeit. Zool.-Zoot. Inst. Würzburg, vii. (1884) pp. 1–28 (1 pl.). See this Journal, iv. (1884) p. 571.

§ Proc. Amer. Soc. Micr., 7th Ann. Meeting, 1884, pp. 171–2 (2 figs.).

shaft I is mounted the carrier-arm J, which is kept from turning by a spline working in the slot L, and is rigidly connected with the nut (which is 4 in. long) by the screw *e d* passing through the sleeve and spline and screwing into the nut. M is the feed-wheel mounted on the right-hand end of the feed-screw. N is a lever, the upper end embracing the shaft I, the lower end connected with the projecting arm P of the eccentric, which, by its revolution with the driving-wheel, communicates the necessary vibratory motion to the carrier-arm, as may be seen in dotted lines in the elevation at I. The eccentric can be given any throw within its compass by sliding along

Fig. 176.




*Elevation*

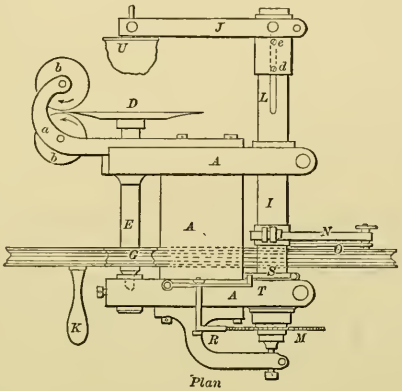
the slotted arms of the driving-wheel. The throw may also be varied by connecting the eccentric with the vibrating lever N, at the various points 1, 2, 3, 4, &c. When making a cut, all the parts connected with the shaft I rotate in the direction of the arrow on the feed-wheel M, but in the return stroke the pawl R catches in the teeth of the feed-wheel, and holds it while all the other parts continue the return motion to the end of the stroke; this causes the screw to turn in the nut, or rather the nut to turn on the screw, and advance the carrier and specimen to the knife. S is a cam embracing the shaft I, and may be set in any position around the shaft, and by its action on the part T of the pawl determines the number of teeth that will be taken at each stroke.

The feed-screw has twenty threads to the inch, and the wheel one hundred teeth; the finest feed is therefore two thousand to one inch.

The two wheels *b b* on the plan and *b* on the elevation, supported

by the bar *a*, constitute the automatic sharpener. Their surfaces are covered with leather, which is supplied with tripoli or rouge from time to time as needed. These wheels are set at a slight angle with the radius of the knife, as shown in elevation, and while the knife may have a very rapid revolution, the wheels move but slowly. When not

Fig. 177.




needed the bar *a* and wheels may be turned up out of the way. After the specimen is imbedded by dipping or casting, one side is cut flat, the plate U is heated and held in contact with the flattened surface a short time, and the stem put into the carrier-arm and turned. If the specimen is to be kept in book form, put a piece of tissue-paper on the lower side of the cast and cut to it.

**Notes on Section-cutting.***—Mr. E. L. Mark, of the Museum of Comparative Zoology at Cambridge, Mass., U.S.A., writes as follows:—

"My only apology for the present communication is the hope that it may prove a saving of time to those who have encountered the difficulties of cutting eggs, which are composed largely of yolk-corpuscles liable to crumble in the ordinary paraffin method. The difficulty I have experienced lies not alone in the impossibility of making sections—even from eggs very thoroughly permeated by the paraffin—which will not crumble during the removal to the prepared slide, but also in the fact that sections successfully transferred to the slide are liable to have portions of the yolk-granules loosened and floated over other portions of the section during the removal of the paraffin. While by the ordinary methods of mounting (Giesbrecht, Schällibaum) those elements of the section which lie on its *under* side, and therefore come in immediate contact with the fixative, are safely held in place, it may happen that many from the *upper* surface are loosened and washed away, because the fixative does not penetrate the whole thickness of the section.

* Amer. Natural., xix. (1885) pp. 628-31.

This obstacle may be entirely avoided by the proper use of collodion.

We are indebted to Mason,* so far as I am aware, for the first suggestion of the use of collodion in this connection. But the method employed by Mason has serious objections. A *drop* of collodion on the surface of a paraffin-imbedded preparation softens the object to such an extent that cutting is a very slow process, and thin sections are not easily attainable. The thickness of the collodion film, moreover, interferes more or less with accurate study of the mounted object, even if the sections are inverted when applied to the slide. The gradual drying of the surface of the film also causes the section to roll into a hollow cylinder with its collodion surface innermost, so that the inversion of the section becomes difficult, if not altogether impossible. The consistency of the collodion to be used is stated by Mason, but this is of little value, since even a short exposure to the atmosphere often repeated will quickly change the condition of the collodion in the bottle.

All these impediments—but for which, I believe, the method would have come into more general use—may be largely if not entirely obviated by using *a very small amount of a rather thin collodion.*

The criterion which serves me is: *the collodion must dry almost instantly* (within two or three seconds after being applied) *without leaving a trace of glossiness on the surface of the paraffin.*†

In this collodion process I use at present the following method:—

The object, imbedded in paraffin in the ordinary way, is placed in a receiver of a Thoma's microtome and the paraffin cut away to within 1 mm. to 2 mm. of the object on four sides, leaving a rectangular surface of paraffin, two edges of which are parallel to the edge of the knife.

A slide prepared by being painted with *a thin coat* of Schällibaum's mixture of collodion and clove-oil is placed at the left of the microtome.

At the right of the latter, handy to the right hand, is a small bottle half-full of the thin collodion, into which dips the tip of a camel's-hair brush; the quill of the brush is thrust through a hole in a thin flat cork, which serves at once as a temporary cover to the bottle and a support to the brush, the latter being adjusted to any height of the collodion by simply pushing it up or down through the hole in the close-fitting cork. Near by is a small bottle of ether, with which the collodion is thinned as soon as it begins to leave a shining surface on the paraffin.

The operator should sit *facing the light*, so that he may judge

* N. N. Mason, 'Use of Collodion in cutting thin Sections of Soft Tissues, Amer. Natural., xiv. (1880) p. 825.

† Judging from the effects, I am inclined to think that by this method the collodion penetrates the preparation to a certain depth, fixing the parts in their natural relations without producing a superficial film. At any rate, if the sections are made sufficiently thin (e. g. 5 $\mu$) there is no curling, whereas with much thicker sections, the superficial portion of which alone contains in that case the collodion, there is often a tendency to roll. This I have attributed to the slight shrinkage in the upper or collodion-impregnated portion of the section.

accurately of the condition of the surface of the paraffin, which reflects the light. Everything being in readiness, the brush is lifted and wiped on the mouth of the bottle to *remove most of the collodion*, and then the paraffin and the object are *at once* painted by *quickly drawing the brush across the surface*, care being used that it is evenly applied and that the collodion is not carried on to the vertical faces of the block. The temporary moistening vanishes like a cloud from the surface of the paraffin; the brush is then returned to the bottle; the knife is drawn and returned, leaving the section on the edge of the blade. The object in the block is then painted again, but before drawing the knife a second time the first section is removed with a scalpel and placed on the slide with its *upper face in contact with the fixative*. Then the knife is drawn again, and the other steps of the process repeated. Thus the collodion has time to dry thoroughly before the section is made. If the precautions above given are observed it will not be necessary to wait for the drying of the collodion, but the section may be cut at once, i. e. within five seconds after painting. It is thus possible to cut as fast as one can paint the surface, and with some practice it becomes possible to cut *continuous ribbons* of sections, which may be transferred at intervals. Practically I find it most convenient to cut enough to form one row or half a row of sections at a time and transfer at once to the slide, rather than to cut the whole object without interruption, as is done in the ordinary method.

The following precaution may prove serviceable:—Especial care should be exercised to prevent the painting of the vertical face nearest the operator, since the section is then liable to cling along its whole edge to this vertical film and be carried *under* the knife-blade. If by chance this should occur, the section should be removed from the block *before the knife is moved back*, as it is liable to be caught and lacerated between the face of the block and the under surface of the returning blade. The possibility of the section being thrown under the knife-blade may, however, be obviated either by carefully trimming the vertical face in case it is accidentally painted (to allow of which the *hither margin* of the paraffin may be left broader than the other three), or by drawing the knife *slowly*, so that the first indication of a failure to cut through the vertical film may be recognized and the section held in place on the blade by a slight pressure with a soft brush, whereupon the knife will cut through the film and leave the section free.

If by chance the paraffin block has been painted with too much collodion or with collodion which is too concentrated, thus leaving a shiny surface, the film should be at once broken by pressing it gently two or three times in quick succession with the end of a rather stiff, blunt, *dry* brush. This enables the collodion to dry quickly, and thus prevents the softening of the paraffin.

If the sections have a tendency to curl they may be flattened out on the slide by means of a brush, for a section thus impregnated with collodion may be handled during the first few seconds after contact with the Schällibaum mixture with much greater impunity than one

not so treated. If the collodion has been too much thinned with ether the fact will become apparent from the softening of the paraffin, and may be remedied by waiting for the evaporation of the ether or by adding thicker collodion.

This process can in no way be considered as a substitute for the ordinary method of cutting objects, since it requires more time and closer attention to details, but for those cases where there is a liability to crumbling, or where sections of sufficient thinness cannot be procured free from folds, it will doubtless be found very serviceable."

**Sections in Series.***—Herr F. Spee remarks that the success of cutting sections depends on the quality of the imbedding mass, on the shape which is given to the paraffin around the object to be cut, and on proper manipulation in cutting. His imbedding mass consists of paraffin with a melting-point of 50° C., which is prepared by melting it in an open porcelain dish over a spirit-lamp flame, and further heating it until it assumes the colour of yellow wax or honey. When cool, it appears as a homogeneous mass without air-bubbles; its cut surface feels soapy and greasy. This material has the advantage that sections made with a microtome adhere firmly together by their edges at the ordinary temperature of the room.

To imbed specimens, they are placed in the mass at a temperature of 60°–65° C. for 4–6 hours till they are thoroughly permeated by the paraffin, which is then allowed to cool. To cut sections, the superfluous paraffin is cut away and the remaining piece of paraffin so arranged that the edges of the sections which are made pass over each other and adhere together. This end is attained by giving the paraffin the shape of a parallel sided prism, of which the base is a right angle. The paraffin is melted on to a cork by a hot spatula, and fastened on to the object-carrier of the microtome in such a way that its broad side is parallel to the edge of the razor. As a rule, a layer of paraffin about 1/2–1½ mm. thick should be left round the specimen. No section should be thicker than 1/100 mm., and all the sections should be as nearly as possible of equal thickness. If thicker than 1/100 mm. they roll easily, while too great unevenness interferes with the continuity of the ribbon. The best ribbons are obtained with specimens which have a small surface. For practical purposes the ribbons should not be longer than 15–20 cm. To fix them on the slide the author uses the gum solution of Flögel with good results.

**New Carmine Solution.**†—For the investigation of Protozoa, Medusæ, Echinodermata, *Lumbrici*, *Podura*, &c., Dr. O. Hamann uses a solution which is made as follows:—30 grms. carmine are mixed with 200 grms. concentrated ammonia, and glacial acetic acid is added until the solution is neutral or only faintly acid. The filtered solution is ready for use in two to four weeks. Dr. W. Krause recommends it, used warm, for staining the retina, nervous system, and glands of Vertebrata.

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 6–12.

† Internat. Monatsschr. f. Anat. u. Histol., i. (1884) Heft 5.

**Method of Preparing Hæmatoxylon Staining Fluid.***—Dr. S. J. Hickson states that the best method of preparing hæmatoxylon fluid is to follow Mitchell's instructions, taking some further precautions.

Take 56 grammes of the logwood extract, and thoroughly pound it in a mortar. Then place it on a filter, and pour about a litre and a half of ordinary tap water through it. The filtrate may be thrown away, and the residue allowed to dry. In the meantime prepare a solution of alum as follows:—Take 25 grammes of alum, and after they have been thoroughly pounded in a mortar pour them into 250 cc. of distilled water. To this solution add strong potash until a precipitate is formed which will not dissolve upon stirring and standing. Pour the alum solution upon the hæmatoxylon residue, and allow them to macerate together for three or four days in a warm room. Then filter the hæmatoxylon solution into a bottle provided with a closely fitting stopper, and add to it 10 cc. of pure glycerin and 100 cc. of 90 per cent. spirit. The residue need not be thrown away, for it can be macerated again with alum solution for a week or more, and a good strong stain obtained as before. When the solution is thus made it should be well shaken, and allowed to stand for some weeks before being used. This solution of hæmatoxylon improves considerably with age. The oldest which the author has was made about twelve months ago, and is by far the best.

The hæmatoxylon stain produced by this recipe possesses several advantages over others. In most cases it differentiates the tissues admirably; nuclei stain deeply, cell-protoplasm faintly; it seems to last a long time without showing signs of fading, and, as it penetrates well, it is very useful for staining in bulk.

**Staining for the Study of Red Blood-corpuscles.**†—In the study of red blood-corpuscles in bone-marrow, Professors G. Bizzozero and Torres employ as a staining reagent salt solution of varying strength (in Reptilia 0·55–0·60 per cent.) to which 1/10 per cent. methyl or gentian violet is added. No other stain contrasts so sharply with the ground-stain of the hæmoglobin-containing stroma. In animals with very large blood-corpuscles, subsequent treatment with 0·5 per cent. acetic acid must be adopted to render the cell-substance transparent.

To study the process of division in the blood of Anura larvæ, they must be examined in the living state, and rendered motionless by placing them before observation in 0·5 per cent. solution of curara.

**New Double Stain for the Nervous System.**‡—Dr. H. Sahli finds the following an excellent method.

The sections, which should not be in water for more than five to ten minutes after they have been cut, are placed for several hours in a concentrated watery solution of methylen-blue, washed in water, and transferred to a saturated watery solution of acid fuchsin for about five minutes. They are then quickly washed in water and

* Quart. Journ. Micr. Sci., xxv. (1885) p. 244.
† Arch. Ital. de Biol., iv. (1883) pp. 309-29.
‡ Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 1-7.

placed for a few seconds in a 1 per cent. alcoholic solution of caustic potash, and washed in a large quantity of water. The white substance then appears to the naked eye blue or violet, and the grey substance red. With high powers one can see in transversely divided fibres the axis-cylinder red, while in some fibres the whole medullary sheath is composed of "cyanophilous," in others of "erythrophilous" substance, or, again, the sheath is composed of concentric layers of blue and red stained substances. In the grey substance of the spinal cord Gerlach's network of delicate fibres is stained blue or violet on a red ground.

**New Method of Staining the Spinal Cord.***—Prof. A. Adamkiewicz finds that by staining with saffranin and methylen-blue, individual segments of the cord can be differentiated. These "chromoleptic zones" are situated in general round the grey substance, following the outer contour of the cord. They also occupy the internal part of the posterior fasciculus, and the part of the lateral fasciculi which occupies the angle between the anterior and posterior cornua. The non-chromoleptic zone forms a ring round the periphery of the cord.

**Staining the Axis-cylinder of Medullated Nerve-fibres.**† — As the result of his investigations, Dr. C. Kupffer finds that the axis-cylinder contains the nerve-fibrils, which float loose in nerve-serum. A compact axis-cylinder is an artificial product. To demonstrate the nerve-fibrils in the axis-cylinder, the nerve is fixed on a cork and placed for two hours in a 1/2 per cent. solution of osmic acid, washed for two hours with distilled water, stained for 24–28 hours in a saturated solution of acid fuchsin, washed for 6–12 hours in absolute alcohol, clarified with oil of cloves, imbedded in paraffin, and cut. The fibrils in the axis-cylinder are stained bright red, and appear in cross section as stained points.

**Staining Desmids.**—Mr. W. B. Turner sends us the following process for staining desmids without contraction of the endochrome.

When quite fresh gathered, wash and place in a solution of chromic acid, so weak that it requires three days to decolorize a large desmid. When the colour has gone, wash well in at least two waters and stain with anilin. Fix with a little tartaric or weak nitric acid. Then wash and mount in camphorated or carbolized water (about 10 to 90 per cent. distilled water).

All fresh-water algæ seem to do well under this process, including the delicate *Draparnaldia*, which entirely fail after a little time in the ordinary fluids.

**Boro-glyceride for Mounting.**‡—Mr. A. P. Wire has for two years experimented on this substance, and with, at present, such good results, that he considers it worthy of extended trial. Boro-glyceride is composed of boracic acid and glycerin, and exists in two forms, the

* SB. K. Akad. Wiss. Wien, lxxxix. (1884) p. 245.

† SB. K. Bayer. Akad. Wiss., 1884, pp. 466–75.

‡ Journ. of Proc. Essex Field Club, iv. (1885) pp. lxxix.–lxxx. Sci.-Gossip, 1885, pp. 139–40.

glacial and the hydrated. For mounting, a saturated solution of glacial boro-glyceride is used, made by dissolving the substance in warm water—using about one part to twelve of water—and allowing the surplus to crystallize out and settle. It is excellent for vegetable tissues. It does not act on them in any way, grains of chlorophyll even remain unchanged. It does not destroy the anilin colours used for staining, although the delicate colours of flower petals appear to bleach in the solution. It answers for mounting insects whole and without pressure. Gold size or brown cement does for fixing the upper glass of the cell.

**Litharge and Glycerin as a Cement.**—Mr. J. C. Douglas writes that if sifted dry litharge powder is mixed with glycerin, it forms a cement which hardens rapidly in air and water, bears 275° C., and is very resistant to reagents. It is stated to be adhesive to all materials, the articles to be cemented being preferably moistened with glycerin. The cement will probably be found well suited to many purposes of the microscopist.

**Hamlin's Ideal Slide.***—Mr. F. M. Hamlin considers an "ideal slide" to be one where the slide and cell are of *one* piece of glass, thus doing away with all cement except that required to secure the cover-glass.

When a cell of ordinary depth is required, an excavation could be made in a slide of usual thickness, which could not only contain the object, but the cover-glass, so that the upper surface of the latter should be even with the surface of the slide, thus protecting it from

Fig. 178.

being displaced by accident. (This plan was suggested by Mr. B. Piffard last year. See this Journal, Vol. IV. (1884) p. 655.) The diameter of the excavation for the cell should be a little less than that for the cover-glass, so as to form a ledge for it to rest upon (fig. 178).

When a cell of greater depth is required than an ordinary slide will permit, a very different case is presented, unless a slide of unusual thickness is used. To secure in the middle of the slide the necessary thickness, the glass could be cast in a mould which would, at the same time, form the cell and the ledge for the support of the cover-glass (fig. 179).

There are difficulties in the way of carrying out these ideas, but

Fig. 179.

the author cannot think them insuperable, or, if overcome, that they will render such slides too expensive for general use.

Apart from the saving of time and labour, the chief advantages would be in the perfect safety and imperishability of the mount, for

* Proc. Amer. Soc. Micr. 7th Ann. Meeting, 1884, pp. 179-80 (2 figs.).

the object practically would be sealed hermetically in glass; the contact of the media with the cement would be so slight as to be hardly worth considering. Objects thus mounted would, it is claimed, be as permanent as the glass itself.

**Finish for Slides.***—Dr. J. E. Hays recommends the following as a handsome finish for slides.

Take one of the packages of "gold or silver paints" put up by Wells and Richardson, of Burlington, Vt., and sold in connection with their "diamond dyes," and add it to 1/2 oz. of the best dammar varnish, warming the varnish so as to make the paint mix with it well, and apply with a fine brush. The paint will settle to the bottom upon standing, but by warming a little and shaking well it is diffused again. This makes a very pretty finish, and adds strength to the cover cement as well.

**Counting of Microscopic Objects for Botanical purposes.†**—M. E. C. Hansen recommends the application to botany of the method of counting blood-corpuscles adopted by physiologists. The apparatus devised by Hayem and Nachet is equally applicable to the counting of yeast-cells, as well as in examinations of air, water and soil for microbes. It is also useful for making pure cultures when it is necessary to ascertain the number of micro-organisms in a given quantity of liquid to determine the extent of the dilution required. In a similar way Jörgensen determined the proportions of each substance in a mixture of rye and wheat flour.

**Styrax and Balsam.**—Prof. A. B. Aubert's‡ experience with styrax has proved that in most cases it can be used instead of Canada balsam—indeed, that it is superior to balsam, showing the finer part of objects more clearly. He has entirely discarded balsam for diatoms. Cartilage, when properly stained, shows very well, better in his opinion than in glycerin-jelly. For histological objects generally, he anticipates it will be a welcome addition to the present stock of mounting media. Tooth, bone, and other sections would undoubtedly show to better advantage in this medium than in balsam.

Mr. C. V. Smith, the well-known mounter of botanical objects, to whom he sent specimens of the gum, spoke very highly of it for botanical mounts, and said that he never tried any medium which showed aleurone-grains in section of castor-oil plant so satisfactorily. It also shows the mycelia of fungi more clearly than most other media.

Objects mounted a year ago show no sign of deterioration, and there is every reason to believe that it will prove an excellent medium for permanent mounts, preferable to balsam, not only on account of its highly refractive index but also because it seems somewhat less brittle. When the solutions kept in capped bottles become thick by evaporation, it is best to transfer them to a common bottle and add the proper amount of solvent. This will cause a flocculent precipitate.

* The Microscope, v. (1885) p. 112.
† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 191–210 (6 figs.).
‡ Amer. Mon. Micr. Journ., vi. (1885) pp. 86–7.

Let stand for several days, filter back into capped bottle, when a clear solution, ready for use, will be obtained.

On the other hand, Mr. J. Deby finds that styrax never dries completely, and he considers that, except for tests, the old balsam mount is the safest and longest-lived of all.

**Bureau of Scientific Information.***—With a view to the more general dissemination of the results of scientific investigation, and facilitating the work of the student in natural history, certain members and officers of the Academy of Natural Sciences of Philadelphia have associated themselves into a "Bureau of Scientific Information," whose function is the imparting, through correspondence, of precise and definite information bearing upon the different branches of the natural sciences. It is believed that through an organization of the kind considerable assistance can be rendered to those who, by the nature of their surroundings, are precluded from the advantages to be derived from museums and libraries. The scope of the organization does not embrace considerations of a purely professional character—such as mineral or chemical analyses—nor the determination of collections, except by special agreement. Dr. J. Leidy undertakes the Mycetozoa, Rhizopoda, Entozoa, &c.; E. Potts, pond life, freshwater sponges, and Bryozoa; Dr. B. Sharp, worms and histology; and Dr. J. Gibbons Hunt, microscopical technology.

**A New Departure.**†—The following advertisement is appearing: "Microscopic objects for hire, histological, botanical, geological, by the best mounters. Let out on most moderate terms."

ADAMKIEWICZ, A.—**Neue Rückenmarkstinctionen. I. Ergebnisse am normalen Gewebe. II. Ergebnisse der Saffraninfärbung am kranken Rückenmarksgewebe.** (New stains for spinal cord. I. Results with normal tissue. II. Results of saffranin staining in diseased tissue.) [*Supra*, p. 742.]
*SB. K. Akad. Wiss. Wien*, LXXXIX. (1884) p. 245 (3 pls.).
*Anzeig.*, 1884, No. 10. See also *ante*, p. 428.

ADY, J. E.—**The Microscopic Study of Rocks. V., VI.**
[Mounting, finishing, and storing.]
*Illus. Sci. Monthly*, III. (1885) pp. 163–6, 198–202.

„ „ **Observations on the Preparation of Mineral and Rock Sections for the Microscope.** *Mineral. Mag.*, VI. (1885) pp. 127–33 (2 figs.).
Abridgment in *Engl. Mech.*, XLI. (1885) pp. 342–3 (2 figs.).

**Bacterial Pathology.**
[A series of papers on the exhibits at the biological laboratory of the Health Exhibition, with figures showing the appearance of the bacteria and the apparatus used in preparing and cultivating them.]
40 pp., 30 figs. 8vo, New York, 1885 (reprinted from *Lancet*).

BASTIN, E. S.—**Directions for Preparing and Mounting Sections of Stems and Leaves.** *Western Druggist.* Noted in *Bot. Gazette*, X. (1885) p. 264.

BOOTH, M. A.—**Why do dry mounts fail?** [*Post.*]
*Micr. Bulletin* (Queen's) II. (1885) pp. 17–8.

BOTTONE, S.—See Volvox.

---

* Science, iv. (1884) p. 108. † Nature, xxxii. (1885) p. xxix.

Burrill, T. J.—[Stains for Vegetable Sections.]

[His stain for tubercle bacillus is excellent also for vegetable sections, being remarkably selective in regard to the different tissues.]

*Micr. Bulletin* (Queen's) II. (1885) p. 21.

Castellarnau, J. M. de.—**La Estacion zoologica de Napoles y sus procedimientos para el examen microscopico.** (The zoological station at Naples and its processes for microscopical examination.)

[An elaborate and ably prepared report to the Spanish Director General of Agriculture, Industry, and Commerce, forming a classified description of processes for preparing objects.]

xiii. and 207 pp. 8vo, Madrid, 1885.

Cole, A. C.—**Studies in Microscopical Science.**

Vol. III. Sec. I. Part 5, pp. 17–20. The Sexual Reproductive Organs of *Chara*. Plate V. Part 6, pp. 21–4. Structure of Archegonium in *Marchantia*. Plate VI. *Marchantia* showing its sexual organs and sporogonium.

Sec. II. Part 5, pp. 17–20. The Integument. Plate V. V. S. of Skin of Frog. Stained Carmine. × 75. Part 6, pp. 21–4. Integumentary Appendages. Plate VI. Tail-feather of young Starling (*in situ*). T. S. × 100.

Sec. III. Part 5, pp. 17–20. Interstitial Pneumonia. Plate V. × 200. Part 6, pp. 21–4. Tubercle, Pulmonary Tuberculosis. Plate VI. Miliary Tubercle × 200.

Sect. IV. Part 5, pp. 17–20. Leeches (*concld.*). Hair. Plate V. Hair of Peccary (Dicotyles). Tr. Sec. × 210. Part 6, pp. 21–4. The tail of a Puppy (including methods of preparation (*post*). Plate VI. T. S. double stained × 30.

Collins's (C.) **Slides of Parasites of Birds, &c.** *Sci.-Gossip*, 1885, p. 140.

Cooke, M. C.—**Collecting, Examining, and Preserving Freshwater Algæ.**

[Demonstration.] *Journ. Quek. Micr. Club*, II. (1885) pp. 148–50.

Courroux, E. S.—**On Diatoms in the Stomachs of Shell-fish and Crustacea.** [*Supra*, p. 734.] *Journ. of Microscopy*, IV. (1885) pp. 196–8.

Doane, L. G.—**Gold and Silver Ferns.**

[Upon a slip of glass put a drop of liquid auric chloride or argentic nitrate, with half a grain of metallic zinc in the auric chloride, and copper in the silver. A growth of exquisite gold and silver ferns will form beneath the eye.]

*The Microscope*, V. (1885) p. 112.

Draper, E. T.—**Graphic Microscopy. XVIII. Seeds of Love-lies-bleeding** (*Amaranthus caudatus*). **XIX. Section of Shell of Barnacle.** (*Balanus sulcatus*).

*Sci.-Gossip*, 1885, pp. 121–2 (1 pl.), 145–6 (1 pl.).

**Embedding in Bayberry Tallow.** [*Supra*, p. 735.]

*Amer. Mon. Micr. Journ.*, VI. (1885) p. 98, from *Louisville Med. News*.

*Fabre-Domergue.*—See *Klein, E.*

Flahault, C.—**Récolte et préparation des Algues en voyage.** (Collection and preparation of algæ when travelling.) 12 pp., 8vo, Montpellier, 1885.

*Fol, H.*—**The Cultivation of Microbes.** *Science*, V. (1885) pp. 500–4 (10 figs.).

Transl. and abridged from the article in *La Nature*.

[Frazer, P.]—**Report of Microscopical Examination of Thin Transverse Sections of Carbons.**

[With five photo-collotypes through the Microscope of thin sections of electric light carbons.]

*Reports of Examiners on Electric Lamps and Carbons for Arc Lamps. International Electrical Exhibition of the Franklin Institute*, 1884, pp. 22–5 (1 pl.). (*Supplt. to Journ. Franklin Inst.*, 1885.)

*Gierke, H.*—**Staining Tissues in Microscopy. III.** [*Post.*]

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 106–7. Transl. from *Zeitschr. f. Wiss. Mikr.*

Gillo, R.—**On Mounting Beetles and other Insects without pressure.** [*Supra*, p. 732.] *Journ. of Microscopy*, IV. (1885) pp. 151–4.

Goodwin, W.—**Double-staining Vegetable Tissues.**

*Proc. and Trans. Nat. Hist. Soc. Glasgow*, I. (1885) pp. v–vi.

GRANT, F.—**Mounting Bacteria—Comma Bacilli.**
[Reply to "Medicinæ Doctor," *ante*, p. 565.]
*Engl. Mech.*, XLI. (1885) p. 324.

„ „ See Volvox.

GREGORY, J. W.—**Microscopical Examination of Rocks.**
[Abstract only.]
*8th Ann. Report Hackney Micr. and Nat. Hist. Soc.*, pp. 20–1.

HAACKE, W.—**Ueber die Verwendung von Kühleimern beim Sammeln von Seethieren.** (On the use of coolers in the collection of marine animals.)
[*Post.*] *Zool. Anzeig.*, VIII. (1885) p. 248.

HARE, A. W.—See Woodhead, G. S.

HAYS, J. E.—**A Handsome Finish for Slides.**
[*Supra*, p. 744.] *The Microscope*, V. (1885) p. 112.

HEURCK, H. VAN.—**Synopsis des Diatomées de Belgique.** (Text.)
[Contains chapters on the drawing, collecting, and preparation of diatoms.]
235 pp. and 3 supplementary plates, 8vo, Anvers, 1885.

HILGENDORF, F.—**Eine Methode zur Aufstellung halbmikroskopischer Objecte.** (A method of preserving semi-microscopic objects.) [*Post.*]
*SB. Gesell. Naturf. Freunde Berlin*, 1885, pp. 13–6.

Hinton's (E.) **Type Slide of Blood.**
[Blood-corpuscles of man, frog, bird, fish, and snake on one slide.]
*Sci.-Gossip*, 1885, p. 139.

[HITCHCOCK, R.].—**Postal Club Boxes.**
[List of preparations, with remarks.]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 117–8.

HORNER, J.—**Work for the Microscope.**
[I. Introductory. II. The Collecting of Objects.]
*Our Corner*, V. (1885) pp. 361–5; VI. (1885) pp. 34–8.

IHL, A.—**Ueber neue empfindliche Holzstoff- und Cellulose-Regentien.** (New reagents for Lignin and Cellulose.) *Chemiker-Ztg.*, IX. (1885) No. 14–15.

JACKSON, E. E.—See Walmsley, W. H.

JACOBS, F. O.—**New Freezing Microtome.** [*Post.*]
*Amer. Natural.*, XIX. (1885) pp. 734–6 (2 figs.).

*James, F. L.*—**Ciment de blanc de zinc pour construire les Cellules.** (White zinc cement for making cells.) [*Post.*]
*Journ. de Microgr.*, IX. (1885) pp. 209–12,
Translated from article in the *National Druggist*.

JENKINS, A. E.—**Methods of Work. II.**
[The preparation of animal tissues (Killing. Osmic Acid. Chromic Acid. Picric Acid. Nitric Acid and Acetic Acid). Mixtures of various acids (Osmic-acetic Acid. Chromic-acetic Acid. Chromo-osmic-acetic Acid. Chromic-nitric Acid. Merkel's fluid).]
*The Microscope*, V. (1885) pp. 126–31.

JOHNE, —.—**Ueber die Koch'schen Reinculturen und die Cholera-bacillen.** (On Koch's pure cultures and the cholera bacillus.)
[Contains complete directions for cultivation and observation.]
2nd ed., 28 pp. and 1 fig., 8vo, Leipzig, 1885.

*Klein, E.*—**Microbes et Maladies. Guide pratique pour l'étude des micro-organismes.** (Micro-organisms and Disease. Practical guide to the study of micro-organisms.)
[*Transl.* by Fabre-Domergue.] 292 pp. and 116 figs., 8vo, Paris, 1885.

LATHAM, V. A.—**The Microscope and how to use it. II., III. On Mounting Microscopic Objects.**
*Journ. of Microscopy*, IV. (1885) pp. 96–104 (1 fig.), 186–98.

Le Pelley's (C.) **Dipping Tubes.**
[Exhibition only—"of a superior kind."]
*Journ. Quek. Micr. Club*, II. (1885) p. 161.

LOOSS —.—**Neue Lösungsmittel des Chitins.** (New medium for dissolving chitin.) [*Post.*] *Zool. Anzeig.*, VIII. (1885) pp. 333–4.

MARK, E. L.—**Notes on Section-cutting.** [*Supra*, p. 737.]
*Amer. Natural.*, XIX. (1885) pp. 628–31.

MARSHALL, W. P.—**Pennatulida. Microscopic Sections and the mode of Automatic Section-cutting and Mounting.**
[Description of the accepted processes.]
*Midl. Natural.*, VIII. (1885) pp. 191–3.

Mayer's (P.) **Carbolic Acid Shellac.** [*Post.*]
*Amer. Natural.*, XIX. (1885) p. 733.

M'CALLA, A.—**The Working Session.**
["Further thoughts in its favour."]
*Micr. Bulletin* (Queen's) II. (1885) p. 19.

MONDINO, C.—**Sull' uso del bicloruro di mercurio nello studio degli organi centrali del sistema nervoso.** (On the use of bichloride of mercury in the study of the central organs of the nervous system.) [*Post.*]
*Giorn. R. Accad. Med. Torino*, 1885, pp. 38–47.

NOLL, E.—**Eau de Javelle, ein Aufhellungs- und Lösungsmittel für Plasma.** (Eau de Javelle, a clearing and dissolving medium for protoplasm.) [*Post.*]
*Bot. Centralbl.*, XXI. (1885) pp. 377–80.

PELLETAN, J.—**Microtome à triple pince.** [*Post.*]
*Journ. de Microgr.*, IX. (1885) pp. 171–4 (1 fig.).

PERAGALLO, H.—**Diatomées du Midi de la France.** (Diatoms of the south of France.)
[Containing chapters on the collection, preparation, and examination of diatoms, pp. 201–34.]
*Bull. Soc. D'Hist. Nat. Toulouse*, XVIII. (1884) pp. 189–272.

QUEEN, J. W.—**Glass Disc for Arranging Diatoms.**
["For arranging diatoms in symmetrical patterns, a good device is a glass disc with radial and concentric lines to fit to the eye-piece."]
*Micr. Bulletin* (Queen's) II. (1885) p. 24.

REX, G. A.—**The Myxomycetes—their Collection and Preservation.**
["Few of the lower orders of plants equal these in beauty as microscopic objects, whether viewed in their entirety with the binocular, or in their structural details with high powers. Some genera, as *Diachea* and *Lamproderma*, display a brilliant metallic or iridescent lustre of the sporangia walls. Others, of the Physaraceæ, are characterized either by snowy crystals or highly coloured granules, orange, scarlet, lilac, or purple, of calcium carbonate. Still others, of the Trichiaceæ and Arcyriaceæ, by their beautiful spore and thread-markings and sculpturing, are worthy objects for the use of the higher lenses of the Microscope."]
*Bot. Gazette*, X. (1885) pp. 290–3.

RICHARD, J.—**Nouveau réactif de fixation des animaux inférieurs.** (New fixing agent for the lower animals.) [*Post.*]
*Zool. Anzeig.*, VIII. (1885) pp. 332–3.

ROHRBECK, H.—**Neuerungen an bakteriologischen Apparaten.** (Improvements in bacteriological apparatus.) *Gæa*, XXI. (1885) Heft 6.

ROMITI, G.—**Une noticina di technica embriologica.** (Note on technical embryology.) [*Post.*] *Boll. Soc. Cultori Sci. Med. Siena*, III. (1885).

SLACK, H. J.—**Pleasant Hours with the Microscope.**
[The minute structure of the anthers of plants—"Blight" Insects and Mites.]
*Knowledge*, VII. (1885) pp. 548–50 (1 fig.), VIII. pp. 91–2 (3 figs.).

SMITH, E.—**Varnish for "Ringing" Slides.**
[Evaporate Canada balsam by gentle heat until it sets hard when cold; then dissolve it in as much benzole as will allow it to flow freely from the brush.]
*Journ. of Microscopy*, IV. (1885) p. 122.

STOWELL, C. H.—**The Microscope in Medicine.**
[In the diagnosis of disease. In the detection of fraud. In the detection of adulteration of powdered drugs. In correcting diagnoses. In the differential diagnosis of the new formations.]
*The Microscope*, V. (1885) pp. 121–6.

TATE, A. N.—**Microscopical Examination of Potable Water.**
[Paper read to Liverpool Microscopical Society.]
*Engl. Mech.*, XLI. (1885) p. 145.

TAYLOR, T.—**Discrimination of Butter and its Substitutes.** [*Post.*]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 115.

**Tea, Microscopical Examination of.**
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 101–2 (2 figs.).

THURSTON, E.—**The Staining of Bacteria for Micro-photographic purposes.**
*The Microscope*, V. (1885) pp. 138–40, from *Photographic News.*

VAN BRUNT, C.—**Diatoms fastened by heat.**
[When diatoms are thus fastened to the cover-glass, only so much heat should be applied as is found to be really necessary. Least heat is required when the diatoms are taken from a solution of alkali.]
*Journ. N. York Micr. Soc.*, I. (1885) p. 123.

**Volvox globator, keeping alive and mounting.**
[Replies by S. Bottone and F. Grant to query.—Mount in a mixture of equal bulks of methylated spirits, water, and glycerin (S. Bottone). Solution of osmic acid, anilin-green, magenta, and Hantsche's fluid, "The result is a double stain which is distinctive but not very effective" (J. Grant).]
*Engl. Mech.*, XLI. (1885) p. 440.

WALMSLEY, W. H.—**The Merits of White Zinc Cement.**
[Commendation of it. Also note by editors and E. E. Jackson.]
*The Microscope*, V. (1885) pp. 135–6, see also p. 137.

WALTERS, W. H.—**Histological Notes for the use of Medical Students.**
vi. and 65 pp., 8vo, Manchester, 1884.

WARLOMONT, R.—**Note sur la technique microscopique de l'œil.** (Note on the microscopic technique of the eye.) [*Post.*]
[Description of the processes used at the Royal Ophthalmic Hospital, Moorfields.]
*Bull. Soc. Belg. Micr.*, XI. (1885) pp. 201–8.

WEDDING, H.—**Properties of Malleable Iron.**
["Microscopical investigation had led him to modify the explanation of welding he had given some years ago. He had now come to the conclusion that the strength of a finished piece of iron depends on the sectional area of the mass of iron it contains. From the total sectional area of a piece of weld iron, the slag conclusions, and in the case of ingot iron the blow-holes, must be deducted. This calculation is decidedly in favour of the ingot iron, though he pointed out it can only be superficially effected, even with our present knowledge of microscopy."]
*Science*, V. (1885) p. 492.

WHITMAN, C. O.—**The Uses of Collodion.** [*Post.*]
*Amer. Natural.*, XIX. (1885) pp. 626–8.

WILLIAMS, C. F. W. T.—**Crystals for the Polariscope.**
[Recommends mounting in castor-oil as a remedy for the instability referred to by Mr. J. W. Neville, *ante*, p. 566.]
*Sci.-Gossip*, VII. (1885) p. 140.

WIRE, A. P.—**Note on a new Medium for Mounting Moist Vegetable Tissues for the Microscope.** [*Supra*, p. 742.]
*Journ. of Proc. Essex Field Club*, IV. (1885) pp. lxxix.–lxxx.
See *Sci.-Gossip*, 1885, pp. 139–40.

WOODHEAD, G. S., and A. W. HARE.—**Pathological Mycology. An Enquiry into the Etiology of Infective Diseases. Sec. I. Methods.** [*Supra*, p. 698.]
x. and 174 pp., 60 figs., 8vo, Edinburgh, 1885.

## PROCEEDINGS OF THE SOCIETY.

Meeting of 10th June, 1885, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 13th May last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Wythe, J. H., The Microscopist, a Compendium of Microscopic Science. 4th edition, pp. xii. and 434, 252 figs. 8vo, Philadelphia, 1883 .. .. .. .. .. .. .. .. .. | *The Author.* |
| Bale, W. M., Catalogue of the Hydroid Zoophytes in the Australian Museum. pp. 198 and 19 pls. 8vo, Sydney, 1884 .. .. .. .. .. .. .. .. .. .. .. | *The Author.* |
| "Star" Microscope .. .. .. .. .. .. .. .. .. | *Mr. Joseph Beck.* |
| Slides (55) showing action of diamond in ruling glass .. .. | *Prof. W. A. Rogers.* |

**Mr. Suffolk** exhibited a collecting bottle with flat sides, which had been ground and polished. Every one must have found the inconvenience of the ordinary round bottles through which it was impossible to see anything clearly, and therefore would welcome one which had flat sides worked to a true surface, through which an ordinary objective could be focused, and would give perfect definition. The bottles were made by Mr. Stanley.

Prof. Bell said that flat bottles had been made for some time, but they were not to be had except from foreign makers. He believed that some had been used at the College of Surgeons, but the glass was very bad, and their use had in consequence been discontinued. Round bottles were very inconvenient, and he hoped that as an English maker had taken up the matter, they might be able to get flat ones of different sizes.

Prof. Stewart said they had almost ceased to use these bottles at the College of Surgeons because the sides were so rough and the tops so far from flat as to be of very little value. The first samples were very much better, but the later ones were so bad as to be practically useless.

**Prof. Stewart** called attention to a specimen he exhibited under the Microscope, showing the special eyes of Chitonidæ described by Prof. Moseley. He also showed a model of the species of *Chiton*, but having found at the College of Surgeons a better specimen than the one from which Prof. Moseley's model had been made, he had brought it to the meeting. A section showed that the shell was raised into numerous corneal elevations beneath which it was

tunnelled out in a very distinct manner. Behind the elevation was a substance like a lens, and below this a space caverned out, at the lower end of which was a series of rods from which a number of filaments proceeded, together with some pigmented matter, forming a sort of choroid coat, a part of which projected forwards forming an iris. The optic nerves proceeded directly upwards, so that there was no turning over as in the eyes of the Pectens. In addition to the specimens exhibited Professor Stewart illustrated his remarks by drawings on the blackboard.

Prof. Bell said that he thought the Society should know something of the kind of work which was being done by Mr. Hill, who had been assisting Prof. Moseley, and had made the model exhibited. Whatever the general opinion of models might be, those who had any experience could speak as to their great use for purposes of illustration in class instruction.

---

Mr. H. G. A. Wright's letter with reference to Dr. Anthony's criticism on his note on the structure of the tongue of the blow-fly was read as follows:

"The February number of the Journal of the Royal Microscopical Society is only just to hand. At p. 174, I note Dr. Anthony's letter read at the January meeting of the Society, as to my observations on the structure of the tongue of the blow-fly. I have looked up his paper on 'The Suctorial Organs of the Blow-fly' in the June number of 'The Monthly Microscopical Journal' for 1874, and I at once disclaim any previous knowledge of it. I can only now regret that it was unknown to me, as I should have certainly given all the credit to Dr. Anthony for the discovery of the 'suctorial organs' which he so well earned by the long and arduous work he bestowed on this subject during the whole of a blow-fly 'season.' After speaking of his numerous dissections, he says, 'Many a hundred coaxings were necessary to get the parts into definite positions ere I could satisfy myself of the arrangement of what I will venture to call the 'suckers' attached to the pseudo-tracheæ of Diptera.' These suckers he likens to 'earlike appendages,' 'mouse ears,' or 'bat's ears.'

Before I sent the slide of the proboscis in September last, I consulted all the most recent standard works on the Microscope, as well as Mr. B. T. Lowne's 'Anatomy and Physiology of the Blow-fly,' and I could not glean any information that the details of structure described in my letter had been observed. This description was only such as would suggest itself to any one conversant with anatomy.

I hope I may be permitted to make this explanation so as to show that Dr. Anthony's charge that I have plagiarized, although not wilfully, must fall to the ground, and that it was, in fact, as he suggests, a 're-discovery.'

I wish to call attention to the fact, that the proboscis of the blow-fly as prepared and mounted by Mr. Sharp, requires no dissections or coaxings to display the leaf-like processes or 'suckers' *in situ*. Under a sufficiently high power, they at the first glance arrest the observer's attention, their visibility being entirely due to the mode

of preparation, and to the highly refractive fluid in which the object is mounted. I find with a 2/3 Tolles of 65° or a 1/4 inch of 90° (made twenty-five years ago by the late Andrew Ross) the 'suckers' can be distinctly seen, although not with equal brilliancy to the performance of my Tolles 1/10 immersion lens. When viewed with the latter, each of the suckers appears as an actual protrusion of the lining membrane of the pseudo-trachea through a corresponding forked opening of the chitinous ring, and its expansion forms the leaf-like process or 'sucker'; each of these has a longitudinal slit or fissure extending from the base to the apex; in some of the suckers, the slit is seen with the margins in close contact, in others it is more or less widely open, and they all, on each pseudo-trachea, communicate with a central undulating channel running its whole length.

The elasticity of the chitinous rings does not satisfactorily explain the way the suckers act; the opening and closing of the slit is most likely effected by some inherent contractile power in the sucker itself, which probably is under the control of the insect's will. In the imbibition of fluids, capillary attraction must also play a very important part, and it seems possible that the so-called 'suckers' may maintain a regulating action in this respect, and thus prevent what would be an injurious, or even fatal absorption.

I think if Dr. Anthony will examine a proboscis mounted by Mr. Sharp's method, he will candidly admit that his illustrations need something more than 'small alterations and corrections' to bring them 'up to date.'

As no allusion to his paper was made by any of the members present at the November meeting of the Society, the inference is, that with the exception of those to whom Dr. Anthony has personally shown his preparations and dissections, the 'suctorial organs' up to that time were generally unknown.

I used the term 'endoderm' in the same way Mr. B. T. Lowne has done in his work on the 'Anatomy and Physiology of the Blow-fly,' to indicate 'the innermost cuticular layer of the integument.'

It is likely that the 'suckers' consist of the three layers of the integument; certainly, they have an outer layer of the proto-derm, which Mr. Lowne describes (p. 9, 'Anatomy and Physiology of the Blow-fly') as 'transparent and continuous over the whole surface of the insect, investing all the appendages and processes of the skin, even the hairs, and covering the surface of the eyes. It appears to be continuous with the lining membrane of the tracheal system, and to extend throughout the digestive cavity, even although it is somewhat modified in the latter.'

I beg to send a slide of the blow-fly proboscis (mounted by Mr. Sharp), showing the 'suctorial organs,' as a donation to the Society's cabinet.

Mr. Sharp also sends for publication his method of preparation and mounting in the biniodide of mercury solution" (*supra*, p. 733).

The President said Mr. Wright's communication placed the matter in a somewhat different light and gave them additional information.

Mr. Suffolk said he had examined Mr. Wright's first specimen and

he had also made a similar specimen of his own, but the conclusion he came to was that the appearances described were due to some sort of diffraction effect and that they were in fact out-of-focus appearances.

---

Mr. J. Mayall, jun., called attention to the fact that a Nobert 19-band test-plate had been successfully mounted in Prof. Hamilton Smith's medium having a refractive index of 2·4, the result being to render the lines very much more visible than had been the case before. The preparation was made by Dr. van Heurck, and was attended with considerable difficulty.

---

Mr. Crisp said they had received from Prof. W. A. Rogers, of Cambridge, U.S.A., a collection of upwards of 50 slides showing the action of a diamond in ruling lines upon glass. The series was accompanied by a descriptive paper which when printed in the Journal would enable the Fellows to compare it with the slides.

The President said that Prof. Rogers had expressed the hope that some one might feel sufficiently interested in the subject to make a careful study of the slides. They had not yet had any opportunity either of examining the slides or reading the paper, but their best thanks were due to Prof. Rogers for his valuable donation.

A vote of thanks to Prof. Rogers was carried by acclamation.

---

Mr. Crisp, in exhibiting Theiler's "Universal Pocket Microscope," read some of the press notices of it and commented on the extravagant manner in which it had been referred to in some journals (*supra*, p. 704).

---

Dr. Maddox said that since the last meeting he had continued his experiments on the feeding of insects with bacilli, and had fed both the wasp and the blow-fly formerly alluded to, with the anthrax bacillus. They had lived on through the month until that very hot day when the thermometer rose to 136° in the sun, when they succumbed to what he believed was heat asphyxia, so that he was unable to attribute their deaths to any effect of the bacilli (*supra*, p. 606).

---

Mr. Waters read his paper "On the use of the Avicularian Mandible in Classification," the subject being illustrated by drawings.

---

Mr. Cheshire described a method of mounting which he had found of great advantage with the particular class of preparations with which he had lately been engaged, and he proposed to give some account of it, as likely to be of interest to others similarly working. All present were no doubt aware of the great value of glycerin as a mounting medium for delicate structures, Canada balsam being destructive to soft tissues and cells. Glycerin also possessed a marvellous immunity from freezing. The great difficulty about its use for mounting purposes generally arose from the fact that when once the surface of glass had been contaminated with glycerin it was very troublesome

to get rid of. The reason of this was that the surface of glass, however well polished, was not mathematically true, the most highly polished surface having its face covered with very fine lines, and these not all running in the same direction. In fact, if marks were made upon a piece of glass with glycerin or turpentine the traces of them could be distinctly seen after the glass had been well rubbed. The first thing therefore to do was to get a perfectly clean slip, and having put it upon the turntable, to make a ring of Canada balsam dissolved in benzole. The next thing was to get a perfectly clean cover-glass, and in order to hold this conveniently he had found it an excellent plan to mould a small piece of beeswax into a semicircular form having about the diameter of the cover, which if slightly pressed upon the upper side of the cover adhered to it sufficiently to form a kind of handle by which it could be lifted, and if it were turned upside down it would stand upon the corner of the table until it was wanted for use. A ring of the balsam was then put upon the under side of the cover-glass of the same size as that upon the glass slip. The next step was to select the object, and he had found that the most convenient things in which to keep stained objects were the small china saucers which were to be bought at the artists' colour shops; they were much better than watch-glasses. He then took up a small drop of glycerin and put it in the ring of balsam which had been made on the slide (and for this purpose he had found nothing better than the ivory handle of a small dissecting-knife), and then the object was placed on the slide. In doing this he had found nothing so useful as a watchmaker's eye-glass, and to save the inconvenience of having to take it up every time it was wanted he had it fastened round his head with a piece of elastic web, and when not in use it was pushed up upon the forehead. Having placed the object on the slide in proper position it was well to remove all superfluous glycerin, and the best way to do this was with a small sable brush, sucking off the fluid when the brush was full. Another drop of glycerin was then put upon the under side of the cover-glass, which was then placed in position on the slide; the two rings of balsam were slightly pressed together; they adhered immediately, and the thing was done. A small amount of practice would enable any one to judge exactly how much glycerin was required to fill the space; but if it happened that too much had been used it would force a small channel for itself and squeeze out through the balsam, which would afterwards close together again quite tightly. The only thing remaining to be done was to put on a coating of Hollis's glue to prevent the balsam from setting, and by adopting this system it would be found that the cover could be pressed down just as much as was required. The usual process was to smear the glass with glycerin first, and then of course the cement would not adhere properly and the result was leakage. Mr. Cheshire further illustrated his meaning by drawings upon the blackboard and by the exhibition of specimens which were handed round for inspection.

Mr. J. W. Groves said that Mr. Cheshire's first statement was that delicate structures and cells could not be seen in balsam-mounted

specimens; this, however, he was prepared to deny, knowing from experience that there was no difficulty in the matter. With regard to Mr. Cheshire's suggestion of sticking the clean cover on a piece of wax and letting it remain with the under side upwards until wanted, he could only say that if a cover was left like that in his laboratory for even two or three minutes it would get so coated with dust as to need cleaning again before it could be used. The plan of cleaning up the excess of glycerin by means of a brush was the one he usually adopted. With regard to putting two rings of balsam, there were, he thought, other things which would do better, and he should suggest Miller's caoutchouc cement instead, if there was no glycerin upon the slide. And instead of putting glycerin on the under side of the cover a better plan was simply to breathe on the cover—it answered quite as well and was much less trouble. In using a watchmaker's eye-glass, a far more convenient way was to have it mounted upon a piece of light spring wire fixed in a heavy block as a stand; it was then very easy to bend it over the object and apply the eye when required, and the moment the head was moved away, it sprang on one side without any attention being required by the worker.

Mr. Cheshire said that notwithstanding the remarks of the last speaker he must still persist in stating that there were some structures which were absolutely destroyed by mounting in Canada balsam. For instance, there was a certain part of the dorsal vessels, which contained cells which could not possibly be mounted in balsam without destruction. Certainly, if any one could so mount them without he should be very glad to see them.

Mr. Groves said he would willingly accept the challenge, the results to be shown in that room.

Mr. Cheshire said the proposal to breathe upon the cover-glass was just undoing the thing he had been advocating, and as regarded the difficulty of keeping the cover-glass clean, if mounting was done in such dusty places the cover might be placed with the under side downwards if necessary.

The President said they were very much obliged to Mr. Cheshire for his remarks. There were doubtless some amongst them who would derive useful hints from the communication. They would also be much interested in seeing the results of the mounting in balsam concerning which the challenge had been accepted.

---

**Prof. M. N. Dutt's** letter was read, accompanying some white powdery substance, found spread over a partly sandy and partly rocky extent of land adjoining the city of Delhi, which, when submitted to microscopic examination, appeared to be a living substance, and not simply lime and sand. The particles (to all appearances particles of lime, &c.) when examined with a low power, presented a white flocky appearance quite unlike any particles of lime. On dissolving a little of the powder in a drop of pure water and examining the solution with a high power, three and only three kinds of objects could be detected, viz.: (1) Crowds of rod-like bodies floating in the

liquid; (2) irregularly shaped gelatinous patches, of yellow and orange colour—few and in masses; (3) round, clear corpuscles. When the solution evaporates, these assume an elliptic form, the minor axis being disproportionately short. Most of these corpuscles had the Brownian movement when examined.

---

**Mr. White** inquired whether anything had been done in reference to the complaints made at the Rochester meeting of the American Society of Microscopists, of discrepancies in the gauges for the Society screw.

Mr. Crisp said that all that was known on the subject was what was recorded in the American Society's Proceedings.* No communication had up to the present time been received by this Society on the subject. It would no doubt come as soon as their friends on the other side were ready to make it, and in anticipation the Council had appointed a committee consisting of Mr. J. Beck, Mr. J. Mayall, jun., Mr. Bevington, and the Secretaries, to deal with any communication that might be received during the recess.

---

**Mr. G. Massee's** paper on "New British Micro-fungi" was read, in which he described five new species.

---

**Mr. W. B. Turner's** letter was read, describing a method of staining desmids without contraction of the endochrome (*supra*, p. 742).

---

**The President** announced that in consequence of the illness of the Librarian, the library would not be opened on Wednesday evenings for the present, and also that the library would in future be closed for four weeks, commencing from the Monday preceding the second Wednesday in August, instead of from the 1st August. The latter change was desirable in order to facilitate the issue of the August number of the Journal.

---

**The following Instruments, Objects, &c., were exhibited:—**

Mr. Crisp:—Theiler's Universal Pocket Microscope.

Mr. J. Mayall, jun.:—Nobert's 19-band plate mounted in Smith's medium.

Prof. W. A. Rogers:—Slides showing action of a diamond in ruling lines upon glass.

Mr. Sharp:—Proboscis of blow-fly mounted in biniodide of mercury.

Prof. Stewart:—Slides and model of eyes of Chitonidæ.

Mr. Suffolk:—Collecting bottle with flat sides.

Mr. Waters:—Slides illustrating his paper.

---

**New Fellows:**—The following were elected *Ordinary* Fellows:—(At the May meeting) Mr. Samuel R. Hallam. (At the June meeting) Messrs. Frederick H. Baker, Conrad Beck, and Rev. John More Gordon.

* Proc. Amer. Soc. Micr., 1884, pp. 153-9.

The Journal is issued on the second Wednesday of February, April, June, August, October, and December.

Ser. II. Vol. V. Part 5. OCTOBER, 1885. {To Non-Fellows, Price 5s.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

## CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

## ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

## MICROSCOPY, &c.

*Edited by*

**FRANK CRISP, LL.B., B.A.,**

*One of the Secretaries of the Society and a Vice-President and Treasurer of the Linnean Society of London;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S., *Lecturer on Botany at St. Thomas's Hospital,*

JOHN MAYALL, JUN., F.Z.S.,

F. JEFFREY BELL, M.A., F.Z.S., *Professor of Comparative Anatomy in King's College,*

FRANK E. BEDDARD, M.A., F.Z.S.,

AND

B. B. WOODWARD, F.G.S., *Librarian, British Museum (Natural History),*

FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED.] [STAMFORD STREET AND CHARING CROSS.

# CONTENTS.


TRANSACTIONS OF THE SOCIETY— PAGE

XIV.—NEW BRITISH MICRO-FUNGI. By G. Massee, F.R.M.S. (Plate XIII.) .. .. .. .. .. .. .. .. .. .. 757

XV.—ON EROSION OF THE SURFACE OF GLASS, WHEN EXPOSED TO THE JOINT ACTION OF CARBONATE OF LIME AND COLLOIDS. By William M. Ord, M.D., F.R.M.S., F.L.S. .. .. .. 761

XVI.—ON A SEPTIC MICROBE FROM A HIGH ALTITUDE. THE NIESEN BACILLUS. By G. F. Dowdeswell, M.A., F.R.M.S., F.L.S., &c. .. .. .. .. .. .. .. .. .. .. 769

XVII.—ON THE USE OF THE AVICULARIAN MANDIBLE IN THE DETERMINATION OF THE CHILOSTOMATOUS BRYOZOA. By Arthur Wm. Waters, F.R.M.S., F.L.S. (Plate XIV.) .. .. .. 774


## SUMMARY OF CURRENT RESEARCHES.

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.


DOHRN, A.—*Primitive History of the Vertebrate Body* .. .. .. .. .. .. 780
MINOT, C. S.—*Formative Force of Organisms* .. .. .. .. .. .. .. .. 780
FOL, H.—*Tail of Human Embryo* .. .. .. .. .. .. .. .. .. .. .. 781
LAULANIE—*Nature of the Placental Neoformation and the Unity of Composition of the Placenta* .. .. .. .. .. .. .. .. .. .. .. .. 783
DENIKER, J.—*Fœtus of Gibbon and its Placenta* .. .. .. .. .. .. .. .. 783
BROWN, H. H.—*Spermatogenesis in the Rat* .. .. .. .. .. .. .. .. .. 783
GERLACH, L.—*Hatching of Birds' Eggs after Lesion of the Shell* .. .. .. .. 784
SPENCER, W. BALDWIN—*Early Development of Rana temporaria* .. .. .. .. 785
BROOK, G.—*Development of Motella mustela* .. .. .. .. .. .. .. .. 785
RYDER, J. A.—*Development of the Salmon* .. .. .. .. .. .. .. .. .. 786
EWART, COSSAR, & G. BROOK—*Spawning of the Cod* .. .. .. .. .. .. .. 786
RETTERER—*Development of Vascular Glands* .. .. .. .. .. .. .. .. 787
MELLAND, B.—*Simplified View of Histology of Striped Muscle-fibre* .. .. .. .. 787
HOWES, G. B.—*Atlas of Practical Elementary Biology* .. .. .. .. .. .. 787


### B. INVERTEBRATA.


CONN, H. W.—*Marine Larvæ and their Relation to Adults* .. .. .. .. .. .. 788
RANSOM, W. B.—*Cardiac Rhythm of Invertebrates* .. .. .. .. .. .. .. 789
VARIGNY, H. DE—*Physiology of the Unstriated Muscles of Invertebrata* .. .. .. 791
FRENZEL, J.—*Temperature Maxima for Marine Animals* .. .. .. .. .. .. 791


#### Mollusca.


FRENZEL, J.—*Mid-gut Gland (Liver) of the Mollusca* .. .. .. .. .. .. .. 792
HALLER, B.—*Renal Organ of Prosobranchiata* .. .. .. .. .. .. .. .. 793
BOUVIER, E. L.—*Nervous System of Buccinidæ and Purpuridæ* .. .. .. .. 793
BOURNE, A. G.—*Communication of the Vascular System with the Exterior in Pleurobranchus* .. .. .. .. .. .. .. .. .. .. .. .. 794
GRIESBACH, H.—*Inception of Water among Mollusca* .. .. .. .. .. .. .. 794
SCHÜLER, P.—*Relations of Cavernous Spaces in the Connective Tissue of Anodonta to the Blood-vascular System* .. .. .. .. .. .. .. .. .. .. .. 794
GRIFFITHS, A. B., & H. FELLOWS—*Organs of Bojanus in Anodonta* .. .. .. .. 795
OSBORN, H. L.—*Mimicry among Marine Mollusca* .. .. .. .. .. .. .. 795

PAGE

## Molluscoida.

### α. Tunicata.

BENEDEN, E. VAN, & C. JULIN—*Postembryonal Development of Phallusia scabroides* 795
JOURDAIN, S.—*The Synascidian Diplosomidæ* .. .. .. .. .. .. .. .. 796

### β. Polyzoa.

LANKESTER, E. RAY—*Polyzoa* .. .. .. .. .. .. .. .. .. .. .. .. .. 797
OSTROUMOFF, A.—*Metamorphosis of Cyphonautes* .. .. .. .. .. .. .. .. 798

## Arthropoda.

### α. Insecta.

BEAUREGARD, H.—*Natural Development of Cantharis* .. .. .. .. .. .. .. 798
WIELOWIEFSKI, H. v.—*Formation of Ova in Pyrrhocoris* .. .. .. .. .. .. 798
KOROTNEFF, A.—*Development of Gryllotalpa* .. .. .. .. .. .. .. .. 798
VIALLANES, H.—*Optic Ganglion of Aeschna* .. .. .. .. .. .. .. .. .. 800
POULTON, E. B.—*Nature of the Colouring of Phytophagous Larvæ* .. .. .. .. 801
DEWITZ, H.—*How Insects adhere to flat vertical surfaces* .. .. .. .. .. .. 801

### γ. Prototracheata.

SEDGWICK, A.—*Development of Peripatus capensis* .. .. .. .. .. .. .. 802

### δ. Arachnida.

DAHL, F.—*Season Dimorphism in Spiders* .. .. .. .. .. .. .. .. .. 803
TROUESSART, E. L.—*Sarcoptidæ* .. .. .. .. .. .. .. .. .. .. 803

### ε. Crustacea.

CLAUS, C.—*Morphology of Crustacea* .. .. .. .. .. .. .. .. .. .. 803
SCHIMKEWITSCH, W.—*Development of Astacus* .. .. .. .. .. .. .. .. 805
GRIFFITHS, A. B.—*Extraction of Uric Acid Crystals from the Green Gland of Astacus fluviatilis* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 805
SAINT-LOUP, R.—*Parasites of Mæna vulgaris* .. .. .. .. .. .. .. .. 805
PELSENEER, P.—*Nervous System of Apus* .. .. .. .. .. .. .. .. .. 805
PACKARD, A. S.—*Embryology of Limulus polyphemus* .. .. .. .. .. .. .. 806
DYBOWSKI, B.—*Crustacea of Lake Baikal* .. .. .. .. .. .. .. .. .. 807
SMITH, SIDNEY I.—*New Crustacean* .. .. .. .. .. .. .. .. .. .. 807

## Vermes.

SAINT-LOUP, R.—*Organization of the Hirudinea* .. .. .. .. .. .. .. .. 807
HATSCHEK, B.—*Development of the Head of Polygordius* .. .. .. .. .. .. 808
HALLEZ, P.—*Development of Nematodes* .. .. .. .. .. .. .. .. .. 809
LEUCKART, R.—*Development of Sphærularia bombi* .. .. .. .. .. .. .. 810
LEIDY, J.—*New Bothriocephalus* .. .. .. .. .. .. .. .. .. .. 810
OUDEMANS, A. C.—*Circulatory and Nephridial Apparatus of the Nemertea* .. .. 810
SALENSKY, W.—*Development of Monopora vivipara* .. .. .. .. .. .. .. 811
BEDDARD, F. E.—*Nephridia of Acanthodrilus sp.* .. .. .. .. .. .. .. 813
ZACHARIAS, O.—*Nephridia of Microstoma lineare* .. .. .. .. .. .. .. .. 813
DUPLESSIS-GOURET, G.—*Fresh-water Monotidæ* .. .. .. .. .. .. .. .. 813
PERRONCITO, E.—*Action of Sodium Chloride on Cercariæ* .. .. .. .. .. .. 814
GRAFF, L. v.—*New Species of Myzostoma* .. .. .. .. .. .. .. .. 814
IMHOF, O. E.—*Pelagic and Fresh-water Rotatoria* .. .. .. .. .. .. .. 814

## Echinodermata.

CARPENTER, P. HERBERT—*Vascular System of Echinoids* .. .. .. .. .. .. 814
PERRIER, E.—*Ambulacra of Echinoderms* .. .. .. .. .. .. .. .. .. 815
PROUHO—*Anatomy of Dorocidaris* .. .. .. .. .. .. .. .. .. .. 815
DUNCAN, P. M.—"*Tag*" *of Cœlopleurus Maillardi* .. .. .. .. .. .. .. 815
CARPENTER, P. H.—*New Species of Metacrinus* .. .. .. .. .. .. .. .. 815

## Cœlenterata.

FAUROT—*Adamsia palliata* .. .. .. .. .. .. .. .. .. .. .. .. 816

## Porifera.

MARSHALL, W.—*Cœlenterate Nature of Sponges* .. .. .. .. .. .. .. .. 816
CARTER, H.—*Circulation in Spongida* .. .. .. .. .. .. .. .. .. .. 816
GOETTE, A.—*Development of Spongilla* .. .. .. .. .. .. .. .. .. 817
POTTS, E.—*New Fresh-water Sponge* .. .. .. .. .. .. .. .. .. .. 817

PAGE

## Protozoa.

LANKESTER, E. RAY—*Protozoa* .. .. .. .. .. .. .. .. .. .. .. 817
HALLIBURTON, W. D.—*Chemical Composition of Zoocytium of Ophrydium versatile* . 818
MÖBIUS, K.—*Freia Ampulla O. F. Müll., the Flask-animalcule* .. .. .. .. .. 818
BALBIANI, E. G., & A. SCHNEIDER—*Anoplophrya circulans* .. .. .. .. .. 818
STOKES, A. C.—*New Vorticella* .. .. .. .. .. .. .. .. .. .. .. 819
IMHOF, O. E.—*Difflugia cratera* .. .. .. .. .. .. .. .. .. .. .. 819
BLANCHARD, R.—*New Type of Sarcosporidia* .. .. .. .. .. .. .. 820

# BOTANY.

## A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

### α. Anatomy.

RUSSOW, E.—*Protoplasm in the Intercellular Spaces* .. .. .. .. .. .. .. 820
HENNUM, J. O.—*Forms of Cells* .. .. .. .. .. .. .. .. .. .. .. 820
ZACHARIAS, E.—*Structure of the Nucleolus* .. .. .. .. .. .. .. .. 821
GUIGNET—*Chlorophyll and its Combinations* .. .. .. .. .. .. .. 822
BORODIN, J. P.—*Crystals in the Leaves of Leguminosæ* .. .. .. .. .. .. 823
TIEGHEM, P. VAN—*Secreting Canals of Plants* .. .. .. .. .. .. .. 823
TICHOMIROW, W. A.—*Peculiar Structures in the Flesh of the Date* .. .. .. .. 824
PAX, F.—*Anatomy of Euphorbiaceæ* .. .. .. .. .. .. .. .. .. .. 824
KLERCKER, J. E. F. AF—*Anatomical Structure and Development of Ceratophyllum* 825
ZAHLBRUCKNER, A.—*Lenticels* .. .. .. .. .. .. .. .. .. .. .. 825
PFURTSCHELLER, P.—*Anatomy of the Wood of Conifers* .. .. .. .. .. .. 825
FISCHER, H.—*Comparative Anatomy of the Tissue of the Medullary Rays and Annual Zones of Growth in Conifers* .. .. .. .. .. .. .. .. .. .. .. 826
MARKFELDT, O.—*Behaviour of the Leaf-trace-bundles of Evergreen Plants as the stem increases in thickness* .. .. .. .. .. .. .. .. .. .. .. 826
TIEGHEM, P. VAN—*Gum-canals of the Sterculiaceæ* .. .. .. .. .. .. .. 827
HÖHNEL, F. v.—*Striated Woody Tissue* .. .. .. .. .. .. .. .. .. .. 828
HERAIL, J.—*Structure of Stem of Strychnos* .. .. .. .. .. .. .. .. 828
TSCHIRCH, A.—*Mechanical Tissue-system* .. .. .. .. .. .. .. .. .. 828
BACHMANN, E.—*Structure and Function of the Aril in certain Leguminosæ* .. .. 829
WORONIN, M.—*Leaves of Statice monopetala* .. .. .. .. .. .. .. .. 829
EBELING, M.—*Absorbing Organs of Albuminous Seeds* .. .. .. .. .. .. 829
STRASBURGER, E.—*Embryo-sac of Santalum and Daphne* .. .. .. .. .. .. 830
BACCARINI, F.—*Morphology of the Receptacle* .. .. .. .. .. .. .. 831
BALDINI, A.—*Spur of Cucurbitaceæ* .. .. .. .. .. .. .. .. .. 831
ADLERZ, E.—*Anatomy of the Fruit of Ranunculaceæ* .. .. .. .. .. .. 831
CUGINI, G.—*Anatomy of the Female Inflorescence of Dioon edule* .. .. .. .. 832
COSTANTIN, J.—*Influence of the Medium on the Structure of Roots* .. .. .. .. 832
SABLON, LECLERC DU—*Structure and Dehiscence of Anthers* .. .. .. .. .. 832
GRAVIS, A.—*Vegetative Organs of Urtica dioica* .. .. .. .. .. .. .. 833
LABORIE, E.—*Anatomy of Peduncles compared with that of the Primary Axes and of Petioles* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 833
HEGELMAIER, F.—*Wolffia microscopica* .. .. .. .. .. .. .. .. .. 834

### β. Physiology.

CORRY, T. H.—*Fertilization of Asclepias Cornuti* .. .. .. .. .. .. .. 834
KRAUS, G.—*Blooming of Arum italicum* .. .. .. .. .. .. .. .. .. 835
BRONOLD, A.—*Influence of Electricity on the Growth of Plants* .. .. .. .. .. 835
BONNIER, G., & L. MANGIN—*Respiration of Plants* .. .. .. .. .. .. .. 835
" " *Respiration of Plants at different seasons* .. .. .. 836
BRUNCHORST, J.—*Galvanotropism of Roots* .. .. .. .. .. .. .. .. 836
JANSE, J. M.—*Movement of Water in Plants* .. .. .. .. .. .. .. .. 836
KRAUS, C.—"*Bleeding*" *of Parenchymatous Tissues* .. .. .. .. .. .. .. 837
BURGERSTEIN, A.—*Physiological and Pathological Effect of Camphor on Plants* .. 837
TIMIRIAZEFF, C.—*Chemical and Physiological Action of Light on Chlorophyll* .. .. 837

## B. CRYPTOGAMIA.

SCHAARSCHMIDT, G.—*Cell-wall-thickenings and Cellulin-grains in Chara and Vaucheria* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 838

PAGE

### Cryptogamia Vascularia.

LACHMANN, P.—*Apical Growth of the Root of Todea* .. .. .. .. .. .. .. 839
BRUCHMANN, H.—*Prothallium of Lycopodium* .. .. .. .. .. .. .. .. 839
GALLOWAY, D. H.—*Spores of Lycopodium* .. .. .. .. .. .. .. .. .. 839
CROZIER, A. A.—*Node of Equisetum* .. .. .. .. .. .. .. .. .. .. 840

### Muscineæ.

SABLON, LECLERC DU—*Development of the Sporangium of Frullania* .. .. .. .. 840
BREIDLER, J., & G. BECK—*Trochobryum, a new genus of Mosses* .. .. .. .. 841

### Algæ.

WILLE, N.—*Physiological Anatomy of Algæ* .. .. .. .. .. .. .. .. .. 841
MÖBIUS, M.—*New Epiphytic Floridea* .. .. .. .. .. .. .. .. .. 842
BUFFHAM, T. H.—*Conjugation of Rhabdonema arcuatum* .. .. .. .. .. .. 842
PRINZ, W.—*Sections of Diatoms from the Jutland "Cementstein"* .. .. .. .. 843
PICCONE, A.—*Phytophagous Fishes as Disseminators of Algæ* .. .. .. .. .. 843

### Lichenes.

FÜNFSTÜCK, M.—*Formation of Thalli on the Apothecia of Peltidea aphthosa* .. .. 843

### Fungi.

WORTMANN, J.—*Thermotropism of the Roots of Æthalium septicum* .. .. .. .. 844
MÖLLER, H.—*Plasmodiophora Alni* .. .. .. .. .. .. .. .. .. .. 844
FRANK, B.—*Nutrition of Trees by means of Underground Fungi* .. .. .. .. 844
POLECK—*Composition and Spore-cultivation of Merulius lacrymans* .. .. .. .. 845
HARTIG, R.—*Germination of the Spores of Merulius lacrymans* .. .. .. .. 845
FISCH, C.—*New Chytridiaceæ* .. .. .. .. .. .. .. .. .. .. 846
BORZI, A.—*Nowakowskia, a new Genus of Chytridiaceæ* .. .. .. .. .. 846
ERIKSSON, J.—*New Fungus-parasite on the Rose* .. .. .. .. .. .. .. 847
HECKEL, E.—*Mycological Monstrosities* .. .. .. .. .. .. .. .. .. 847
COOKE, M. C.—*Some Remarkable Moulds* .. .. .. .. .. .. .. .. .. 848
SCHÜTZ—*Pneumonomycosis of Birds* .. .. .. .. .. .. .. .. .. 848

### Protophyta.

HANSEN, E. C.—*Ferments* .. .. .. .. .. .. .. .. .. .. .. 849
BIZZOZERO, G.—*Microphytes of Normal Human Epidermis* .. .. .. .. .. 849
FISCH, C.—*Systematic Position of the Bacteria* .. .. .. .. .. .. .. 850
BUCHNER, E.—*Influence of Oxygen on Fermentation by Schizomycetes* .. .. .. 850
CHEYNE, W. W., & E. VAN ERMENGEM—*Cholera Bacillus* .. .. .. .. .. 850
KOCH, R.—*Etiology of Tuberculosis* .. .. .. .. .. .. .. .. .. 851
HAUSER, G.—*Development and Pathogenous Properties of a Bacterium* .. .. .. 852
CORNIL & BABES' "*Bacteria*" .. .. .. .. .. .. .. .. .. .. .. 853

## MICROSCOPY.

### *a.* Instruments, Accessories, &c.

DEBY'S *Twin Microscope* (Fig. 180) .. .. .. .. .. .. .. .. .. .. 854
KLEIN'S *Mineralogical and Petrological Microscopes* (Figs. 181–183) .. .. .. 856
REICHERT'S *Mineralogical-Geological Microscope* (Fig. 184) .. .. .. .. .. 858
WATSON-WALE *Microscope* (Fig. 185) .. .. .. .. .. .. .. .. .. .. 860
SCHIECK'S *Microscope with Screw Stage-Micrometer* (Fig. 186) .. .. .. .. .. 861
HART, C. P.—*Microtome-Microscope* .. .. .. .. .. .. .. .. .. .. 861
DUBOSCQ'S *Projection Microscope* .. .. .. .. .. .. .. .. .. .. 861
"TWIN" *Simple Microscope* (Fig. 187) .. .. .. .. .. .. .. .. .. .. 862
LAURENT'S *Apparatus for registering the Curvature and Refraction of Lenses* (Figs. 188 and 189) .. .. .. .. .. .. .. .. .. .. .. .. .. 863
GUNDLACH'S *Improved Objectives* .. .. .. .. .. .. .. .. .. .. .. 863
STODDER, J. C.—*Series of Objectives* .. .. .. .. .. .. .. .. .. .. 863
NELSON, E. M.—*Right-angled Prism instead of a Plane Mirror* .. .. .. .. 864
HEURCK, H. VAN—*Hélot-Trouvé apparatus for Electrical Illumination* (Figs. 190–192) 864
D'ARSONVAL—*Illumination for Projection Microscopes* .. .. .. .. .. .. 866
VORCE, C. M.—*Lantern Transparencies* .. .. .. .. .. .. .. .. .. 866
MICROSCOPICAL *Electrical Apparatus* (Figs. 193–207) .. .. .. .. .. .. .. 867
REGNARD, P.—*Apparatus for watching the phenomena that animals subjected to great pressure present* (Figs. 208 and 209) .. .. .. .. .. .. .. .. .. .. 877

PAGE

Westien's *apparatus for comparing symmetrical parts of the webs of the right and left feet of a frog* (Fig. 210) .. .. .. .. .. .. .. .. .. .. .. 879
Sollas, W. J.—*Apparatus for Determining the Specific Gravity of Minute Objects under the Microscope* (Figs. 211 and 212) .. .. .. .. .. .. .. .. .. 879
Keeping *both Eyes open in Observation* .. .. .. .. .. .. .. .. .. .. 881
Aperture *Puzzles* (Figs. 213 and 214) .. .. .. .. .. .. .. .. .. .. 882
The 'Times' *on the Microscope* .. .. .. .. .. .. .. .. .. .. 883
Hippisley, J.—*A Pocket Field Microscope* .. .. .. .. .. .. .. .. .. 890
Repairing *Nicol Prism* .. .. .. .. .. .. .. .. .. .. .. .. 891

### β. Collecting, Mounting and Examining Objects, &c.

Olivier, L.—*Method for Observing Protoplasmic Continuity* .. .. .. .. .. 892
Noll, F.—*Eau de Javelle as a Medium for Clarifying and Dissolving Plasma* .. 893
Richard, J.—*Cocaine for Mounting Small Animals* .. .. .. .. .. .. .. 893
Rabl, C.—*Preparing Tissues to show Cell-division* .. .. .. .. .. .. .. 893
Beckwith, E. F.—*Method for showing the Distribution and Termination of Nerves in the Human Lungs* .. .. .. .. .. .. .. .. .. .. .. .. 894
Cole, A. C.—*Preparing Tail of Puppy* .. .. .. .. .. .. .. .. .. 894
Hertwig, O.—*Demonstrating Spindle-shaped Bodies in the Yolk of Frog's Ova* .. 895
Warlomont, R.—*Microscopical Technique of the Eye* .. .. .. .. .. .. 895
Hilger, C.—*Preparing Eyes of Gasteropods* .. .. .. .. .. .. .. .. .. 895
Looss—*Method of Softening Chitin* .. .. .. .. .. .. .. .. .. .. 896
Sazepin, B.—*Demonstrating Nerve-end Organs in the Antennæ of Myriopods* .. .. 896
Heller—*Sources of Error in the Examination of Fresh Tissues* .. .. .. .. 896
Braun, M.—*Mounting Media for Nematodes* .. .. .. .. .. .. .. .. 897
Beard, J.—*Preparing Myzostoma* .. .. .. .. .. .. .. .. .. .. 897
Ihl, A.—*Sensitive Tests for Wood-fibre and Cellulose* .. .. .. .. .. .. 897
Hay, O. P.—*Modification of Semper's Method of making Dry Preparations* .. .. 898
D. S. W.—*Freeing Objects from Air* .. .. .. .. .. .. .. .. .. .. 898
Debes, E.—*Cleaning and Preparing Diatom Material—Mounting Diatoms* .. .. 898
Gowen's *Microtome* .. .. .. .. .. .. .. .. .. .. .. .. 899
Jacobs's *Freezing Microtome* (Figs. 215 and 216) .. .. .. .. .. .. .. 899
Eternod's *Microtome with Triple Pincers* .. .. .. .. .. .. .. .. .. 900
Minot, C. S.—*Gannett's Dripping Apparatus* (Fig. 217) .. .. .. .. .. .. 900
Gierke, H.—*Staining for Microscopical Purposes* .. .. .. .. .. .. .. 900
List, J. H.—*Staining Methods* .. .. .. .. .. .. .. .. .. .. 902
Mays, K.—*Staining Nerves in Muscle* .. .. .. .. .. .. .. .. .. .. 903
List, J. H., & P. Schieferdecker—*Anilin-green* .. .. .. .. .. .. .. .. 903
Mondino, C.—*Perchloride of Mercury in the study of the Central Nervous System* .. 904
Pommer, G.—*Decalcification and Staining of Osseous Tissue* .. .. .. .. .. 905
Wielowiejski, v.—*Staining the Nucleus of the Germinal Vesicle in Arthropoda* .. 905
Osborn, H. F.—*Double Injections for Dissecting Purposes* .. .. .. .. .. .. 905
Hay, O. P.—*Double Injections for Histological Purposes* (Fig. 218) .. .. .. .. 906
Zenger, C. V.—*Double-sided Slide* .. .. .. .. .. .. .. .. .. .. 908
Mark, E. L.—*Uses of Collodion* .. .. .. .. .. .. .. .. .. .. 908
Sharp, H.—*Mounting in Cells with Canada Balsam* .. .. .. .. .. .. .. 909
Zenger, C. V.—*Monobromide of Naphthalin and Tribromide of Arsenic* .. .. 909
Mayer's *Carbolic Acid Shellac* .. .. .. .. .. .. .. .. .. .. 909
Slide-boxes (Fig. 219) .. .. .. .. .. .. .. .. .. .. .. .. 910
Chapman's *Mould for Cells* .. .. .. .. .. .. .. .. .. .. .. 911
Sternberg, G. M.—*Selection and Preparation of Objects for Photographing* .. .. 911
Dolley's *Technology of Bacteria Investigation* .. .. .. .. .. .. .. .. 917
Taylor, T.—*Discrimination of Butter and its Substitutes* .. .. .. .. .. .. 918
Assmann, R.—*Microscopical Observations on the Constituents of Clouds* .. .. .. 919
Lindt, O.—*Micro-chemical Test for Brucin and Strychnin* .. .. .. .. .. .. 920
Wichmann, A.—*Micro-chemical Examination of Minerals* .. .. .. .. .. .. 920
Streng, A.—*Isolating Minerals in Sections for Micro-chemical Examination* .. .. 921
Williams, G. H.—*The Microscope in Geology* .. .. .. .. .. .. .. .. 921
Tichborne—*Application of the Microscope to Practical Mineralogical Questions* .. 922
Joly, J.—*Microscopical Examination of Volcanic Ash from Krakatoa* .. .. .. 923
Gunning, J. W.—*Examination of Potable Waters* .. .. .. .. .. .. .. 923
Frankland, P. F.—*Removal of Micro-organisms from Water* .. .. .. .. .. .. 923
Cox, C. F.—*Hard-rubber Cells* .. .. .. .. .. .. .. .. .. .. .. 925
Davis, J. J.—*A Simple Cover-compressor* .. .. .. .. .. .. .. .. .. 925
Hitchcock, R.—*Microscopical Exhibitions* .. .. .. .. .. .. .. .. .. 926
Queen's *Prepared Diatoms in fluid ready for mounting* .. .. .. .. .. .. 927
Technical Notes .. .. .. .. .. .. .. .. .. .. .. .. .. .. 928

Proceedings of the Society .. .. .. .. .. .. .. .. .. 929

# ROYAL MICROSCOPICAL SOCIETY.

## COUNCIL.

ELECTED 11th FEBRUARY, 1885.

**PRESIDENT.**

Rev. W. H. Dallinger, LL.D., F.R.S.

**VICE-PRESIDENTS.**

John Anthony, Esq., M.D., F.R.C.P.L.
G. F. Dowdeswell, Esq., M.A.
Prof. P. Martin Duncan, M.B., F.R.S.
Albert D. Michael, Esq., F.L.S.

**TREASURER.**

Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

**SECRETARIES.**

*Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.
Prof. F. Jeffrey Bell, M.A., F.Z.S.

**Twelve other MEMBERS of COUNCIL.**

Joseph Beck, Esq., F.R.A.S.
A. W. Bennett, Esq., M.A., B.Sc., F.L.S.
*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
James Glaisher, Esq., F.R.S., F.R.A.S.
*J. William Groves, Esq.
John Matthews, Esq., M.D.
John Mayall, Esq., Jun.
*John Millar, Esq., L.R.C.P., F.L.S.
Urban Pritchard, Esq., M.D.
Stuart O. Ridley, Esq., M.A., F.L.S.
*Prof. Charles Stewart, M.R.C.S., F.L.S.
William Thomas Suffolk, Esq.

**LIBRARIAN and ASSISTANT SECRETARY.**

Mr. James West.

* Members of the Publication Committee.

---

MEETINGS FOR 1885, at 8 p.m.

| | | | |
|---|---|---|---|
| Wednesday, January .. .. | 14 | Wednesday, May .. .. .. | 13 |
| „ February .. .. | 11 | „ June .. .. .. | 10 |
| *(Annual Meeting for Election of Officers and Council.)* | | „ October .. .. | 14 |
| „ March .. .. | 11 | „ November .. .. | 11 |
| „ April .. .. .. | 8 | „ December .. .. | 9 |

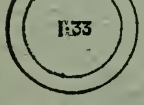
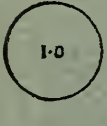
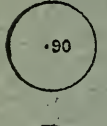
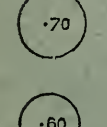
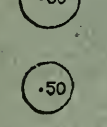
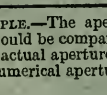
---

## ADVERTISEMENTS FOR THE JOURNAL.

## I. Numerical Aperture Table.

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n$ sin $u$, $n$ being the refractive index of the medium and $u$ the semi-angle of aperture. The value of $n$ sin $u$ for any particular case is the "*numerical aperture*" of the objective.

| Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power ($\frac{1}{2}$ in.) from 0·50 to 1·52 N. A. | Numerical Aperture. ($n$ sin $u = a$.) | Angle of Aperture ($= 2u$). *Dry* Objectives. ($n = 1$.) | Angle of Aperture ($= 2u$). *Water-Immersion* Objectives. ($n = 1{\cdot}33$.) | Angle of Aperture ($= 2u$). *Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.) | Illuminating Power. ($a^2$.) | Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\,\mu$ = line E.) | Penetrating Power. $\left(\frac{1}{a}\right)$ |
|---|---|---|---|---|---|---|---|
|  | 1·52 | .. | .. | 180° 0′ | 2·310 | 146,528 | ·658 |
| | 1·50 | .. | .. | 161° 23′ | 2·250 | 144,600 | ·667 |
| 1·52 | 1·48 | .. | .. | 153° 39′ | 2·190 | 142,672 | ·676 |
| | 1·46 | .. | .. | 147° 42′ | 2·132 | 140,744 | ·685 |
| | 1·44 | .. | .. | 142° 40′ | 2·074 | 138,816 | ·694 |
| | 1·42 | .. | .. | 138° 12′ | 2·016 | 136,888 | ·704 |
| | 1·40 | .. | .. | 134° 10′ | 1·960 | 134,960 | ·714 |
| | 1·38 | .. | .. | 130° 26′ | 1·904 | 133,032 | ·725 |
| | 1·36 | .. | .. | 126° 57′ | 1·850 | 131,104 | ·735 |
| | 1·34 | .. | .. | 123° 40′ | 1·796 | 129,176 | ·746 |
|  | 1·33 | .. | 180° 0′ | 122° 6′ | 1·770 | 128,212 | ·752 |
| 1·33 | 1·32 | .. | 165° 56′ | 120° 33 | 1·742 | 127,248 | ·758 |
| | 1·30 | .. | 155° 38′ | 117° 34′ | 1·690 | 125,320 | ·769 |
| | 1·28 | .. | 148° 28′ | 114° 44′ | 1·638 | 123,392 | ·781 |
| | 1·26 | .. | 142° 39′ | 111° 59′ | 1·588 | 121,464 | ·794 |
| | 1 24 | .. | 137° 36′ | 109° 20′ | 1·538 | 119,536 | ·806 |
| | 1·22 | .. | 133° 4′ | 106° 45′ | 1·488 | 117,608 | ·820 |
|  | 1·20 | .. | 128° 55′ | 104° 15′ | 1·440 | 115,680 | ·833 |
| 1·16 | 1·18 | .. | 125° 3′ | 101° 50′ | 1·392 | 113,752 | ·847 |
| | 1·16 | .. | 121° 26′ | 99° 29′ | 1·346 | 111,824 | ·862 |
| | 1·14 | .. | 118° 00′ | 97° 11′ | 1·300 | 109,896 | ·877 |
| | 1·12 | .. | 114° 44′ | 94° 56′ | 1·254 | 107,968 | ·893 |
| | 1·10 | .. | 111° 36′ | 92° 43′ | 1·210 | 106,040 | ·909 |
| | 1·08 | .. | 108° 36′ | 90° 33′ | 1·166 | 104,112 | ·926 |
|  | 1·06 | .. | 105° 42′ | 88° 26′ | 1·124 | 102,184 | ·943 |
| 1·0 | 1·04 | .. | 102° 53′ | 86° 21′ | 1·082 | 100,256 | ·962 |
| | 1·02 | .. | 100° 10′ | 84° 18′ | 1·040 | 98,328 | ·980 |
| | 1·00 | 180° 0′ | 97° 31′ | 82° 17′ | 1·000 | 96,400 | 1·000 |
| | 0·98 | 157° 2′ | 94° 56′ | 80° 17′ | ·960 | 94,472 | 1·020 |
|  | 0·96 | 147° 29′ | 92° 24′ | 78° 20′ | ·922 | 92,544 | 1·042 |
| | 0·94 | 140° 6′ | 89° 56′ | 76° 24′ | ·884 | 90,616 | 1·064 |
| ·90 | 0·92 | 133° 51′ | 87° 32′ | 74° 30′ | ·846 | 88,688 | 1·087 |
| | 0·90 | 128° 19′ | 85° 10′ | 72° 36′ | ·810 | 86,760 | 1·111 |
| | 0·88 | 123° 17′ | 82° 51′ | 70° 44′ | ·774 | 84,832 | 1·136 |
| | 0·86 | 118° 38′ | 80° 34′ | 68° 54′ | ·740 | 82,904 | 1·163 |
| | 0·84 | 114° 17′ | 78° 20′ | 67° 6′ | ·706 | 80,976 | 1·190 |
|  | 0·82 | 110° 10′ | 76° 8′ | 65° 18′ | ·672 | 79,048 | 1·220 |
| ·80 | 0·80 | 106° 16′ | 73° 58′ | 63° 31′ | ·640 | 77,120 | 1·250 |
| | 0·78 | 102° 31′ | 71° 49′ | 61° 45′ | ·608 | 75,192 | 1·282 |
| | 0·76 | 98° 56′ | 69° 42′ | 60° 0′ | ·578 | 73,264 | 1·316 |
| | 0·74 | 95° 28′ | 67° 36′ | 58° 16′ | ·548 | 71,336 | 1·351 |
|  | 0·72 | 92° 6′ | 65° 32′ | 56° 32′ | ·518 | 69,408 | 1·389 |
| ·70 | 0·70 | 88° 51′ | 63° 31′ | 54° 50′ | ·490 | 67,480 | 1·429 |
| | 0·68 | 85° 41′ | 61° 30′ | 53° 9′ | ·462 | 65,552 | 1·471 |
| | 0·66 | 82° 36′ | 59° 30′ | 51° 28′ | ·436 | 63,624 | 1·515 |
| | 0·64 | 79° 35′ | 57° 31′ | 49° 48′ | ·410 | 61,696 | 1·562 |
|  | 0·62 | 76° 38′ | 55° 34′ | 48° 9′ | ·384 | 59,768 | 1·613 |
| ·60 | 0·60 | 73° 44′ | 53° 38′ | 46° 30′ | ·360 | 57,840 | 1·667 |
| | 0·58 | 70° 54′ | 51° 42′ | 44° 51′ | ·336 | 55,912 | 1·724 |
| | 0·56 | 68° 6′ | 49° 48′ | 43° 14′ | ·314 | 53,984 | 1·786 |
| | 0·54 | 65° 22′ | 47° 54′ | 41° 37′ | ·292 | 52,056 | 1·852 |
|  | 0·52 | 62° 40′ | 46° 2′ | 40° 0′ | ·270 | 50,128 | 1·923 |
| ·50 | 0·50 | 60° 0′ | 44° 10′ | 38° 24′ | ·250 | 48,200 | 2·000 |

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil). Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

## II. Conversion of British and Metric Measures.

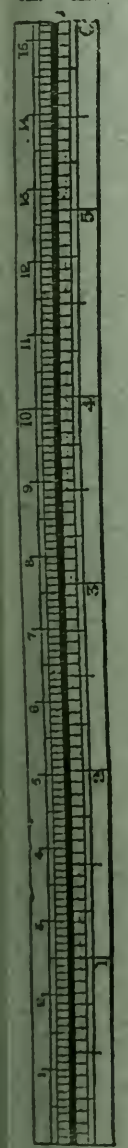
### (1.) Lineal.

*Micromillimetres, &c., into Inches, &c.*

| μ | ins. | mm. | ins. | mm. | ins. |
|---|---|---|---|---|---|
| 1 | ·000039 | 1 | ·039370 | 51 | 2·007892 |
| 2 | ·000079 | 2 | ·078741 | 52 | 2·047262 |
| 3 | ·000118 | 3 | ·118111 | 53 | 2·086633 |
| 4 | ·000157 | 4 | ·157482 | 54 | 2·126003 |
| 5 | ·000197 | 5 | ·196852 | 55 | 2·165374 |
| 6 | ·000236 | 6 | ·236223 | 56 | 2·204744 |
| 7 | ·000276 | 7 | ·275593 | 57 | 2·244115 |
| 8 | ·000315 | 8 | ·314963 | 58 | 2·283485 |
| 9 | ·000354 | 9 | ·354334 | 59 | 2·322855 |
| 10 | ·000394 | 10 (1 cm.) | ·393704 | 60 (6 cm.) | 2·362226 |
| 11 | ·000433 | 11 | ·433075 | 61 | 2·401596 |
| 12 | ·000472 | 12 | ·472445 | 62 | 2·440967 |
| 13 | ·000512 | 13 | ·511816 | 63 | 2·480337 |
| 14 | ·000551 | 14 | ·551186 | 64 | 2·519708 |
| 15 | ·000591 | 15 | ·590556 | 65 | 2·559078 |
| 16 | ·000630 | 16 | ·629927 | 66 | 2·598449 |
| 17 | ·000669 | 17 | ·669297 | 67 | 2·637819 |
| 18 | ·000709 | 18 | ·708668 | 68 | 2·677189 |
| 19 | ·000748 | 19 | ·748038 | 69 | 2·716560 |
| 20 | ·000787 | 20 (2 cm.) | ·787409 | 70 (7 cm.) | 2·755930 |
| 21 | ·000827 | 21 | ·826779 | 71 | 2·795301 |
| 22 | ·000866 | 22 | ·866150 | 72 | 2·834671 |
| 23 | ·000906 | 23 | ·905520 | 73 | 2·874042 |
| 24 | ·000945 | 24 | ·944890 | 74 | 2·913412 |
| 25 | ·000984 | 25 | ·984261 | 75 | 2·952782 |
| 26 | ·001024 | 26 | 1·023631 | 76 | 2·992153 |
| 27 | ·001063 | 27 | 1·063002 | 77 | 3·031523 |
| 28 | ·001102 | 28 | 1·102372 | 78 | 3·070894 |
| 29 | ·001142 | 29 | 1·141743 | 79 | 3·110264 |
| 30 | ·001181 | 30 (3 cm.) | 1·181113 | 80 (8 cm.) | 3·149635 |
| 31 | ·001220 | 31 | 1·220483 | 81 | 3·189005 |
| 32 | ·001260 | 32 | 1·259854 | 82 | 3·228375 |
| 33 | ·001299 | 33 | 1·299224 | 83 | 3·267746 |
| 34 | ·001339 | 34 | 1·338595 | 84 | 3·307116 |
| 35 | ·001378 | 35 | 1·377965 | 85 | 3·346487 |
| 36 | ·001417 | 36 | 1·417336 | 86 | 3·385857 |
| 37 | ·001457 | 37 | 1·456706 | 87 | 3·425228 |
| 38 | ·001496 | 38 | 1·496076 | 88 | 3·464598 |
| 39 | ·001535 | 39 | 1·535447 | 89 | 3·503968 |
| 40 | ·001575 | 40 (4 cm.) | 1·574817 | 90 (9 cm.) | 3·543339 |
| 41 | ·001614 | 41 | 1·614188 | 91 | 3·582709 |
| 42 | ·001654 | 42 | 1·653558 | 92 | 3·622080 |
| 43 | ·001693 | 43 | 1·692929 | 93 | 3·661450 |
| 44 | ·001732 | 44 | 1·732299 | 94 | 3·700820 |
| 45 | ·001772 | 45 | 1·771669 | 95 | 3·740191 |
| 46 | ·001811 | 46 | 1·811040 | 96 | 3·779561 |
| 47 | ·001850 | 47 | 1·850410 | 97 | 3·818932 |
| 48 | ·001890 | 48 | 1·889781 | 98 | 3·858302 |
| 49 | ·001929 | 49 | 1·929151 | 99 | 3·897673 |
| 50 | ·001969 | 50 (5 cm.) | 1·968522 | 100 (10 cm. = 1 decim.) | |
| 60 | ·002362 | | | | |
| 70 | ·002756 | | | | |
| 80 | ·003150 | | | | |
| 90 | ·003543 | | | | |
| 100 | ·003937 | | | | |
| 200 | ·007874 | | | | |
| 300 | ·011811 | | | | |
| 400 | ·015748 | | | | |
| 500 | ·019685 | | | | |
| 600 | ·023622 | | | | |
| 700 | ·027559 | | | | |
| 800 | ·031496 | | | | |
| 900 | ·035433 | | | | |
| 1000 (= 1 mm.) | | | | | |

| decim. | ins. |
|---|---|
| 1 | 3·937043 |
| 2 | 7·874086 |
| 3 | 11·811130 |
| 4 | 15·748173 |
| 5 | 19·685216 |
| 6 | 23·622259 |
| 7 | 27·559302 |
| 8 | 31·496346 |
| 9 | 35·433389 |
| 10 (1 metre) | 39·370432 |
| = 3·280869 ft. | |
| = 1·093623 yds. | |

Scale showing the relation of Millimetres, &c., to Inches.




1000 μ = 1 mm.
10 mm. = 1 cm.
10 cm. = 1 d n
10 dm. = 1 metre.

*Inches, &c., into Micromillimetres, &c.*

| ins. | μ |
|---|---|
| $\frac{1}{25000}$ | 1·015991 |
| $\frac{1}{20000}$ | 1·269989 |
| $\frac{1}{15000}$ | 1·693318 |
| $\frac{1}{10000}$ | 2·539977 |
| $\frac{1}{9000}$ | 2·822197 |
| $\frac{1}{8000}$ | 3·174972 |
| $\frac{1}{7000}$ | 3·628539 |
| $\frac{1}{6000}$ | 4·233295 |
| $\frac{1}{5000}$ | 5·079954 |
| $\frac{1}{4000}$ | 6·349943 |
| $\frac{1}{3000}$ | 8·466591 |
| $\frac{1}{2000}$ | 12·699886 |
| $\frac{1}{1000}$ | 25·399772 |
| | mm. |
| $\frac{1}{900}$ | ·028222 |
| $\frac{1}{800}$ | ·031750 |
| $\frac{1}{700}$ | ·036285 |
| $\frac{1}{600}$ | ·042333 |
| $\frac{1}{500}$ | ·050800 |
| $\frac{1}{450}$ | ·056444 |
| $\frac{1}{400}$ | ·063499 |
| $\frac{1}{350}$ | ·072571 |
| $\frac{1}{300}$ | ·084666 |
| $\frac{1}{250}$ | ·101599 |
| $\frac{1}{200}$ | ·126999 |
| $\frac{1}{150}$ | ·169332 |
| $\frac{1}{100}$ | ·253998 |
| $\frac{1}{50}$ | ·507995 |
| $\frac{1}{25}$ | 1·015991 |
| $\frac{1}{20}$ | 1·269989 |
| $\frac{1}{16}$ | 1·587486 |
| $\frac{1}{15}$ | 1·693318 |
| $\frac{1}{12}$ | 2·116648 |
| $\frac{1}{10}$ | 2·539977 |
| $\frac{1}{8}$ | 3·174972 |
| $\frac{1}{6}$ | 4·233295 |
| $\frac{8}{16}$ | 4·762457 |
| $\frac{1}{5}$ | 5·079954 |
| $\frac{1}{4}$ | 6·349943 |
| $\frac{5}{16}$ | 7·937429 |
| $\frac{3}{8}$ | 9·524915 |
| | cm. |
| $\frac{1}{10}$ | 1·111240 |
| $\frac{1}{9}$ | 1·269989 |
| $\frac{9}{10}$ | 1·428737 |
| $\frac{8}{9}$ | 1·587486 |
| $\frac{11}{10}$ | 1·746234 |
| $\frac{8}{8}$ | 1·904983 |
| $\frac{12}{10}$ | 2·063732 |
| $\frac{7}{8}$ | 2·222480 |
| $\frac{15}{16}$ | 2·381229 |
| 1 | 2·539977 |
| 2 | 5·079954 |
| 3 | 7·619932 |
| | decim. |
| 4 | 1·015991 |
| 5 | 1·269989 |
| 6 | 1·523986 |
| 7 | 1·777984 |
| 8 | 2·031982 |
| 9 | 2·285979 |
| 10 | 2·539977 |
| 11 | 2·793975 |
| 1 ft. | 3·047973 |
| | metres. |
| 1 yd. = | ·914392 |


G. Massee del. ad nat.

West, Newman & Co. lith.

New British Micro-fungi.

JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1885.

## TRANSACTIONS OF THE SOCIETY.

### XIV.—*New British Micro-Fungi.* By G. Massee, F.R.M.S.

(*Read* 10*th June*, 1885.)

Plate XIII.

*Didymium hypnophilum* n. sp. (Plate XIII. figs. 8–12). Sporangia sessile on a broad base, hemispherical or elongated, subdepressed, powdered with white amorphous granules of lime; columella hemispherical, large, white; capillitium of violet-coloured threads which are attached to each other at intervals in a fasciculate manner, thus forming a loose irregular net, furnished sparingly with slender fusiform thickenings, which sometimes contain a few yellowish granules of lime; spores globose, large, spinulose, dull violet. On moss, Scarborough.

### EXPLANATION OF PLATE XIII.

Fig. 1.—*Stilbum flexuosum*, nat. size.
„ 1*a*.—Same × 30.
„ 2.—Same, section of head × 350.
„ 3.—Same, portion of head with conidia × 500.
„ 4.—*Helminthosporium pumilum*, parasitic upon *Stilbum flexuosum*, × 30.
„ 5.—Same × 500.
„ 6.—*Arthrobotrys rosea*, nat. size.
„ 6*a*.—Same × 350.
„ 7.—Same, conidium × 500.
„ 8.—*Didymium hypnophilum*, nat. size.
„ 9.—Same × 30.
„ 10.—Same, section of plant × 50.
„ 11.—Same, portion of capillitium attached to wall of sporangium, × 500.
„ 12.—Same, spores × 500.
„ 13.—*Corepthoris paradoxa*, nat. size.
„ 14.—Same × 350.
„ 15.—Same, conidia × 500.
„ 16.—*Corepthoris epimyces*, nat. size.
„ 17.—Same × 350.
„ 18.—Same, conidia × 500.
„ 19.—*Sporidesmium atrum*, spore × 500.

This species agrees with *D. confluens* in the large spinulose spores and fasciculate capillitium, but differs in the sporangia not being confluent and the white columella.

The spores of *Lycogala epidendrum* Bux. are not smooth as described in Cooke's 'Myxomycetes of Great Britain,' but distinctly warted; the same remark is also true of *Prototrichia flagellifer* B. and Br.

*Sporidesmium atrum* Link. (fig. 19). "Tufts scattered, black, pulverulent, true stroma absent; spores oblong, attenuated at both ends, transversely 3–4 septate, 4–5 celled, slightly constricted at the septa, epispore smooth, brown, pedicel white, diaphanous."

While examining some sections of *Eutypa scabrosa* Fckl., a few spores were observed which resembled those of some *Phragmidium*, but the habitat—on bark of sycamore—did not favour this idea; and on further examination, they were found to agree in every particular with Corda's figure and description of *Sporidesmium atrum* Link. as given in his 'Icones Fungorum,' vol. vi. t. i. f. 14. As detached spores only were seen, Corda's description of the species is given. New to Britain.

*Stilbum flexuosum* n. sp. (figs. 1–3). Gregarious; black; head clavate, then globose, smooth; stem long, filiform, often flexuous or geniculate, a little thickened at the base; conidia colourless, subglobose.

On rotten wood, Scarborough. About a line high, head viscid, so that when placed in water the conidia disperse very slowly. Septate threads of stem bright brown by transmitted light. Allied to *S. rigidum* P., but differing in the flexuous stem and black head.

*Helminthosporium pumilum* n. sp. (figs. 4 and 5). Fasciculate or scattered; stem simple, subulate, straight, with about four septa, base dark brown, opaque, becoming paler and pellucid towards the apex; conidia broadly obovate, at first pale, then pitch brown, opaque, shining, without septa.

Parasitic on all parts of *Stilbum flexuosum*. Scarborough.

Very minute, head shining like a black glass bead. Related to *H. obovatum* Berk., but readily distinguished by its habitat and eseptate conidia. I have seen what appears to be the same, or a very closely allied species, parasitic on a new and very remarkable Hepatic (*Mytilopsis albifrons* Spruce), collected by Dr. Spruce in the Peruvian Andes.

*Helmisporium stemphylioides* Corda. This species was found some years ago near Scarborough and determined by Mr. Phillips, but owing to some oversight, has not up to the present been recorded as British.

*Arthrobotrys rosea* n. sp. (figs. 6 and 7). Tufted; pale rose colour; fertile flocci erect, sparingly septate, with from three to five swollen nodes at equal distances, each node bearing a globose

head of conidia; conidia broadly obovate, uniseptate, slightly constricted at the septum, apical segment largest, base apiculate.

On damp decaying branches, Scarborough. The nodes are covered with minute spicules arranged in a spiral, to which the conidia are attached. The conidia readily germinate within a few hours when placed in water; usually one filament springs from the apical segment close to the septum, this elongates for some distance, when the contents of the conidium pass into it and it developes into a much branched, septate, procumbent, floccose tuft. At this stage growth was arrested owing to desiccation, but from an examination of the fully developed plant, the fertile flocci appear to originate as erect lateral branches from the procumbent vegetative mycelium.

Very distinct from *A. superba* Corda, which is pure white with oblong conidia divided into two equal parts by the septum.

Corda's two genera *Arthrobotrys* and *Gonatobotrys* would appear to be too closely related; the most important point of distinction consists in the latter having unilocular conidia, and in *Gonatobotrys simplex* Corda, which is not uncommon in this district, I have occasionally met with uniseptate conidia along with the normal eseptate ones.

*Corepthoris paradoxa* Corda (figs. 13–15). Gregarious; stem erect, yellowish-olive, clavate, composed of numerous slender flocci; apical portion barren, the remainder with numerous septate compound branches, some of which bear heads of simple elliptical conidia; branches and conidia brownish olive.

On an old shoe in a damp ditch, growing along with *Ascobolus saccharinus* B. and C. Agreeing with Corda's figure of this species given in 'Prachtflora,' except that the stem has a brighter yellow tinge.

*Corepthoris epimyces* n. sp. (figs. 16–18). Gregarious; pure white; stem conical, composed of a bundle of flocci; branches simple or compound, springing from every part, except the expanded base, septate, patent, some supporting subglobose heads of conidia; conidia colourless, hyaline, linear-oblong, obliquely apiculate.

On decaying *Agaricus* (*Mycena*) *purus* P. along with *Mucor fusiger* Link. Scarborough.

This plant, on account of its conical stem and colourless conidia, does not quite agree with Corda's generic character, as given in 'Prachtflora,' yet as the two plants in all important points are so closely allied, an emendation of the genus seems preferable to the establishment of a new one. The following is Corda's definition of the genus, and if the bracketed portions are omitted, it would include both species:—"*Corepthoris.* Stroma erectum, primum simplex, [subclavatum], dein supra multifidum, e fibris longissimis, simplicibus, intricatis constipatum, infra ramulis fertilibus hetero-

geneis obsitum. Ramulis fertiles septati, cornei ramosi, bi- vel trifidi, apice ramuli subverticillatis, et sporis simplicibus heterogeneis in capitula conglobatis ornati. Sporæ acrogenæ, heterogenæ, simplices, (uniloculares); [episporio simplici diaphano, intus nucleo et guttulis oleosis repleto]."

When young the stem is quite smooth; soon the fibres of which it is composed separate more or less and become patent; some remain short and simple, resembling hairs; others increase in length, become branched, and bear at their apices the heads of conidia.

## XV.—*On Erosion of the Surface of Glass, when exposed to the Joint Action of Carbonate of Lime and Colloids.*

By William M. Ord, M.D., F.R.M.S., F.L.S.

(*Read* 11*th March*, 1885.)

More than a year ago there appeared in 'Nature' a letter from Surgeon-Major Bidie, now Sanitary Commissioner, Madras, describing a sort of etching of some glass vessels at points on which white-ant mud had been deposited.

There was much in this letter to arouse my interest. The story made it probable that the deposit of ant-mud had somehow eaten away the polish of the glass. The first explanation of the erosion was found, plausibly, in the hypothesis of the presence in the ant-mud of an acid capable of dissolving glass after the fashion of hydrofluoric acid. But no organic acids are known to possess such a property, and the presumable presence of some colloidal organic matter in the ant-mud led me to seek an explanation of a very different kind.

The observations and reasonings of my distinguished teacher, the late Mr. George Rainey, had been always fresh in my mind. I knew that in some of his experiments he had, incidentally, noted an erosion of glass surfaces wherein no free acid or alkali was concerned. At the risk of wearying the members of this Society by the repetition of a story already well known to them, I will briefly recapitulate the observations to which I refer. Mr. Rainey was engaged in investigating the causes leading to the assumption by carbonate of lime of a spherical form in various solutions. In some of his experiments he allowed two solutions of gum, one containing carbonate of potash, the other containing carbonate of calcium, to mix slowly; the one being superimposed upon the other. Next he introduced glass slides of the kind ordinarily used for microscopic purposes, into the apposed solutions, with the expectation, confirmed by the result, that a deposit of carbonate of lime would be presently formed on their surfaces. After prolonged immersion under conditions which precluded the occurrence of evaporation, the glass slides were found to have become covered with adherent spherules of carbonate of lime. The adhesion was of considerable firmness. The spheres remained attached after washing with water; and where their complete removal was sought, the use of diluted hydrochloric acid was necessary. It was then observed that the surface of the glass was no longer smooth and transparent. Mr. Rainey took casts of the surface with collodion, and was able to show from examination of the casts that the loss of transparency was brought about by the formation of shallow

depressions of a rounded form, corresponding severally to the points of contact of the spherules. Mr. Rainey had already shown the great probability—I might perhaps indeed say the certainty—that the exquisite spherules which he had produced by his experimental method were built up first by the agglomeration of small granules into small spherules, next by the agglomeration of small spherules into larger spherules.

More minutely considered, the actual process appeared to be not a simple one of agglomeration of granules into spherules, and of smaller spherules into larger spherules; but, throughout, of readjustment of the molecules constituting the several contingent spherules. In the process of deposit, the first-formed spherules were surrounded by others till groups were formed, comprehending several spherules in contact with each other. Presently, their constituent molecules, hitherto held in each independent sphere around its centre by virtue of their mutual attraction, were disturbed by the attraction of surrounding spheres, and were impelled to arrange themselves round a new centre of mutual attraction placed somewhere in the midst of the group of spheres. In the end the small spheres and granules vanished, having been incorporated into one large sphere.

Touching the erosion of the glass surface, Mr. Rainey argued that when such a spherule was formed on a glass surface with the surrounding colloid gum sticking to the glass surface, and actually entering also into the composition of the sphere, the same attractive power which had determined the incorporation into one sphere of a number of spherules in contact with one another would determine also the incorporation of adjoining molecules of the glass into the incumbent sphere. The result would be the excavation of a pit in the glass opposite each sphere in contact therewith.

With these things already in my mind, on reading Surgeon-Major Bidie's letter I wrote to him to suggest that the etching of glass which he had observed, might be explained on the hypothesis that "white-ant mud" consisted of a mixture of some colloid with earthy matter. Dr. Bidie wrote to me afterwards a very courteous letter telling me that, to his great regret, he could not provide me with white-ant mud, but that he had sent some of the earth in which the white ants worked. This I duly received. I made only two experiments with the earth, which were inconclusive, and I regret to be obliged to confess that the misplaced zeal of a housemaid put an end to my opportunities of making further experiments.

It was, however, open to me to institute experiments bearing upon the erosion of glass by carbonate and phosphate of lime in the presence of colloids. So far, I have only used the carbonate. The following experiments were set in action. In the first, strong

solutions of gum containing respectively carbonate of potash and chloride of calcium were superimposed one upon the other after Mr. Rainey's plan. Glass slides were coated with solid paraffin; the letters of the word ANT were inscribed on them, with a piece of matchwood which easily removed the paraffin without injuring the surface of the glass. The slides were then placed in the gum solution as in Rainey's method. In a second experiment, albumen was used in a similar way. In a third, glycerin was used in a similar way. In a fourth, a slide coated with paraffin and subsequently marked with the letters A N T was laid horizontally. Over the exposed surface a mixture of egg-albumen and glycerin was smeared to the depth of 1/10 of an inch; then a few drops of a strong solution of chloride of calcium were placed in contact with one end of the islet of glycerin and albumen, and a few drops of a solution of carbonate of potash in contact with the other end, so that the two solutions would diffuse through the mixture of glycerin and albumen, would meet therein, and produce, by mutual decomposition, carbonate of lime. Glycerin was added to diminish evaporation and to aid the contact of the colloid with the exposed surface of the glass. Evaporation was further opposed by placing the preparation in a moist chamber. Lastly, a controlling experiment was made by placing a glass slide, similarly coated and inscribed, in a mixture of pure glycerin and carbonate of potash. In parallel experiments, slides of mother-of-pearl, and of ivory, coated with paraffin and marked like the others, took the place of the glass slides. In all the experiments large stoppered bottles were used, so that no evaporation was possible. It was not till the end of a twelvemonth that the bottles were opened and the slides examined. Inspection showed that the paraffin had not been an effective insulating substance in the case of the glass slides. It had peeled off from them in flakes, and had floated away, so that their whole surface was encrusted, in all the experiments except the last, with a deposit of carbonate of lime. The carbonate of lime was found to have assumed the form of small spherules closely aggregated in dense masses and much deformed by mutual reaction. Mr. Rainey in his experiments had used exceedingly dilute solutions in order to obtain his beautiful spherules. To imitate the ant-mud I had used much stronger solutions. But the result was that I obtained a very much more complete etching of the glass, and had, as I suppose, fairly imitated what Surgeon-Major Bidie had seen. The slides which I show to-night are, I think you will say, deeply etched. They represent the etching effected by carbonate of lime in the presence of gum, of albumen, and of albumen and glycerin together. I may note in passing, that pure glycerin in combination with carbonate of potash produced no etching.

Under the Microscope the etched surface of the glass shows

erosions of various kinds. In the first place there are a number of scattered erosions of circular form varying in size from fine points as seen under a 1/4 in. objective up to cavities three or four times the diameter of a blood-corpuscle. Secondly, the surface of the glass is marked by a number of lines taking various directions, which must correspond either to original scratches on the surface of the glass, or to lines of detachment of the paraffin. Erosion has occurred along these lines in a beaded fashion, the size of the beads corresponding with the size of the spherules of carbonate of lime deposited. Thirdly, over considerable areæ the entire surface of the glass has gone. The floor of these depressed areæ is marked with closely approximated circular and dumbbell-shaped depressions, in many of which an inner circle or concentric circles may be seen. At first sight these inner circles appeared to indicate projections in the centre of depressions; but so far as I can make out by careful focusing they are, in fact, deeper excavations marking a deeper extension of the process of molecular disintegration of the glass.

It is hardly necessary to point out that the last experiment—with glycerin and carbonate of potash—was made in order to determine the possibility of a solution of glass by carbonate of potash, the occurrence of which would have introduced a different element of a chemical kind.

This, having evoked no response, enables us, I think, fairly to fall back on Mr. Rainey's explanation of the phenomena occurring in his own observations. I have mentioned that in addition to glass slides I have used slips of mother-of-pearl and of ivory. Here the paraffin kept the firm hold which I had hoped it would maintain on the glass surface; and I am able to show slips of this kind in which, after removal of the paraffin, the word ANT is clearly seen etched on the surface. The etching here occurred in all the experiments, even in that where glycerin was used with the carbonate of potash, a point of some interest when viewed in certain aspects of these experiments.

I wish to draw the following inferences from the experiments I have related. First, that without the use of the acids or the alkalies which are known to be capable of dissolving glass, a glass surface may be eroded almost to opacity when placed in contact with carbonate of lime and a colloid. Secondly, that the erosion so effected may be explained on the basis of Mr. Rainey's observations on molecular coalescence. Thirdly, that, in contact with glycerin and carbonate of potash, ivory and mother-of-pearl may be eroded, although as far as can be seen, no spherules of carbonate of lime are deposited. The first part of these conclusions is applicable to Dr. Bidie's observations; the third part has a different, and, as I think, a wider application.

Mr. Rainey's chapter on what he called "Molecular Disintegra-

tion" has always seemed to me to have an importance as great as that of his chapters on "Molecular Coalescence." The two together presented a beautiful correlation, enabling one to follow the building up of skeletal formations in the first place, and their adaptation to altered conditions of growth and repair in the second.

In bone, for example, we could see, in principle, how the structure of the first Haversian systems was determined by the law of molecular coalescence; how the earthy matters deposited in colloid ground-substance ceased to show crystalline form and were moulded into laminæ wherein the organic and inorganic matters were intimately mingled and distributed. We could see in it by the light of the principle of molecular disintegration the formation of Haversian spaces, as a part of remoulding and repair. May I for a moment step aside to remind you of what Mr. Rainey meant by this expression, "molecular disintegration"? He meant this—that when spheres of carbonate of lime, or spheres of mixed carbonate and phosphate, had been formed in a matrix of gum, and were afterwards transferred to a fresh solution of gum of the same kind as that first used, they lost their sharp outline, became visibly fibrous in their structure, and gradually faded away. The advent of a new colloid, differing ever so little from the first, determined a complete disorganization of the attractions which held the molecules together. They—the molecules—were reft asunder for a time, and were afterwards gathered into new spherical combinations. In applying the principle deducible from these observations to the explanation of the formation of the tubular erosion-spaces in bone which have been called Haversian spaces, a seeming difficulty arises. We have indeed no reason to assume that the quality of the circulating and acceding colloids varies in such a way as to bring about such a difference between the sphere and the surrounding matter as was present in the experiment. The seeming difficulty rests upon the assumption that the colloid matter entering into the spherical combination remains unchanged. If we can be convinced that the colloid is changed by reason of its prolonged contact with the crystalloid matter, we can understand how the afflux of fresh supplies of the original colloid may determine the breaking-up of spherical combinations wherein the original colloid has undergone chemical and physical change. It can be shown most clearly that the colloid matrix of spheres, whether of collagenous or of albuminous nature, is altered after no very long time. It takes on chemical reactions approaching those belonging to ripe epithelial structures and chitine. Such a change, if occurring in bone, may be conceived to be a part of senescence. The transformation of an active into an inactive colloid must presently call for complete reorganization. The altered balance of colloids will constitute an enabling condition. Each part of a bone as it grows old is swept

away by the dynamic influence of fresh nutritive matter, knowing, so to speak, nothing of the past. The post is vacated by the superannuated colloid, which first yields up its crystalloid associate and then disappears, leaving the ground free for fresh organization.

It may be observed that the parts which are thus swept away are in the outcome, though possibly not in the beginning, the circumferential portions of Haversian systems; and that they are removed in such a way as to include portions of two or three adjacent systems. These are, of course, the oldest or first-formed parts, of the several systems. The form assumed by the nutritive matter which is presumably active in determining the breaking-down of the old tissue is most interesting. At the points where the bone is being broken down we find lodged in cup-shaped recesses of eroded bone little masses of protoplasmic matter with ill-defined surface but well-marked nuclei, which, to all appearance, are the agents of the change. These are the so-called osteoclasts. Their surface is ill-defined because, on the one hand, it merges into the colloid of the vanishing bone, showing at the point of junction a curious striate marking, suggestive of the existence of currents running between the protoplasm and the old bone; and on the other, it is connected by processes with the protoplasmic material filling the gradually increasing cavity, of which protoplasm it is in fact an extension. It appears to me that we have here, before our eyes, the direct application of a new and active colloid to an old product of molecular coalescence, with the sequence of molecular disintegration.

I cannot resist the temptation of referring to one or two other processes in which both molecular coalescence and molecular disintegration play a part.

Mr. Rainey has shown that the first—molecular coalescence—is an essential part of the building-up of the shells of the Mollusca. The second—molecular disintegration—appears to me to come into action in the later stages of the growth of molluscous shells. For instance, in the whorled shells of the Gasteropods, apical parts of the interior which have been occupied by the young mollusc are removed as the growth of the animal and its shell proceeds, so as to economize the space available in the whole shell. I have no knowledge of the existence of anything like osteoclasts in this case; but the contact of the tissues of a rapidly-growing mollusc with the old coalescence formation will, I think, be sufficient to account for the solution of hard structures now superannuated.

Mr. George Busk, F.R.S., after seeing my letter in 'Nature' on this subject, was good enough to tell me that he saw in the principles which I sought to establish an explanation of a phenomenon which had puzzled him, namely the excavation of shell surfaces to which Polyzoa had been attached. He has lent me for ex-

amination a piece of smooth shell—the internal surface of a pinna—over which a colony of *Lepralia punctata* has been spread. In this genus, as Mr. Busk has demonstrated to me, the ectocyst of the under or attached surface of the cœnœcium is not continuous, but leaves oval spaces corresponding to the middle portions of polypides, through which the soft tissues of the polypide come into direct contact with the surface of the shell. When the cœnœcium is detached from the shell, its under surface is therefore seen to be regularly fenestrated. And in the specimen of which I am speaking, the surface of the shell from which the cœnœcium has been removed presents regular markings exactly corresponding to the fenestræ. These markings turn out, on microscopical examination, to be depressions in the surface of the shell, produced by erosion. It can be plainly seen that their floor is totally different from the surface proper, both in colour and texture. The surface of the shell is smooth, and reddish in colour; the excavations present a granular white floor. In another specimen, stained while the animal matter was yet in its place, the points which would after removal of the cœnœcium have been occupied by the shallow pits, have attached to every one a strongly adherent piece of dried stained animal matter. Mr. Busk's observation is in fact an illustration of my experiments, which shows what was sought better than did the experiments themselves. Through the windows in the framework of the cœnœcium the organic matter of the polypides has, so to speak, stencilled the structure upon the surface of the shell, as I had tried to engrave letters on the surface of the glass. I cannot resist the temptation of expressing the gratitude which I feel to so great an authority as Mr. Busk for his kindness in giving attention to my letter in 'Nature,' and in letting me have the opportunity of seeing his specimens under his own demonstration.

Another illustration of this kind of action was, as I think, adduced by Professor Charles Stewart in the admirable course of lectures on the Hydrozoa delivered by him recently at the Royal College of Surgeons. Professor Stewart showed dried specimens of a species of *Hydractinia* investing shells of Gasteropods. The shell had been completely covered by the fleshy expansion of the *Hydractinia*, and had been deprived thereby of all its earthy material.

I have long believed that the action of the little sponges which bore into molluscous shells, particularly those of Lamellibranchs, was molecular. It is of course conceivable that the action might be chemical; that an acid might be excreted having the power of dissolving carbonate of lime. It is also conceivable that the action might be mechanical. The boring sponges contain siliceous spicules, which, moved by the contractions of the protoplasmic material, might grind away the softer shell matter. I have tested fresh sec-

tions without detecting the presence of an acid, and Professor Stewart has given me the opportunity of examining, under the Microscope, sections of the cavities produced by the boring sponge. The position occupied in these sections by the siliceous spicules makes it certain that they cannot be the agents of erosion, at least in a mechanical way. In the sections we can see everywhere small hemispherical excavations of the shell occupied by extensions of the protoplasm of the sponge. Yet, at many points, long attenuated conical cavities are seen invading the substance of the shell; always filled with the protoplasm, often containing one or two siliceous spicules, which from their length and position must have been totally incapable of exerting any mechanical action. As it seems to me, we have here a transposition of the conditions which in the experiments related at the beginning of the paper brought about the breaking-up of the glass surface. There we had a colloid containing carbonate of lime applied to a glass surface; here we have a colloid containing silica applied to a surface of carbonate of lime mixed with another colloid. I venture to believe that in the case of the boring sponges, the action upon the shell is of compound nature; consisting partly in the contact of a new colloid, partly in the addition of the presence of a different crystalloid. Examining carefully the sections which Professor Stewart has lent me, I am able to recognize in the substance of the protoplasm adjoining the excavations, delicate spherules having all the appearance of carbonate of lime re-arranged in a new matrix.

I have cited here but a few illustrations of the possible application of Mr. Rainey's observations to explain the formation, and still more, the removal or absorption of shells and shell-like substances.

I venture to hope that the attention of this Society will be more and more drawn to the contemplation of these subtle non-chemical agencies as factors in the process of building and repair in the hard, and, very probably, in the soft structures of animal bodies.

## XVI.—*On a Septic Microbe from a high altitude. The Niesen Bacillus.*

By G. F. Dowdeswell, M.A., F.R.M.S., F.L.S., &c.

(*Read 8th April*, 1885.)

At the present time, when the functions of micro-organisms in all the provinces of nature, more especially in relation to disease, are exciting such general interest, their occurrence in the atmosphere has engaged renewed attention.

The systematic study of the particulate constituents of the atmosphere commenced with Ehrenberg, though in the previous century Leeuwenhoek had made the first recorded observations upon Bacteria, and shown their occurrence in rain-water. Ehrenberg examined dust from various situations in extensive series of observations, and particularly with reference to the outbreak of cholera in 1848, though with negative results, but found that numerous forms of organic life, both vegetable and animal, as he regarded them, were present in dust of the most varied situations; he recognized the occurrence of bacteria, which he termed infusoria, in rain-water that was allowed to stand, but could not detect any in the fresh drops, in dew, or in the atmosphere.

After that time the subject was pursued by numerous observers, till towards the year 1859 the promulgation of the vital, or "germ," theory of fermentation and putrefaction by Pasteur, aroused the controversy respecting spontaneous generation, so fertile in results, in the French Academy, and this induced the first systematic observations of Pouchet, the foremost of the Abiogenetists, and those of Pasteur himself, upon atmospheric germs, followed by a constant succession of observers, amongst whom, however, the most diverse views as to the occurrence of organic germs in the air have prevailed till quite recently, when the question has been finally set at rest, firstly by the systematic observations of Dr. Miflet, of Kiew, made in the Botanical Institute of Breslau in conjunction with Professor F. Cohn,* with the object of determining whether the microbes that produce fermentation and putrefaction are veritably contained in the atmosphere, or whether they are not derived exclusively from water or contact with contaminated surfaces, as previous experiments, by Prof. Cohn himself and others, seemed to indicate.

The result of these observations was to show clearly that by aspirating the air of different localities through cultivating fluids of suitable constitution, various species of bacteria or their germs were introduced, and developed when placed in the incubator at the

* Beitr. Biol. Pflanz., i. (1879) p. 143.

requisite temperature. Thus were explained the previous failures to recognize the presence of organisms in the atmosphere, by the circumstance that the cultivating fluids then employed had generally been solutions of mineral salts—the so-termed Pasteur's or Cohn's fluids—and which are here shown to be unsuitable for the development of most species of these organisms.

More recently has appeared the remarkable work* carried out during some years past by Dr. Miquel at the Observatory of Montsouris, near Paris, some of the results of which have recently been brought to the notice of this Society by one of our Fellows, himself amongst the earliest investigators in this direction.

As a branch of this subject, the examination of the air at different altitudes has not been neglected: the purity of the atmosphere in these situations has ever been a matter of common observation; and the different experiments that have been made at various heights, have all, with one exception, tended to show the extreme rarity of organic germs in it.

Recently, M. Freudenreich, of Bern, a former pupil of Dr. Miquel, under his auspices and following his exact methods, has made several series of systematic observations upon this point, far exceeding in scope anything previously attempted; this he has done by aspirating large measured quantities of air on different mountains at various elevations, with the general result that the rarity of micro-organisms it contains is proportionate to the altitude, for whilst at Bern, at an elevation of 1900 feet 300 to 400 of these bodies occurred in a cubic metre of air, which is less than a tenth part of their numbers in Paris, at higher elevations they became proportionately rarer,† and above 7000 feet were generally altogether absent; but in one series of these observations on the summit of Mount Niesen in the Bernese Alps, at an elevation of 7900 feet, close on the line of perpetual snow, together with three bacteria and one of the moulds, a form of bacillus hitherto undescribed occurred in 500 litres of air aspirated; preparations from the cultivation of this organism which I lately received from M. Freudenrich through Dr. Maddox, are here shown to-night.

This microbe, in Cohn's classification a bacillus, in form is very similar to the common hay bacillus, *B. subtilis*, but is readily distinguished from it by not forming a pellicle on the surface of the

* 'Les Organismes vivants de l'Atmosphère,' Paris, 1883.

† As shown in the following table ('Annuaire de l'Observatoire de Montsouris,' 1883, p. 538).

Number of bacteria contained in 10 cubic metres of air in different situations:—

| | |
|---|---|
| 1. At altitudes from 6000 to 12,000 ft. .. .. .. | 0·0 |
| 2. On Lake Thun, 18,000 ft. .. .. .. .. .. | 8·0 |
| 3. On land, in the vicinity of the same lake .. .. | 25·0 |
| 4. In the park at Montsouris .. .. .. .. .. | 7,600·0 |
| 5. In the streets of Paris .. .. .. .. .. .. | 55,000·0 |

cultivating fluid; it is, too, generally less active, whilst it differs from the *B. anthracis* by the segments, of which the longer rods and filaments are composed, being more rounded at the ends—less rectangular—than the almost cubical cells which compose the latter; it is, too, a little larger in width than either of the two other microbes; though somewhat variable in the same medium, it averages fully 1 micromillimetre (0·001 mm.) in breadth. It frequently forms spores at one or both ends of the short rods in an early stage of development; the cells themselves develop to long sinuous leptothrix filaments, the segmentation of which is obscure, unless demonstrated by special reagents. It forms, as already mentioned, no zoogloea nor pellicle on the surface of the nutrient fluid, and this character again distinguishes it at once from the hay bacillus; it grows diffusely through the liquid, rendering it uniformly turbid, not forming the clouds or flecks which characterize the anthrax bacillus. It forms numerous spores, as may be observed in the preparation under the Microscope. These at maturity are set free, the plasma of the segments which contain them degenerating and disappearing, having been used up in the reproductive process—sporulation—the other segments remaining unchanged for a time, till ultimately their life cycle ends in the same manner. This is the significance of the numerous shadowy forms apparent in preparations of this organism; the wall of the cell alone remains, the living plasma, or "protoplasm," has died and disappeared. This form of degeneration in the cell was first, I believe, figured and described by Dr. Klein,* in the case of *B. anthracis*, the appearances it offers, which are conspicuous in the preparation here shown, having sometimes been misunderstood by previous observers.

The spores when set free appear to germinate in the same nutrient medium in which they were developed, as is not the case with some other species; they develop regularly in the direction of their longer axis, never, as far as I have observed in innumerable instances, in the excentric manner described by Brefeld † in the case of *B. subtilis*, and copied by so many subsequent observers from him, in that case also, I may mention, quite contrary to my own observations.‡

There is a peculiarity in the spores of this organism at once apparent in the preparation under the Microscope; it is, that they

* Rep. Med. Off. Loc. Govt. Bd., 1883, and Quart. Journ. Micr. Sci., 1883.

† Bot. Untersuch. über Schimmelpilze (Leipzig, 1872) p. 46, &c.

‡ As, however, there are at least three or four distinct species of hay bacilli, all of which are more or less resistent to heat, and it is difficult accurately to diagnose Cohn's species of *B. subtilis*, it is possible that the spores of some one of these species may germinate in the excentric manner described, though this has not been the case with any of those that I have hitherto obtained, in very numerous experiments, by the usual methods of boiling, &c.

are more circular—less elongated—than those of either of the other organisms; they stain, too, readily with the usual dyes, which the others do not; and thus the microbe may generally be distinguished at a glance from either of its prototypes.

Cultivated in nutrient gelatin it liquefies the medium regularly from the point or line of inoculation, forming clouds or flecks in it, but no pellicle; in aga-aga bouillon or pepton it forms a creamy-white scum on the surface, but does not liquefy the jelly.

It might have been supposed that an organism, the habitat of which is on the confines of perpetual snow, would have been more at home at a low temperature; it, however, developes more readily at about 100° F. than at 50° or 60°, though the difference produces no appreciable variation in its form or habit.

It does not develop in hay infusion, neutral or alkaline, this character again at once distinguishing it from both the microbes which it resembles in form; neither does it germinate in solutions of mineral salts. It will not develop in cultivating fluids that are slightly acid; 0·1 per cent. of free hydrochloric acid in solutions of pepton, or bouillon and pepton, entirely prevents its germination.

It is not pathogenic when inoculated or injected in considerable quantities into the tissues of rodents, and must be considered a septic organism; it occasions, however, no very marked fetor in the fluids in which it developes.

It bears a general resemblance to the widely diffused bacilli that occur so generally in putrid matter. The characters of these, which are probably of many different species and varieties, have never been particularly described. They are sometimes termed blood bacilli, from their occurrence in putrid blood, but have been more appropriately named collectively by Klein * *Bacillus septicus*. They, however, usually, or as far as I have yet observed, invariably, form a pellicle in cultivating fluids, which the Niesen bacillus does not.

The labour and difficulty of such observations as those here referred to, in which the microbe now described was obtained, is obvious, involving the transport of the requisite apparatus and instruments to such inaccessible places, and the obstacles to be overcome in making experiments with the requisite precautions in these situations. This, however, does not apply to the examination of air at more moderate and accessible elevations, such for instance as the hills and mountains of our own country, or even on high buildings, where, as far as I know, no observations whatever have as yet been recorded, though one of our own countrymen, as is well known, has examined the air of the Alps.

As an instance of how even comparatively slight elevations

* 'Micro-organisms and Disease,' 1884, p. 78.

affect the purity of the air, it may be mentioned that Dr. Miquel (Op. cit., p. 240) found micro-organisms twenty times more numerous in the streets of Paris four feet above the ground than at the summit of the Pantheon at an elevation of 330 feet.

Important as is the microscopical examination of air, and immeasurably as the subject has been advanced and illustrated by the magnificent work of M. Miquel—certainly by far the most extensive and important as yet made in any branch of micrology—there is as yet one void in it, and that is the want of a clear diagnosis of the specific characters of the various microbes that occur in different conditions, seasons, and localities. In a general way no doubt the salubrity of any given portion of air corresponds with the paucity of micro-organisms which it contains, but in spite of the innumerable observations and the laborious statistics that have been given, it has not yet been shown that there is any direct connection between their number and the prevalence of infectious or epidemic diseases. The reason of this appears obviously to be that we are not as yet generally able, from the mere inspection of the outward characters of any micro-organisms, to say that such an one is fatally infective—the bacillus of tubercle—the micrococcus of pneumonia or diphtheria—that another is merely saprophytic or zymotic, harmless to the animal organism.*

When we are able to do this, then will it be possible from the mere microscopical examination of a sufficiently large sample of the air of any locality to connect it certainly with the prevalence of infectious diseases. The same considerations apply equally strongly to the examination of drinking water, and now that the chemical analysis of this has lately been shown to be practically useless,† if not even misleading, it appears that microscopical examination must be relied on in future.

With this object the study of and familiarity with the specific characters of these organisms is one of the most important subjects that can occupy the microscopist. In this view I have brought to notice to-night the diagnostic characters of the microbe now shown, remarkable from the situation where it occurred. A comparison of the preparations under the Microscopes will show that it is not impossible to discriminate by their form alone two microbes somewhat similar, and which to a cursory view might appear identical.

* The habit of growth of the lower fungi in solid cultivations, which has been so much dwelt upon of late, is very unreliable and much over-rated as a means of specific diagnosis, being only at most of very secondary utility, as I shall endeavour to demonstrate shortly.

† Rep. Med. Off. Loc. Govt. Bd., 1882-3.

## XVII.—*On the use of the Avicularian Mandible in the determination of the Chilostomatous Bryozoa.*

By Arthur Wm. Waters, F.R.M.S., F.L.S.

(*Read* 10*th June*, 1885.)

Plate XIV.

In a paper "On the Use of the Opercula in the Determination of the Chilostomatous Bryozoa"* I pointed out the value of these chitinous organs, and figured those of thirty-six species, of which thirty-five were from the Mediterranean. This was really to be looked upon as a supplement to my papers on the Bryozoa from the Bay of Naples,† and in these latter I referred individually to the figures of the opercula. It was almost self-evident that the

EXPLANATION OF PLATE XIV.

Fig. 1.—Avicularian mandible of *Flustra truncata* L., Naples.
„ 2. „ „ *F. armata* Busk, Cape of Good Hope.
„ 3. „ „ *F. foliacea* L., Brighton.
„ 4. „ „ *Diachoris magellanica* Busk, Naples.
„ 5. „ „ *D. hirtissima* Hell., Naples.
„ 6.—Operculum of *Flustra truncata* L., Naples.
„ 7. „ *F. armata* B., Cape.
„ 8.—Avicularian mandible of *Schizoporella linearis* Hass., Naples.
„ 9.—Lateral avicularian mandible of *Cabcrea Boryi* Aud., Rapallo, Italy. × 250 & 85.
„ 10.—Anterior „ „ „ „ „
„ 11.—Avicularian mandible of *Cellaria sinuosa* Hass., Roscoff.
„ 12.—Operculum of *C. sinuosa* Hass., Roscoff.
„ 13. „ *C. fistulosa* L., Roscoff.
„ 14.—Avicularian mandible of *C. fistulosa* L., Roscoff.
„ 15.—Operculum of *Cabcrea Boryi* Aud., Rapallo.
„ 16.—Avicularian mandible of *Smittia Landsborovii* Johnst. × 250 & 85. Naples.
„ 17.—Avicularian mandible of *Retepora Couchii* Hincks. × 250 & 85. Naples.
„ 18. „ „ *Porella cervicornis* E. and Sol., Naples.
„ 19. „ „ *Umbonula verrucosa* Esp., Capri.
„ 20.—Operculum of *Cellaria Johnsoni* Busk, Naples.
„ 21.—Avicularian mandible of *Cellaria Johnsoni* Busk., Naples.
„ 22. „ „ *Schizoporella unicornis* Johnst., Naples.
„ 23. „ „ *Smittia*, Rapallo.
„ 24. „ „ *Smittia nitida* var. *ophidiana* W., Naples.
„ 25. „ „ *Mucronella coccinea* Abild., Naples.
„ 26. „ „ *Schizoporella arrogata* Waters, Naples.
„ 27. „ „ *Diporula verrucosa* Peach, Naples.
„ 28. „ „ *Cellepora pumicosa* Busk. (non. L.). × 250 & 85. Naples.
„ 29.—Mandible of (small) avicularium of *C. coronopus* Wood, Naples.
„ 30. „ large (onychocellaria) avicularium of *C. coronopus* Wood, Naples.

* Proc. Manchester Lit. and Phil. Soc., xviii. (1878) p. 8.

† "Bryozoa of the Bay of Naples," Ann. and Mag. Nat. Hist., ser. 5, iii. (1879) pp. 28, 114, 192, and 267.


Avicularian Mandibles &c. of Bryozoa.

mandibles of the avicularia should also be taken into consideration, but as I had only examined and made preparations of a limited number I did not feel justified in publishing anything about them, but called the attention of many of my friends who were working at the Bryozoa to the use they were likely to be, and showed them drawings.

Since then I have been engaged in the examination of fossil Bryozoa, in which of course the chitinous organs are not preserved, but the careful examination of the oral aperture, from which conclusions as to the shape of the operculum can be drawn, has been the basis of my work with the Australian fossils, and I have prepared the opercula of a large number of *Catenicellæ* and other genera represented by fossil allies, so that although we may never find the chitinous organs fossil, yet the study of them may be of the greatest value paleontologically.

Mr. Busk, when working at the 'Challenger' material, in consequence of my short paper, took up the examination of the chitinous organs, and to him we must give the credit of first applying the form of the mandible in specific determination, the results being especially valuable in the genus *Cellepora;* and Professor MacGillivray has also shown their value in the genera *Cellaria* and *Retepora.**

The most important feature of Mr. Busk's report on the 'Challenger' Bryozoa is undoubtedly the use he makes of the chitinous organs, but as some of his generalizations are evidently based upon incomplete series, I take the opportunity of adding to

---

Fig. 31.—Avicularian mandible of *Cellepora costata* MacG. = *retusa* var. *caminata* Waters, Naples.
„ 32. „ „ *C. avicularis* Hincks, Naples.
„ 33. „ „ *C. sardonica* Waters. × 250 & 85. Naples.
„ 34. „ „ *Cribrilina radiata* var., Naples.
„ 35.—Spatulate avicularian mandible of *Schizoporella auriculata* Hass., Naples.
„ 36.—Oral „ „ „ „
„ 37.—Avicularian mandible of *Cellepora verruculata* Sm., Naples.
„ 38. „ „ *C. digitata* Waters, Capri.
„ 39. „ „ *C. sardonica* Waters, Naples
„ 40. „ „ *Membranipora curvirostris* Hincks, Naples.
„ 41. „ „ *M. tenuirostris* Hincks, Naples.
„ 42. „ „ *M. angulosa* Rss., Naples.
„ 43. „ „ *M. Flemingii* Busk. × 250 & 85. Durham.
„ 44. „ „ *Adeonella polystomella* Rss. × 250 & 85. Naples. *b*, operculum of ditto.

All are shown magnified 85 times, being the same as that adopted in my paper "On the Use of the Opercula," &c., but as some avicularia are too small to show detail this size, they are given as fig. *a* magnified 85 times, and also figured increased to 250 times. All were examined with a power magnifying 500 times.

* "Description of New or Little Known Polyzoa," Trans. Roy. Soc. Victoria, xx. (1883) pp. 103, pls. 1 and 2; also in vol. xxii. (from advance copies).

the number of described mandibles by giving the figures of some in my collection, and as these are mostly from Mediterranean species, this must be considered as another supplement to the description of species from the Bay of Naples.

In the communication referred to, I said, when speaking of the Celleporidæ, that "I believe the opercula may assist very much to bring this family out of its present confusion," and Mr. Busk has now made a good start towards making this a fact. There is, however, one point connected with the *Cellepora* mandibles which requires further notice, as Mr. Busk describes a slender process rising from the middle of the base of the avicularian mandible in the holostomatous division of the genus *Cellepora*, but finds it only in this division, and further only in those from the southern hemisphere. In a paper read before the Geological Society I have shortly pointed out that this is by no means the case, but that it can be found in species from the northern hemisphere, not only in both divisions of this genus, but apparently in other genera. Mr. Busk seems to have looked for it in vain in *Cellepora sardonica* Waters, from the Mediterranean, but this species has two forms of avicularia, one triangular and acute (fig. 39), in which I do not find any process, whereas in the small round avicularium (fig. 33) this process is very distinct, so that perhaps Mr. Busk only examined the one form. Besides occurring in this species of *Cellepora* it is found in *Cellepora coronopus* Woods (fig. 29) and *C. costata* MacG. (fig. 31).* In a similar position there is in many species a process arising from the calcareous bar which divides the aperture of the avicularium. This I figured six years ago in *C. sardonica* (loc. cit. plate XIV. fig. 5), also in *Schizoporella biaperta* (id. plate XI. fig. 1). Smitt also figured it in the avicularia of *Lepralia edax* (Floridan Bry., plate XI. fig. 222), and it is a character which can frequently be distinguished in well-preserved fossils (see fig. *Retepora marsupiata* var., Q. J. Geol. S., vol. xxxix. plate XII. fig. 21). It occurs in *Schizoporella auriculata*, *Porella cervicornis*, *Retepora Couchii*, a New Zealand *Smittia*, &c.

The process in the chitinous mandible Mr. Busk calls a columella, and says that it is covered with "short hairs," but these upon comparison with other mandibles turn out only to be the remains of the attachment of the muscular threads.

In the 'Challenger' report a genus *Adeonella* was made, and includes species having a pore opening into the body of the zoœcia

* The mandible of *Diachoris magellanica* B. (fig. 4) has a double "columella," and since the paper was written the examination of *D. bilaminata* Hincks, shows that the mandibles of both are identical in size and detail structure, and the similarity of other specific minute characters is most close, proving that the two species are most closely allied, although the mode of growth produces a very different general appearance.

below the oral aperture, and having the proximal edge of the aperture straight; while other species have a pore which is peristomial and the aperture has a broad sinus, that is to say, the two most important characters are different, and I think attention having been called to this, that it will be seen that they must be kept distinct.

Mr. Busk, however, points out that "in the entire group" (speaking of the family Adeoneæ) "the avicularian mandibles, both large and small, always exhibit a projecting point or articular process at each end of the base." This is certainly a curious fact, but in order to see what value must be attached to it we must examine whether it is only in this group that this process obtains, and when we have found it in various genera it is only reasonable to conclude that we must not attach generic importance to this when other characters are widely divergent. In *Cribrilina radiata* (fig. 34) this process is pronounced, and it is also seen in the mandibles of *Flustra armata* (fig. 2) and *F. foliacea* (fig. 3), and the structure of several *Membraniporæ* where the basal portion is thicker in the centre than at the corners, is only a modification of the more distinct process of the Adeoneæ. This is shown in *M. curvirostris* (fig. 40) and *M. Flemingii* (fig. 43), and occurs very distinctly in mandibles of a *Membranipora* allied to *M. dentata* d'Orb.*

These processes in the mandibles of *Cellepora* and *Adeona* lead us to the consideration of the importance of such modifications. They indicate differences in the muscular attachments, and both here and in the opercula it is really the muscular system which has the greatest classificatory value; but this is best studied by means of the variations in the chitinous parts. This Mr. Busk does not seem to have fully appreciated; for the muscular attachments or projections for the purpose are not figured by him, where preparations in my possession show such characters very clearly. The pattern of the mandibles, if we may thus call it, depends upon there being either two chitinous layers in places, or upon a thickening of the chitin. In some cases this may be directly for the attachment of the muscles, but more frequently it seems to be rather a thickening to give support to the point of muscular attachment. There are a few cases of very thin mandibles, some of which may be stained, instead of showing up yellow against the coloured tissue. As examples, see the mandibles of *Mucronella coccinea* (fig. 25), *Schizoporella arrogata* (fig. 26), and the large mandible of *Retepora Couchii*.

* Under *Adeonella* I should include *A. polymorpha* B., *A. platalea* B., *A. intricaria* B., *A. atlantica* B., *A. pectinata* B. (?), *A. polystomella* Rss. (*Eschara Pallasii* Hell); but *Microporella distoma* B., *M. coscinopora* Rss., *M. lichenoides* M. Ed., and *M. fissa* Hincks, I should not place in this genus.

Although it is convenient to commence this study with the separated opercula and mandibles, this should only be considered as an introduction to a complete investigation of the muscular systems of both zoœcia and avicularia. Our information with regard to the avicularia is also not complete unless the shape of the openings covered by the mandibles is given; and this can usually be seen without preparation, but sometimes it is necessary to incinerate * a specimen for the purpose. I would lay great stress upon the examination of this character, as it may be of great value in the determination of fossils, and is one which, a reference to my papers on the Australian Bryozoa will show, can frequently be used; though fossils being as a rule less well preserved than recent material, such work should be based upon the examination of recent specimens.

Turning to the mandibles figured, those of three *Membraniporæ* deserve especial attention. One of these is *M. Flemingii* (fig. 43), from Britain, and great variation having been assigned to this species I was misled into calling a species from Naples *M. Flemingii*, and another *M. Flemingii* var., but the former is *M. curvirostris* of Hincks (fig. 40), and the latter *M. tenuirostris* Hincks (fig. 41). The mandibles will be found characteristic in each case, but upon examination the same structures are found throughout, the only difference being in the shape.

The mandibles of *Cellaria sinuosa* (fig. 11), *fistulosa* (fig. 14), and *Johnsoni* (fig. 21), though showing considerable characteristic differences in shape and size, present great similarity in the different parts; and this is the case with other *Cellariæ*.

In *Cellepora sardonica* (the sub-oral avicularia) (fig. 39), *C. digitata* (fig. 38), and *C. verruculata* (fig. 37), the avicularia could scarcely be distinguished except by size.

The similarity of the small oral avicularia of *Smittia Landsborovii* (fig. 16), *Porella cervicornis* (fig. 18), and *Umbonula verrucosa* (fig. 19) must at once strike any one.

On each side of the large mandible of *Membranipora angulosa* (fig. 42) there is a separate thick lunate chitinous mass in the front of the avicularian chamber, and to this the lower corners of the mandible are attached in the position shown. It will be interesting to know whether similar structures are the rule where the mandible is very large and powerful.

In the whole of the Membraniporidæ the opercula are very similar, having a considerable lateral projection for the muscular attachments. Mr. Busk's figures of the opercula of *Vincularia gothica* (loc. cit., p. 72, fig. 2) and *V. labiata* (p. 73, fig. 3) may

* A convenient way of doing this is to place the specimen upon a piece of platinum foil and hold it in the flame of a spirit-lamp until all the organic portion is removed.

be taken as typical Membraniporidan opercula. The opercula of *Selenaria* are also of this form, and those of *Cellaria* approach to this type, having a downward projection (figs. 12, 13, 20). The opercula of a *Lepralia* from New Zealand, which I at present think may be called a variety of *L. adpressa*, has a lateral strengthening bar, and the same is the case in a *Microporella* allied to *M. decorata* Rss.

The operculum of *Monoporella crassatina* Waters, from New Zealand, has a somewhat similar projection, looking like that of *Flustra armata* (fig. 7).

Although the small oral avicularia of *Schizoporella auriculata* (fig. 36) is very different in size and shape from the larger spatulate avicularia (fig. 35), yet the structure of the mandibles is almost identical.

The chitinous organ (fig. 8) of *Schizoporella linearis* I call an avicularian mandible. It closes a cell which Mr. Hincks (Brit. Mar. Poly., p. 251) calls an oœcial cell, and if Mr. Hincks really finds them containing ova, then there can be no doubt about their function. My specimens are all dried ones, and do not enable me to settle this point; but I have never found such a chamber connected with a true ovicell, although there is usually an inflation above it which might easily be mistaken for one. This is shown in my plate IX. fig. 2, "Bryozoa of Naples." *

* Some of the species alluded to were not mentioned in my paper on the Naples Bryozoa, but since that was written I have collected material from a somewhat wider range, and have also found some fresh species among the material collected in Naples, and as soon as I have finished work on hand hope to be able to write a supplementary paper about doubling the number previously given. The following is, however, a provisional list of some additions to be made to the Bay of Naples fauna:—

*Bicellaria ciliata* L.; *Notamia* (*Gemellaria*) *avicularis* Pieper; *Cellaria Johnsoni* Busk; *Membranipora flustroides* Hincks, Capri; *M. Dumerilii* Aud.; *M. Lacroixii* Aud.; *Membraniporella nitida* Johnst., Capri; *Mastigophora Dutertrei* Aud., Capri; *Microporæ coriacea* Esper., Capri; *M. hippocrepis* Goldf., Capri; *Cribrilina figularis* Johnst., Capri; *Microporella distoma* Busk., Capri; *Adeonella polystomella* Rss. (*Pallasii* Hell); *Porina borealis* Busk, Capri; *Palmicellaria elegans* Alder.; *Lepralia ternata* Rss., Capri; *Smittia marmorea* Hincks, Capri; *S. affinis* var., Capri; *S. Landsborovii* Johnst.; *S. cheilostoma* Manz.; *Mucronella Peachii* Johnst.; *M. Peachii* var. *octodentata*; *Retepora Solanderi* Risso; *Diachoris hirtissima* Hell; *Cupularia stellata* Busk, Capri; *Setosella vulnerata* Busk, Capri; *Diastopora patina* Lamk., Capri; *Alcyonidium mytili* Dalyell; *Cylindræcum giganteum* Hincks; *Amathia lendigera* L.; *Scrialaria semiconvoluta*; *Valkeria tuberosa* Hell; *Mimosella gracilis* L.; *Pedicellina gracilis* Sars.

# SUMMARY

OF CURRENT RESEARCHES RELATING TO

# ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

# MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Primitive History of the Vertebrate Body.**†—In his seventh essay Dr. A. Dohrn deals with the origin and differentiation of the hyoid and mandibular apparatus of Selachians, and in the eighth with the thyroids of *Petromyzon*, *Amphioxus*, and the Tunicates.

Dr. Dohrn criticizes very closely the speculations of a number of recent observers, and expresses his own conviction that it is necessary to bring morphological studies into the closest connection with physiological and biological investigations; it was for this purpose that he built the Naples Aquarium, and he hopes to advance it by adding a physiological laboratory. Morphology, in his view, has become too one-sided, and too much restricted to one line of investigation.

**Formative Force of Organisms.**‡—Dr. C. S. Minot thinks that the conception that the forces of the ovum are so disposed that evolution of the adult organism is the mechanical result of the predetermined interplay of those forces, is an inadequate explanation, and that it must be supplemented, if not replaced, by another: "the formative force is a generally diffused tendency, so that all parts inherently tend to complete, by their own growth and modification, the whole organism"; evidence as to this may be arranged under three heads.

1. *Regeneration.* This is a process which is co-extensive with life, but varies greatly in different species; from this it follows that each individual has a scheme or plan of its organization to which it strives to conform. "The act of regeneration of lost parts strikes the imagination almost as an intelligent pursuit by the tissues of an ideal pur-

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, or for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† MT. Zool. Stat. Neapel, vi. (1885) pp. 1-92 (8 pls.).

‡ Science, vi. (1885) pp. 4-6.

pose." The author then refers to the recently published observations of Nussbaum and Gruber, to which reference has already been made in this Journal.*

2. *Duplication of parts.* The evidence on this head is to be judged under the considerations that instances are by no means unusual, and that the agreement with the normal structure is not uniform.

3. *Asexual reproduction.* There may be fission or gemmation, or, as an extreme, multiplication by means of pseudova.

"The evidence forces us to the conclusion that the formative force or cause is not merely the original disposition of the forces and substance of the ovum, but that to each portion of the organism is given (1) the pattern of the whole organism; (2) the partial or complete power to reproduce the pattern." In other words, the formative force is a diffused tendency, and the very vagueness of the expression is useful as emphasizing our ignorance of its real nature.

Dr. Minot insists on our total or comparative ignorance of the fundamental properties of life, the assertions concerning which are, for the most part, entirely worthless.

**Tail of Human Embryo.**†—Prof. H. Fol discusses the question whether the human embryo ever presents at the posterior extremity of its body anything which merits the name of *tail.* It is necessary at the outset to distinguish teratological cases from the more important phenomena of normal embryogeny, and to agree as to the meaning of the word tail. Is this term applicable to every conical or cylindro-conical appendage at the posterior extremity of the back, whatever may be the tissues of which it is composed, or should it be reserved for an organ containing a prolongation of the vertebral column? This latter definition seems to preponderate. An appendage devoid of vertebræ is not a true tail in the anatomical sense of the term, but merely a simple caudal prolongation.

As regards young embryos, an understanding is not possible if we do not first determine the point where the caudal vertebræ begin. Shall we fix the limit at the point where the tail branches off from the body? Or are we to be guided by the position of the anus? Or must we give the name caudal to all the vertebræ situate behind the sacrum? This last-mentioned view has prevailed in comparative anatomy, and from this point of view we may say that the adult man possesses a tail, since he presents four or five coccygeal vertebræ, situate beyond the sacrum. The minimum in this respect is reached by the chimpanzee, which has only two or three coccygeal vertebræ. This ape is consequently, when mature, further from possessing an externally visible tail than is the normal human adult—a fact not without significance.

If we apply the name of tail to the portion of the vertebral column which is situate outside the trunk of the body, it must be admitted that from the age of three weeks to that of two months and

* See this Journal, *ante*, p. 472.

† Comptes Rendus, c. (1885) pp. 1469–72.

upwards the human embryo is endowed with this organ, for at this epoch the coccygeal vertebræ occupy the axis of a cylindro-conical appendage, which is very apparent, and which issues from the posterior extremity of the trunk. If with His we take the position of the anus for a guide, the tail will be shorter, but is still very conspicuous, especially at the age of five to six weeks.

But it is generally admitted as absolutely demonstrated that this caudal appendage of the human embryo never contains any other vertebræ than those found in the coccyx of the adult. Ecker, who gives, in full conviction, the name of tail to the posterior extremity of the human embryo, has declared that he has never met with any supernumerary vertebræ. This author has even studied the well-developed tail of a human embryo 9 mm. in length, and he describes and figures all the terminal part as consisting of an amorphous blasteme. His, however, detects here a prolongation of the dorsal cord and of the spinal marrow, but no segmentation. Both these authorities admit that beyond the thirty-third or thirty-fourth vertebræ there is no further portion of the skeleton.

On this point the researches of Prof. Fol have led him to a result diametrically opposite to that of his predecessors. The error of His is due to the circumstance that the oldest embryos which he has examined, those of 7 mm., have exactly thirty-four myomeres, that is to say, thirty-three vertebræ; and he admits, without any further proof, that this was their ultimate condition.

Prof. Fol gives a summary of his anatomical study of a human embryo of 5·6 mm., i. e. of twenty-five days old. This embryo has as yet only thirty-three somites, representing thirty-two vertebræ. There is, therefore, an increase in number in the fourth week. This fact led Prof. Fol to examine if the number did not go on increasing during the fifth week, and his expectation was not disappointed. The human embryo of from 9 to 10 mm., the age when the tail attains its greatest prominence, possesses a *greater number of vertebræ than the adult.*

Two embryos of the finest appearance, and perfectly fresh when sent to the author, were first photographed and then cut into sections. The series of sections are irreproachable, and one of the two, comprising 320 sections, has been most carefully drawn in the camera lucida in its entirety. On comparing these 320 figures it is easy to count, without any chance of error—(1) the rachidian ganglia; (2) the myomeres; (3) the nascent cartilages of the bodies of the vertebræ. These three enumerations check and confirm each other, since they all three give the same result; *the human embryo of* 8 *mm. has thirty-eight vertebræ.*

This result is further confirmed by an examination of the photographs of the recent parts, since we readily distinguish thirty-five myomeres, and besides a region occupying the external fourth part of the tail where the demarcations are no longer visible through the skin. But the sections show us that in this last quarter, contrary to the opinion of Ecker and His, the mesoderm is most distinctly divided into a double range of somites extending to the very tip of the tail,

presenting dimensions regularly decreasing to the thirty-eighth somite, which measures merely 37 $\mu$ in diameter. This fact is not teratological, but is fully confirmed by various other embryos, all perfectly normal, but slightly differing in age.

With the exception of the last two, all the caudal vertebræ have a blasteme of cartilaginous substance, similar, except in size, to that of every other vertebra of the series. The last two are only indicated by myomeres, perfectly distinct from the rest. The extremity of the tail is formed by the termination of the medullary tube, covered merely by the skin. The dorsal cord extends, therefore, quite close to this extremity.

The last caudal vertebræ have but a very ephemeral existence. Already in embryos of 12 mm., that is to say, of six weeks, the thirty-eighth, thirty-seventh, and thirty-sixth vertebræ are blended together into a single mass, and the thirty-fifth itself has no longer very distinct limits. An embryo of 19 mm. has merely thirty-four vertebræ, the thirty-fourth resulting from the fusion of the four last. At this moment the tail altogether is already much less prominent.

It results from these facts that the human embryo during the fifth and sixth week of its development is furnished with an incontestable tail, regularly conical, elongated, and deserving the name in all respects. It is deprived of all physiological utility, and must rank among the rudimentary organs.*

**Nature of the Placental Neoformation and the Unity of Composition of the Placenta.**†—M. Laulanie discusses the two types of placenta and Ercolani's attempt to reduce these two types to one—the multiple—on account of a constant secretory epithelium. He concludes that in all cases the maternal neoformation of the placenta is the result of a conjunctivo-vascular process, and that the maternal surfaces are invariably destitute of the secretory epithelium which Ercolani has attributed to them.

**Fœtus of Gibbon and its Placenta.**‡—M. J. Deniker describes the fœtus of a species of gibbon (either *Hilobates lar* Saint-Hil. or *H. agilis* F. Cuv.) and its placenta, and points out that the placenta of the anthropoid apes is single, the double placenta being only met with in these animals by way of exception, as in the human race and in certain genera of monkeys, e. g. *Hapale*.

**Spermatogenesis in the Rat.**§—Mr. H. H. Brown finds that the rat is an advantageous animal for the study of spermatogenesis, owing to the large size of its spermatozoa.

The research was conducted by means of sections and by teasing; the history of the nuclei was made out with sections prepared by the paraffin-shellac method and by staining with hæmatoxylin; sections stained in chloride of gold solution showed particularly the protoplasmic structures and the outlines of the cells, while the nuclei,

* See Journ. of Sci., vii. (1885) pp. 416–9.
† Comptes Rendus, c. (1885) pp. 651–3.
‡ Ibid., pp. 651–6.
§ Quart. Journ. Micr. Sci., xxv. (1885) pp. 313–69 (2 pls.).

being unstained, appeared like vacuoles. Osmic acid and teasing revealed the development of the spermatozoa.

With regard to the nomenclature, Mr. Brown has, at the suggestion of Prof. Lankester, avoided the use of such terms as spermatoblast, and has substituted simple descriptive expressions. In the tubule four layers of seminal elements are to be distinguished; the most external consists of cells, the nuclei of which are all in the resting condition; of these nuclei there are three kinds, some belong to *supporting*, some to *growing*, and some to *spore*-cells. In the second layer the cells are large, and the nuclei all in a kinetic condition; those of the third layer are *young spermatozoa;* and those of the fourth, spermatozoa just ready to leave the tubule.

The author describes the origin of the growing cells of the outer layer from spore-cells, which divide in the first instance by a process of budding, and subsequently the resulting cells undergo karyokinesis; the only writer who has given a somewhat similar account is Mr. A. B. Lee, who has studied the spermatogenesis of *Appendicularia;* the explanation which he gives is regarded by Mr. Brown as accounting very well for the process he has observed. The suggestion is that the complex method of division by karyokinesis "is intended to serve for the accurate division of the nucleus between the resulting cells"; the result of budding is to produce dissimilar cells, that of karyokinesis is the production of growing cells precisely alike, which again give origin to young spermatozoa which are again all alike.

The author agrees with Swaen and Masquelin that, in the dog-fish the spermatozoa are derived from primitive male ova, while the supporting cells are derived from follicular cells, and he thinks it probable that the same is the case with Mammals.

**Hatching of Birds' Eggs after Lesion of the Shell.***—Dr. L. Gerlach has made experiments to show that the admission of a diminished quantity of air to the blastoderm of the hen's egg, during hatching, causes dwarfing of the embryo. He then tried whether an increase in the size of the embryo could be obtained by increasing the amount of air.

In order to admit more air a part of the shell was scraped quite thin. When this was done successfully (which rarely happened) and the eggs were put in the incubator, no great increase of size was apparent for the first two or three days, but after that there was a remarkable increase in the rate of development. For example, an embryo after 40 hours' incubation presented an appearance which is generally only visible at the end of the third or in the course of the fourth day.

A second method of admitting more air was to remove whole pieces of the shell, great care being taken so as not to injure the shell membrane or blastoderm.

The fracture must be at some distance from the blastoderm so that the desiccation which ensues on this removal of the outer covering shall not extend to the embryo. These precautions being observed

* SB. Physikal.-Med. Soc. Erlangen, 1884, p. 129.

and the broken part turned downwards, the embryo proceeded to develope itself normally, and at the same accelerated rate as after the scraping of the shell.

Dr. Gerlach gives directions for carrying out these experiments, and describes a process by which the development can be watched without injury to the egg, by substituting a piece of glass for a piece of egg-shell.

The above experiments completely disprove the widely spread opinion that those eggs, of which the shells are broken, cannot produce an embryo.

**Early Development of Rana temporaria.***—Mr. W. Baldwin Spencer first discusses the fate of the blastopore, and comes to the conclusion that, in *Rana*, as in *Triton*, it is transformed into the permanent anus; between the two, however, there is this important difference that the latter shows no connection between the neural and alimentary canals; it is difficult to determine whether this connection in *Rana* should be called a "neurenteric canal"; it cannot be so if we limit that term to its original significance in connection with the inclosure of the blastopore, and when that orifice forms itself a means of communication between the alimentary and neural canals. "Perhaps, however, the term 'neurenteric canal' may be applied to all structures which allow of communication between the two canals, and which itself, in subsequent development, closes up and disappears; using the term in this sense, one is clearly present and well-developed in *Rana*."

The author, secondly, discusses some points connected with the early development of the cranial nerves. Before the closure of the neural canal no development of nerves can be perceived; in other words, the neural ridge of the chick and of the elasmobranch appears to be absent. The first appearance of the nerves is not in the form of a direct outgrowth from the substance of the canal, but along certain lines the cells of the nervous layer proliferate, and from these proliferations the rudiments of the cranial nerves appear. The ganglia are found to arise along the level of the lateral line continued on to the head; this curious mode of origin leads to the view that they arise primitively as ganglia of the sense-organs of the lateral line of the head; in other words, their present position and nature is not primitive, but secondary.

The mode of proliferation of nerves in *Rana* reminds the author of the mode of origin of the lateral and pedal nerve-cords in the Chitons, as recently described by Kowalevsky, and he thinks that the embryonic neural sheath may be found to represent a more ancestral condition than that which obtains in elasmobranchs and birds, resembling as it does the arrangements seen in some invertebrates.

**Development of Motella mustela.†**—Mr. G. Brook has investigated the development of this fish with the following results.

The eggs are pelagic with a large oil-globule to keep them floating.

* Quart. Journ. Micr. Sci.—Suppl., 1885, pp. 123-37 (1 pl.).

† Journ. Linn. Soc. Lond.—Zool., xviii. (1885) pp. 298-307 (3 pls.).

The hypoblast appears to originate as in *Trachinus;* the cells of the periblast are pushed under the germinal disk until they cover the whole floor of the segmentation-cavity; cells absorbed from this layer and free cells from the yolk contribute largely to form, if they do not entirely form, the invaginated layer. Kupffer's vesicle does not appear until after the closure of the blastopore, and consists of a solid mass of rounded cells. Early on the fourth day the oil-globule was found to have an investing membrane binding it to the yolk; this probably consists of hypoblast. As is usual with pelagic fish eggs the circulation does not commence until some days after hatching; like other fish whose ova are pelagic *Motella* spends a long time (six days) within the ovum; the author emphasizes this point by giving a list of the principal species of fish with pelagic ova and the date at which they have been observed to leave the egg.

**Development of the Salmon.***—Mr. J. A. Ryder describes certain features of the development of the land-locked salmon (*Salmo salar* var. *sebago*) viz. the arrangement of the blood-vascular system at the time of hatching; some of the impairments which this system suffers when the young fishes are under the care of the fish-culturist; and the development of the fins.

**Spawning of the Cod.**†—The observations made by Prof. Cossar Ewart and Mr. G. Brook justify the conclusion of Sars that the spawn is shed while the fishes are swimming about freely in the water, and that the eggs are fertilized at, or as they rise to the surface, this being facilitated by the position of the micropyle, which is always found in the lower hemisphere of pelagic fish ova. The eggs and milt are of less specific gravity than the sea-water, and consequently float.

For some time before the first eggs reach maturity, and during the early part of the spawning period, the fish not only refuse food, but give up their regular movements around the tank and swim about in small groups or rest together at the bottom, swimming and resting alternately. The activity of the males was specially evident at dusk and in the early morning, and it was apparently during these periods of activity that the eggs were shed and fertilized. The males swim indiscriminately among the females, sometimes over, sometimes under them, fertilizing the water through which the shed eggs are slowly rising to the surface. Eggs were pressed from a ripe female and fertilized artificially. The females, like the Salmonidæ, are capable of withholding the flow of ripe eggs to a certain extent. A limited number only are ripe at one time, and if the unripe be forced out they sink to the bottom and are incapable of being fertilized. Whether fertilized or not the ripe eggs float immediately after extrusion; but in the latter case they die and sink to the bottom in twelve to fourteen hours.

In perfectly still water the eggs float in a dense mass; when

* Proc. U.S. Nat. Museum, viii. (1885) pp. 156-62 (1 pl.).

† Ann. Rept. Fishery Board for Scotland, 1884. See 'Nature,' xxxii. (1885) p. 282.

carried along by a strong current they become suspended at various depths, but none that are living lie at the bottom. The eggs rise very slowly; in one case noted it took an egg four minutes to rise through $1\frac{1}{4}$ in. of water. During the spawning process the water in the tank became slightly clouded by the spermatozoa which were spread through it. The milt is, however, shed in such a thin stream under natural conditions that it is difficult to detect it.

**Development of Vascular Glands.*** — M. Retterer finds that vascular glands in birds and mammals are formed by two tissues which are different in origin; one is mesodermic and forms the vascular framework, the other is ectodermic or endodermic in origin, and is formed of epithelial elements. The bursa fabricii becomes atrophied in the adult bird, the embryonic lamellar tissue being converted into bundles of dense cellular tissue, while the epithelial elements are compressed and disappear. Amygdaloid lymphatic glands of mammals pass, in the adult, through altogether analogous phases, or in other words, diminish in size and number.

**Simplified View of Histology of Striped Muscle-fibre.†**—Mr. B. Melland finds an intracellular network in the striped muscle-fibre of *Dytiscus*, the bee, frog, lobster, crayfish, and rat; this may be most clearly demonstrated by gold staining; it alone is stained by the reduced gold and is thus easily visible. Network partitions cross the fibre transversely, and more or less separate the muscle-fibre into compartments; down each compartment, and joining the dots at the intersections of the fibres of the transverse network there runs a series of fine rods. This network consists of an isotropous material, and is more highly refractive than the rest of the muscle-substance, which is anisotropous. The author thinks that the knowledge of this network will explain the transverse striation and other complicated phenomena presented by the muscle-fibre, while it brings into harmony many of the conflicting statements of the histologists.

**Atlas of Practical Elementary Biology.‡**—Mr. G. B. Howes has published an atlas of practical elementary biology, which ought to be very useful, especially to those students who are working without the aid of a teacher. The first seven plates deal with the frog, including its histology and development; the next three plates deal with the crayfish; plates 11 and 12 with the earthworm; the snail and the mussel have two plates apiece, and *Hydra* has one. Plate 18 is devoted to the "unicellular organisms"—*Vorticella*, *Amœba*, *Protococcus*, the yeast-plant, and the Bacteria. Plate 19 is devoted to the Fungi, and plate 20 to the stoneworts; the fern and the flowering plant take us to the last or 24th plate. The appendix will be of use to the beginner, and the bibliography will show him how to extend his studies. There is a short preface by Prof. Huxley.

* Comptes Rendus, c. (1885) pp. 1596-9.

† Quart. Journ. Micr. Sci., xxv. (1885) pp. 371-90 (1 pl.).

‡ Howes, G. B., 'An Atlas of Practical Elementary Biology,' 24 pls. 4to, London, 1885.

## B. INVERTEBRATA.

**Marine Larvæ and their Relation to Adults.*** — Dr. H. W. Conn finds that the simplest known larva is the pilidium of the Nemertines, and it seems also to be the most primitive, for it is little more than a gastrula; it has, however, one cilium or a tuft of cilia at the end of the body opposite to the blastopore; these are not locomotor organs, but are carried stiffly, and seem to be sensory. Around the border of the bill of the larva there is, further, a special band of cilia, which is locomotor in function; both these sets of cilia are accompanied by an ectodermal thickening. Although a uniform tuft of cilia cannot be regarded as having any phylogenetic meaning, we may surely come to some conclusions from tracts of cilia; the bands just mentioned seem to the author to indicate "that even in our early pilidium larva as well as in all other larvæ where this tract is represented, there is present a certain tract of ectodermal tissue which has acquired a function different from that of the rest of the ectoderm, a tract which may give rise to cilia, or sensory organs, or tentacles.

Dr. Conn insists that the true teaching of embryology will come from the union of egg embryology and larval history; when they come into conflict each case must be examined by itself; there is no general rule.

The study of the development of *Thalassema* and *Serpula* has led to the following conclusion; "all larvæ which possess in their gastrula stage a circumblastoporal ring must, upon the subsequent completion of the alimentary canal, have both mouth and anus on the same side of this ring"; the ring will subsequently become præoral in position.

When elongation takes place the præoral lobe may be affected, or the oral lobe elongates to form the body, and the præoral remains relatively very small; the former obtains in the Cœlenterata, Polyzoa, and Brachiopoda; the latter in Annelids and Molluscs, and probably also in Sipunculids and Planarians. After a short account of the larvæ of these forms, Dr. Conn comes to the Echinodermata, with which he unhesitatingly associates the Tornaria-larva of *Balanoglossus*.

Here we have to do with very distinct but also very highly modified larval forms; there is nothing which is exactly a pilidium, but in the corresponding stage we find a typical gastrula with a bunch of long cilia at the aboral end; there is no circumblastoporal ciliated ring, and Gegenbaur "has gone beyond legitimate conclusions" in homologizing their ciliated bands with those of a similar name in the trochosphere. The author, in opposition to F. M. Balfour, thinks the Echinoderm larva is later and not earlier than the pilidium, and gives his reasons for this view.

We may, then, conclude that all animals which possess free larval forms other than Arthropods, sponges, or parasitic forms, can be related to each through a form which is essentially a pilidium; the

* Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1885) pp. 165–92 (2 pls.).

three groups contain (1) the Cœlenterata with undifferentiated blastopore, the Polyzoa with the blastopore differentiated into mouth and anus, and the Brachiopoda derived from a modified Polyzoon; (2) in Annelids and Molluscs the circumblastoporal ring is sometimes indicated by tentacles; in Nemerteans, *Balanoglossus*, and Echinoderms the larvæ are more highly modified.

**Cardiac Rhythm of Invertebrates.***—Mr. W. B. Ransom thus sums up the chief results of his investigations on this subject.

In the hearts of the Cephalopoda and Gasteropoda which he examined, as well as in those of the Tunicata, the muscular fibres are transversely striated.

This transverse striation has been noticed by other observers in Lamellibranchiata and in other Gasteropoda, and may probably be considered as the general rule in Mollusca. (It is interesting to notice that in this group striation appears to begin in the heart, a non-voluntary muscle; as the other cases of its occurrence—muscles of the buccal mass, retractor oculi, shell muscle of Lamellibranchiata—do not appear to be so numerous or so constant.)

In no molluscan or tunicate heart examined are ganglion cells to be found. These are, however, occasionally simulated by plasma-cells.

In *Octopus* a system of nerves and ganglia supplies the heart, connecting it with the respiratory centre, and forming a co-ordinating mechanism between the systemic and branchial hearts.

In all the animals examined the cardiac muscle has the power of rhythmical contraction independently of nerve-structures.

In Mollusca, the dependence of the ventricle on the auricle is far less close than is the case in Vertebrata. The two organs are physiologically isolated.

The chief requisite for a regular rhythm is not the connection of ventricle and auricle, but a sufficient internal tension.

The two visceral nerves ("vagi") supplying the heart of *Octopus*, act as inhibitory nerves on the ventricle and auricle; and a single nerve with a similar function supplies the heart of *Helix*.

In *Aplysia* a nerve was traceable to the region of the auricle, but its function was not ascertained.

In *Pterotrachea* no nerves could be found in the heart, and no inhibition could be caused. The same was true for Tunicata.

The fibres of the inhibitory nerve in *Octopus* and *Helix* appear to be uniform in function, i. e. not divisible into an accelerating and an inhibiting set.

The action of these fibres appears to consist in changing the molecular processes resulting in rhythmical contraction into others which prevent at the moment such contraction, but which result in increased irritability and power of rhythmical contraction. This action may be roughly expressed by saying that the nerve diverts the muscle from expenditure to accumulation of contractile material.

Inhibition of a heart by direct stimulation with a weak interrupted

* Journ. of Physiol., v. (1885) pp. 261–311 (4 pls.).

current is in all probability only caused by excitation of inhibitory nerve-fibres scattered through the muscles of the heart.

Where such nerves are absent, acceleration is the only result of stimulation with the interrupted current.

The only action of single induction shocks on the muscle is to excite the contraction. When of sufficient strength they act thus during both systole and diastole; but when just below that strength they are ineffective during systole.

This is due to the excitability of the heart-muscle undergoing periodic changes, being least during systole and greatest in complete diastole.

When a natural contraction of the heart has been artificially increased or prolonged, the succeeding diastole is also prolonged; there is a compensatory rest.

A rapid succession of strong induction shocks may cause a tetanic contraction of the heart.

The strong constant current may call forth a rhythm during its passage through a resting ventricle, the beats proceeding from the cathode.

When the current is weak, a making beat occurs at the cathode and a breaking beat at the anode.

Inhibition of the beating ventricle may be caused by the constant current in two ways:—

(1) By depression of muscular activity at the anode.

This is most effective when the anode is on that part of the ventricle whence contractions normally proceed, viz. the auricular end.

(2) By stimulation of an inhibitory nerve at the cathode.

In the case of the snail, the current has been found to act also in this way when applied high up on the trunk of the visceral nerve.

Atropin and muscarin have no visible effect on the inhibitory nerves of Mollusca, and appear to be exclusively muscle-poisons.

Curari destroys the power of the nerves, but in large doses seems to have a further exciting effect on the muscle.

The mode of action of the inhibitory nerve of *Octopus* and *Helix*, if the view here formed of it at all approaches the truth, is in the present state of our knowledge unique in the animal kingdom.

Not only in Mammalia and Reptilia, but even in Amphibia, the heart has been shown to possess two sets of nerve-fibres—accelerators and inhibitors. Whether this differentiation is primitive, or whether it was preceded by a state in which all the fibres were alike in function, we do not know. Nor can we solve this question, nor the further one as to how fibres primitively alike may have become thus differentiated, until we find not only animals possessing the simpler arrangement but also those within the borderland between the two. The apparent uniformity of function in Cephalopoda and Pulmonata undoubtedly points to the single nerve-supply as being more ancestral; but the question is probably not one which can be settled by considering the heart alone.

A complete solution will entail a comparative study through the

higher Invertebrata (Arthropoda, Mollusca) and the lower Vertebrata (Pisces, Cyclostomata), not only of cardiac but of vasomotor and secretory nerves and of nerves affecting the respiratory and other nervous centres.

The respiratory centre of the *Octopus* seems already to offer a most interesting field for research.

In the meantime it is probable that investigations into the influence on the metabolism of cardiac muscle exercised by vagus (inhibitor) and sympathetic nerve (accelerator) respectively would produce results of the greatest interest. If it could be shown that the true vagus fibres of a tortoise or a frog in any way tended to increase conductive metabolism, while the sympathetic favoured the destructive processes, a step would already be taken in harmonizing the phenomena presented by Mollusca and Vertebrata and in forming a general interpretation applicable to all.

**Physiology of the Unstriated Muscles of Invertebrata.***—From a study of the unstriated muscles of Invertebrata, M. H. de Varigny concludes that no essential difference exists between the physiology of the unstriated and the striated muscles. The unstriated muscles under certain conditions even surpass the striated ones from a physiological point of view. In the Invertebrata their *rôle* is an important one, for whilst remaining the active agents of the movements for nutrition, they become the agents of voluntary movements and in contact with the nerves of voluntary motion derive such an energy and acquire so perfect a physiological development, that they occupy in the functional hierarchy a superior rank to that of certain striated muscles; whilst the striated muscle is the most perfect and most developed contractile agent and the one whose evolution is most advanced.

There is no ground for dividing the physiology of muscles into two classes, the differences existing in certain points are not essential, but of a secondary order only.

**Temperature Maxima for Marine Animals.†**—Dr. J. Frenzel commenced his observations on the influence of heat on marine animals at a temperature of 40° C.; this was supported by a Holothurian for two hours: a *Diopatra* died in about five minutes; a large *Pleurobranchæa meckelii* exhibited at first lively movements, but after five minutes became torpid, but was not killed. Four minutes were enough for a *Scyllarus*. As the Holothurian was the largest of the animals experimented on, the author points out that although the chief reason for its power of resistance might be sought for in its size, yet the others were conquered too rapidly. We can only say that the Holothurian is capable of resisting heat.

In a second series of experiments he started at 30° C., and found that *Antedon* began to break up in two seconds; *Diopatra* survived for eighteen hours, but *Terebella* was more sensitive, showing the effect of heat at 25° C. *Aplysia* can live at 26°, *Murex* bore 30° C.

* Comptes Rendus, c. (1885) pp. 656–8.

† Arch. f. Gesammt. Physiol. (Pflüger), xxxvi. (1885) pp. 458–66.

for a long time, and *Pecten* showed some resistance. *Scyllarus* could bear 25°, but died slowly at 26°, and more quickly at 27°; *Palæmon* died at 26°, *Hippocampus* bore 27° well, and lived for an hour at 30°. Other series of observations were made on the effects of increasing the temperature to which the animal was subjected.

Many marine animals were found to bear high degrees of temperature for an astonishingly long time, as *Actiniæ*, *Murex*, *Tethys* and *Aplysia*. But it is not yet certain what heat they can permanently bear. It is also important to discover how winter animals comport themselves towards increase of temperature, and especially animals such as the Heteropoda and *Phronima*, which are quite wanting in the summer; from what we know we must suppose that at the beginning of summer, when the temperature of the sea becomes raised, they make their way to greater depths, where the heat is less.

## Mollusca.

**Mid-gut Gland (Liver) of the Mollusca.***—Dr. J. Frenzel, who has already studied the mid-gut gland or so-called "liver" of the Crustacea, now gives an account of his observations on the similarly named organ in the Mollusca. The description of the glandular epithelium commences with an account of the granular cells, which are only completely wanting in the Cephalopoda; each cell contains in addition to the protoplasm and the nucleus, a vesicle which incloses a number of more or less strongly coloured grains, fatty spheres of various sizes, and often numerous albuminous masses. The number of the grains varies remarkably even in one and the same species, and their size is, also, subject to considerable variation; they have a definite and characteristic coloration, but this varies in species and even in individuals; the colouring matter is not diffused, but there are clearer and darker spots. These cells are never absent from Lamellibranchs, where the small coloured granules are spherical in form, have a smooth contour, and are generally brownish-green or yellowish-brown; in the Prosobranchiata they are often of a pale yellowish-brown colour, are wrinkled, and contain a number of albuminous masses; in the Pulmonata they are bright yellowish-brown; in the Pteropoda they are markedly brown, and in the Cephalopoda they are absent.

After discussing their chemical properties the author passes to the club-shaped ferment-cells, which differ indeed in form in various molluscs, but are always referable to a common type; they are absent from the Chitons and *Patella*, and probably also from Pteropods and *Fissurella*. It it doubtful whether they are to be seen in certain Lamellibranchs.

Like the granular cells they contain a vesicular secretory ball which contains a more or less strongly coloured body of fluid, mucous, or semi-solid consistency; in addition to it there are fat-drops, albuminous masses, and, in some cases, crystals. They vary in size in different forms, and are club-shaped or pyriform; the liver secre-

* Arch. f. Mikr. Anat., xxv. (1885) pp. 48-84 (1 pl.).

tion, which lies in the spheres, may be very variously coloured. The author details the influence of various chemical reagents, and concludes with a short account of the so-called calcareous cells.

**Renal Organ of Prosobranchiata.***—Dr. B. Haller describes in detail the renal organs of *Fissurella*, *Haliotis*, *Turbo rugosus*, *Dolium galea*, *Cassidaria echinophora*, and *Murex trunculus*.

In comparing the organ in various branchiate gastropods he first directs attention to the arrangements seen in the Placophora, which were almost simultaneously described by Mr. Sedgwick and himself. He has now been able to recognize the error of his own and the exactness of the other anatomist's description of the opening of the renal infundibula into the pericardium; a point as to which Mr. Sedgwick has been supported by Van Bemmelen.

It is clear that the elongated form of the kidney of the Chitons represents a primitive arrangement, and that that of *Fissurella* is derived from it, the renal acini becoming more and more concentrated as the whole organ becomes shorter and wider. *Haliotis* stands near to *Fissurella*, but with regard to histological details it approaches the Trochidæ, for there are two kinds of renal epithelia, while the Chitons and *Fissurella* have but one; there is, in other words, a division of labour in the kidneys of the more advanced forms.

It would seem that, the higher the group, the greater the need for a larger reservoir for the excretions; at any rate in the Trochidæ the reservoir is very large as compared with that of the Haliotidæ. In the consideration of this question, we must not neglect the influence of the torsion of the body, which results in an increased pressure on the renal organs; this is very marked in the Doliidæ; in that group the hinder lobe of the organ is broken up into three connected parts which lie more (*Cassidaria*) or less (*Dolium*) close to one another, or form, as in the Muricidæ, a compact mass. These lobes are histologically different from the anterior.

In comparing the renal organ of these molluscs with those of the Opisthobranchiata, and especially the Nudibranchs, our study must begin with *Bomella* and the Doridiidæ, for these have retained the primitive form, while the sac of *Phyllirhoë* is undoubtedly secondary. *Bomella* has a very acinous kidney, not unlike that of Chitons, and indeed it has a closer resemblance than have the kidneys of the higher Prosobranchs.

**Nervous System of Buccinidæ and Purpuridæ.†**—M. E. L. Bouvier states that the Buccinidæ and Purpuridæ are, to use the language of v. Ihering, chiastoneurous save that the subintestinal ganglion is connected with the commissural ganglion by an accessory connective; this is very short in *Purpura*, still shorter in *Buccinum*, and replaced by a close union in *Concholepas;* thus in the proboscidial region there is a group of centres which form three œsophageal collars, and have in common the two cerebral ganglia which are situated above the œsophagus. The relations of these centres to the

* Morphol. Jahrb., xi. (1885) pp. 1–53 (4 pls.).
† Comptes Rendus, c. (1885) pp. 1509–12.

vascular apparatus are very constant; the right commissural ganglion gives off but one nerve, and this passes to the side walls of the body. There are not many important differences between *Nassa* and *Buccinum;* in the Purpuridæ the proboscis is much shorter than in the whelk, the cerebral ganglia are closely united. *Concholepas* is distinguished from *Purpura* by a number of characters; it is apparently a *Purpura* modified by adaptation; the posterior lobe of the foot being atrophied and the anterior enormously developed, the viscera have come to lie on the back.

**Communication of the Vascular System with the Exterior in Pleurobranchus.***—Dr. A. G. Bourne, referring to the description by Lacaze-Duthiers of a special canal, opening on the one hand to the exterior and on the other to the branchial vein in *Pleurobranchus*, denies its existence. The orifice leads into a sac which is entirely closed; the sac itself is lined by epithelium which dips down into branched crypts, and is of very different thicknesses in different regions; in the more thickened parts there are glandular contents which stain deeply. By the use of injection methods it would have been easy to rupture the thin membrane which divides the lumen of the sac from that of the branchial vein. If this sac is nephridial in nature it is the rudiment of the second nephridium which persists in so few Gastropods (e. g. *Fissurella*, *Patella*); this does not seem to be probable, and it is more likely that, as Prof. Lankester has suggested, it is the homologue of the grape-shaped structure in *Aplysia* which has long been known as the "poison-gland."

**Inception of Water among Mollusca.**†—Dr. H. Griesbach contributes some further remarks upon this vexed question; they consist mainly of a criticism of Lankester's results, who disbelieves any such inception on account of (1) the presence of hæmoglobin in the blood of *Planorbis* and *Solen*, (2) the impossibility of discovering apertures in the foot communicating with the blood-channels. Nalepa has however proved that the subepithelial blood-vessels do communicate with the exterior by pores; and this observation has been confirmed by Schiemenz. Lankester has denied the shedding-out of water by the kidney because the pericardium is not a vascular space. Griesbach, on the other hand, asserts that it is, and that it can be proved to be so by careful injections.

**Relations of Cavernous Spaces in the Connective Tissue of Anodonta to the Blood-vascular System.**‡—Dr. P. Schüler has come to the same conclusions from a study of *Anodonta* as did Flemming with *Mytilus;* and he likewise objects to Griesbach's method of "Selbst-injectionen." He has no doubt that the cavities in the mantle and foot of *Anodonta* are cells with clear mucoid contents. If we had to do with wall-less blood-lacunæ it would not be possible to isolate the vesicles; the injected preparations show conclusively that the vesicles are cells and that the vascular system is closed. The vessels which

* Quart. Journ. Micr. Sci., xxv. (1885) pp. 429–31 (1 pl.).
† Zool. Anzeig., viii. (1885) pp. 329–32.
‡ Arch. f. Mikr. Anat., xxv. (1885) pp. 84–8.

are limited by Langer's vesicles are indeed without endothelium, but not without walls, which are generally formed by the membranes of the mucous cells; it is possible that here and there there is a very slight fringe of protoplasmic substance bounding the lumen of the vessels.

**Organs of Bojanus in Anodonta.***—Messrs. A. B. Griffiths and H. Fellows have undertaken a series of experiments which they consider to establish the renal functions of the organs of Bojanus of the fresh-water mussel.

**Mimicry among Marine Mollusca.**†—Mr. H. L. Osborn directs attention to an observation by Mr. E. B. Wilson on *Ovulum uniplicatum* —a mollusc which lives abundantly on the stems of the *Leptogorgia virgulata;* this sea-fan has a stem of an orange yellow colour, and is often marked with yellow swellings where it has spread itself over the shell of an attached barnacle. The *Ovulum* has a yellow shell, and the skin is of an orange yellow colour. The author has discovered a *Leptogorgia* of a deep rose colour mottled with white, and living with it was an *Ovulum* of a similar coloration. If the red snail and the yellow coral were put into an aquarium, the former did not approach the latter. Another example is afforded by an undetermined species of the nudibranch *Scyllæa*, which has the closest resemblance to the *Sargassum* or gulf-weed; this was not found on the weed, and only one example of it was detected. Against this, however, we must put the fact that the creature is quite incapable of swimming, and that it is not to be expected that it should be found near land.

### Molluscoida.

#### *a.* Tunicata.

**Postembryonal Development of Phallusia scabroides** (n. sp.).‡—Prof. E. van Beneden and M. C. Julin in describing the postembryonal development of a new species of *Phallusia*, state that their attention was called to the persistence in the young Ascidian of the two dorso-lateral orifices which put the peribranchial cavities into direct communication with the exterior. They are of opinion that the proper cloacal cavity ought to be sharply distinguished from the peribranchial cavities; its floor is formed by the dorsal surface of the body of the larva which undergoes a slow and progressive descent. The cloaca, which is at first elongated transversely, becomes gradually a cone of circular section, while the external branchial orifices approach one another, and, finally, fuse to form the single and median cloacal orifice of the adult. The cloacal cavity is bounded solely by the epiblast, which, on the other hand, only bounds the outer part of the peribranchial cavities, while their inner wall is perforated by stigmata of hypoblastic origin. It is necessary to distinguish between the primary stigmata, of which there are six, and the secondary that arise by a kind of constriction, and of which there are six rows. The

* Chem. News, li. (1885) p. 241.
† Science, vi. (1885) pp. 9–10.
‡ Arch. de Biol., v. (1885) pp. 611–38 (1 pl.).

longitudinal sides of the branchial sac are formed by projections into the branchial cavity, which develope into elongated papillæ, then meet and fuse by their ends. The cloacal orifice has a bilateral symmetry.

The authors regard as renal vesicles small closed cavities of varying form which project from the digestive tract; a few connective-tissue cells grouped into an irregular mass bound a quite small cavity which appears in the form of a vacuole. The contents of the vesicles in young individuals are always clear and hyaline, but it cannot be doubted that their future function is renal; they are developed from mesenchymatous cells united into a small aggregation; and we have here a remarkable example of the formation of a secretory epithelium from connective-tissue cells.

The sexual organ may be distinguished in comparatively early larvæ, where it is formed of a mass full of connective cells and of a cellular cord arising from this mass; the former has indefinite boundaries, owing to the peripheral cells having fine anastomosing prolongations. The cord is early formed of a single row of fusiform cells placed end to end. The whole mode of their further development is at first sight very different from that of the same organ in the Vertebrata; but it is more superficial than real, as the authors hope to show in another essay.

The visceral ganglionic cord is to be seen in all stages of the development of the embryo, and it presents a striking resemblance to that of a young *Appendicularia*, as described and illustrated by Fol. The hypophysial organ always appears as a tube ending in a cul-de-sac; in it we may distinguish a funnel-shaped opening into the branchial cavity, a canal lying beneath the brain, and a terminal swelling.

The coronal circlet is at first a quadrilateral organ elongated transversely, and distinctly bilateral; there is at first a tentacle at each right and left angle; later on tentacles appear at the anterior and posterior angles; then there appear four new tubercles; notwithstanding the apparent radial symmetry of the adult the circlet and the mouth are distinctly bilateral.

**The Synascidian Diplosomidæ.***—M. S. Jourdain finds that the bud which will give rise to a new Ascidian does not, as has been supposed, arise from the pyloric but from the œsophageal region of the parent. It appears as a projection, in the form of the finger of a glove, not only from the mantle, but also from the digestive tube; the bud rapidly divides into two parts, one of which forms the thorax, the œsophagus, and the rectum, and becomes very distinct from the other; it soon gives rise to a branchial chamber, and takes on a Y shape. The second part becomes hollowed out into a tubular U-shaped cavity, and forms the median part of the digestive tube, and, perhaps also, the genital gland. There are not, therefore, two distinct buds but two parts of one which was primitively single. The division of the Diplosomidæ cannot be retained. The author discusses the spur-like

* Comptes Rendus, c. (1885) pp. 1512–4.

appendage first described by Macdonald, and seems to think that it will prove to be a persistent embryonic organ; to Jourdain its importance seems to have been singularly exaggerated.

### β. Polyzoa.

**Polyzoa.***—Prof. E. Ray Lankester thinks that the Polyzoa are probably more closely related to the Sipunculoid Gephyrean worms than to any other group of the animal kingdom, but he recognizes the extreme difficulty of interpreting the facts of their ontogeny.

The following classification is adopted:

PODAXONIA.

Class I. Sipunculoidea.
„ II. Brachiopoda.
„ III. Polyzoa.
Section 1. Vermiformia.—*Phoronis.*
„ 2. Pterobranchia.—*Rhabdopleura*, *Cephalodiscus.*
„ 3. Eupolyzoa.
Sub-class 1. Ectoprocta.
Order 1. Phylactolæma.—*Lophopus*, *Plumatella.*
„ 2. Gymnolæma.
Sub-order 1. Cyclostoma.—*Crisia*, *Hornera*, *Tubulipora.*
„ 2. Ctenostoma.—*Alcyonidium*, *Vesicularia.*
„ 3. Chilostoma. — *Cellularia*, *Bugula*, *Flustra*, *Eschara*, *Cellepora.*
Sub-class 2 Entoprocta.—*Pedicellina*, *Loxosoma*, *Urnatella.*

The structure of *Paludicella ehrenbergii* is described in detail; the terms ectocyst, endocyst, and endosarc are rejected; after a short account of the different groups the author passes to a consideration of the genealogical relationships of the groups of Polyzoa; this, though speculative, is "absolutely needful since zoology has become a science—that is to say, an investigation of causes and not merely a record of unexplained investigations." Prof. Lankester thinks that the solitary ancestor was relatively larger in size and more elaborately organized than the majority of living Polyzoa; the modern form has developed an elaborate system of bud-production. When the complete hippocrepian lophophore became specialized in the form of gill-plumes, the ancestral line of the Pterobranchia was started; when the lophophore retained its form but acquired a power of being telescoped into the body, the "Eupolyzoon" appeared; this either had its antitentacular region stalk-like, and the power of telescoping limited, while the arms of the lophophore embraced the anus, when we get the entoproctous type; or the lophophore increased its telescopic capacity, the cuticle thickened, and buds appeared from all parts of the body; from this Pro-ectoprocton two groups arose; one produced resistent statoblasts, became isolated, and lived in fresh water; in the other the arms of the lophophore dwindled, the epistome atrophied, avicularia, tentacles, &c., became developed.

* Encycl. Brit., vol. xix. (1885) pp. 429–41.

**Metamorphosis of Cyphonautes.***—M. A. Ostroumoff has investigated the development of *Membranipora repiachowi*, n. sp. and *M. denticulata* Busk. In the Cyphonautes stage of both the enigmatical organ of Schneider is nothing but the "internal sac" filled with a substance which afterwards spreads out on the surface and becomes an adhesive membrane; then the ciliated disk and the pucker-like organ of Schneider are invaginated to give rise to the most essential parts of the future polyp.

## Arthropoda.

### *a.* Insecta.

**Natural Development of Cantharis.**†—M. H. Beauregard believes he has solved the problem of the mode of development of *Cantharis*. At Aramon, near Avignon, he found some large pseudo-chrysalids of a yellowish colour, among a number of cells of the hymenopterous *Colletes signata*. Bringing them back to Paris, where he lost most of them, he found that, on the 12th of May, the integument of one of the two left opened along the back, and there emerged a larva, which, after two or three days of activity, fell into a state of complete torpidity. Fourteen days later it was transformed into a nymph, and after a few days into a complete *Cantharis*. The larvæ, then, live at the expense of the *Colletes*, but it is not to be supposed that these are the only Hymenoptera that afford them support; various subterranean insects of that order will suffice. It is probable that one larva uses up the honey of several cells. The author takes the opportunity of correcting the error of Neutwick that the vesicating power of *Cantharis* is only developed after copulation.

**Formation of Ova in Pyrrhocoris.**‡—Dr. H. v. Wielowiefski contributes certain interesting details to our knowledge of the formation of the ova in insects; his observations were carried out upon *Pyrrhocoris apterus*, and the main results are as follows. The ova are uninucleate cells which contain within the nucleus a substance closely similar to the chromatin of other cells; these cells in the ripening imago lie in the distal portion of the egg-tubes; the yolk-duct displays a fibrous or finely granular appearance, and at its termination spreads out into a tuft of fine threads between the follicular cells; the latter, instead of lying between the different ova, are collected together at the terminal extremity of the egg-tube and communicate with the ova by means of yolk-ducts.

**Development of Gryllotalpa.**§—Dr. A. Korotneff finds evidence that the eggs are not laid simultaneously by the female, but at more or less short intervals; the eggs are of an elongate oval form, and are inclosed in two structureless envelopes of which the chorion is pretty thick, and the vitelline membrane thin and quite transparent. The endoderm is formed by some of the cells increasing considerably

* Zool. Anzeig., viii. (1885) p. 219.
† Comptes Rendus, c. (1883) pp. 1472–5.
‡ Zool. Anzeig., viii. (1885) pp. 369–75.
§ Zeitschr. f. Wiss. Zool., xli. (1885) pp. 570–604 (3 pls.).

in size, and sending out pseudopodioid processes into the yolk; their nuclei lose their nucleoli and become ellipsoidal in form; their cells sink into the yolk and become covered by the neighbouring ectodermal cells; as they sink they increase in size; this is a very different history from that of some other insects, e. g. some Lepidoptera, and is the direct opposite of what has been observed by Bobretzky in *Oniscus murarius*. In other words, we may, among the Arthropoda, have a centrifugal mode of formation of the endoderm, or a centripetal one. In the scorpion we find an intermediate stage, for in it, after the cleavage of the blastoderm into ecto- and mesoderm, large granular cells appear beneath the latter, and form the rudiments of the endoderm.

The author directs attention to the fact that the mode of formation of the mesoderm in worms is quite different from that which obtains in insects, but is like what is found in molluscs; for in both the mesoderm only arises from large mesoblasts, which are derived from the ectoderm; a similar process has been found in *Gryllotalpa*, and appears to be the first instance of elements homologous with the mesoblasts of worms being found in insects. The development of the myoblasts is next described.

In the middle line there appears a neural groove which divides the nervous thickening into two lateral halves; this extends uninterruptedly from one to the other end of the embryo. The myoblast which lies under the whole of the germinal disk, becomes divided into two layers, and it is not till these appear that we observe the segmentation of the myoblast. The formation of the "dorsal organ" is described, and it is concluded that it is nothing else than a stopper to the "nabel" which would, otherwise, be open, as it is in the Lepidoptera, where, however, the orifice is extremely small.

The inner layer of the myoblast is in the thoracic region, excavated into a spacious cavity; it gives rise to the muscular system of the limbs, the two muscular bands which lie on either side of the ventral nerve-cord, and to the so-called abdominal diaphragm which separates the sinus which incloses the nervous system from the cœlom. The fate of the outer half of the myoblast is connected with the development of the heart, the histiogenesis of which is carefully described.

After the heart the author passes on to the nervous system; there are only seventeen ganglionic masses, the eighteenth segment having none. The pair of sympathetic ganglia cannot be brought into relation with any special segment. After the disappearance of the germinal groove a thickening arises in its place, which consists of cylindrical elements and rounded cells; the nervous system becomes differentiated from the ectoderm from before backwards. No commissures appear until the fibrillar part of the nerve-cord has become developed. The author agrees with Tichomiroff in thinking that each nerve-cell is a simple ectodermal element. *Gryllotalpa*, from the size of its cells, is an admirable object for investigations of this kind. The cephalic nervous system consists of two primitively separate lobes; by an incision the optic part of the brain becomes constricted off; the two

halves approach one another above the œsophagus, and gradually take up a dorsal position.

Two enteric canals are to be found, one in the larva before it comes into the outer world, and the other a week after extrusion; between these there are morphological as well as histological marks of difference; the reason for these is to be found in the relations of the intestine to the yolk. It is very interesting to observe that, after the loss of the altered yolk from the crop that organ becomes filled with air, which has certainly a respiratory significance. This fact points to the possibility of a very interesting comparison of the crop with the lung of vertebrates, a comparison which its position makes still more plausible; but it is one which requires further and comparative investigation.

**Optic Ganglion of Aeschna.***—M. H. Viallanes finds that the optic ganglion of *Aeschna maculatissima* is composed of the layer of post-retinal fibres, the ganglionic layer, the external chiasma, the external medullary mass, and the internal chiasma and medullary mass. From each simple eye there is given off a nerve-fibre which, after having pierced the limiting membrane of the compound eye, passes inwards to the ganglionic layer; this last is a sort of nerve-screen interposed on the course of the post-retinal fibres; in a well-advanced larva it appears to be protected by two limiting membranes and to be composed of three layers. The external layer is formed of unipolar nerve-cells, the prolongations of which pass to the median layer; this is composed of dotted substance, and has no nuclei in its interior; the inner layer is formed of dotted substance also, but contains a number of nuclei. During the development of the larva changes are effected in the constitution of the ganglionic layer. The fibres that pass out from it cross completely to form the external chiasma; this last and the layer of post-retinal fibres undergo during larval life modifications which are merely the result of a movement of translation effected by the ganglionic layer in the course of its development. In the young larva the layer is folded on itself, is at some distance from the eye and very near the brain; as the insect developes the layer unfolds and comes almost into contact with the eye; from this there results an elongation of the fibres of the chiasma, and a considerable shortening of the post-retinal fibres.

The external medullary mass has the form of a groove, which is strongly depressed from before backwards, and flattened from above downwards; it is completely formed of dotted substance. Of the ganglionic centres connected with the external medullary mass, two are formed of small unipolar cells; the anterior ganglionic mass consists of large unipolar cells, and the internal is formed of an aggregation of nerve-cells which invest the concave surface of the external mass.

The posterior capsule is directly connected with the external medullary mass by two large bundles of fibres, which are completely independent of the chiasma, and do not intercross. The internal

* Ann. Sci. Nat.—Zool., xviii. (1884) Art. 4, 34 pp. (3 pls.).

medullary mass is invested by unipolar cells which send out prolongations to it, and these are grouped into four separate lobes.

The optic nerve is formed of two bundles which are perfectly distinct, and have each different origins and terminations; the superior arises from the posterior surface of the posterior capsule and passes to the anterior and superior region of the brain, where it penetrates into the masses of dotted substance, not, as M. Beyer thought, stopping at the cerebral cortex; the lower part of the nerve is much the larger; it arises from the inner edge of the three capsules of the medullary mass, and penetrates the lower and lateral portion of the brain.

**Nature of the Colouring of Phytophagous Larvæ.***—Mr. E. B. Poulton has made some experiments on the relation between the colour of phytophagous larvæ and that of their food-plants. He comes to the conclusion that the influence of the plant is not uniform, that it must act during a large proportion of the whole larval life if it is to produce an effect, and that effects of surface-coloration due to consistence may be imitated in colour; he thinks it extremely probable that the effects accumulate during successive generations. These effects are partially due to the pigment which is proper to the larva and has no immediate relation to the food-plant; more complicated changes obtain with the derived pigments, and these are due to the predominance of one or other of the vegetal colouring matters in the tissues and blood, and before this in the materials which traverse the walls of the digestive tract.

The effects observed cannot be explained by the simple theory of phytophagic influence, and Mr. Poulton thinks the term should be abandoned so far; it only holds good for the broad fact that pigments derived from the food-plant play a most important part in larval coloration, and provide the material which is moulded by some subtler influence into a likeness to a special part of the environment. Nothing can be said as to this influence save that there are indications of a nervous circle whose efferent effects are seen in the regulation of the passage of pigments through the digestive tract into the blood, and thence to the tissues, and in the colour of a certain amount of true larval pigment; the efferent part of the circuit must originate in some surface capable of responding to delicate shades of difference in the colour of the part of the environment imitated. These facts offer some difficulties; they are the gradual working of the process, often incomplete in a single life, the excessively complex and diverse result, and the special character of the pigment.

Variations in the colour of the derived pigments in the blood occur in some opaque forms, and it is possible that the variation began in this way, and was afterwards rendered efficacious by co-ordination with the environment.

**How Insects adhere to flat vertical Surfaces.†**—Herr H. Dewitz gives an account of some further observations on this subject, tending to prove that the secretion by which, e. g. flies adhere to window panes is not a thin fluid of a fatty nature, but much more consistent.

* Proc. Roy. Soc., xxxviii. (1885) pp. 269-315 (1 chart).
† Zool. Anzeig., viii. (1885) pp. 157-9.

He adduces experiments to controvert Rombout's view that a fly can maintain itself on a glass surface by one leg only if that surface be vertical and if the body of the fly be in contact with the glass.

### γ. Prototracheata.

**Development of Peripatus capensis.*** — Mr. A. Sedgwick has found that the embryos of *Peripatus capensis* remain thirteen months in utero, and young ova pass into the uterus a month before last year's young are born. Fertilization seems to be effected in the ovary, and segmentation and the early stages of development take place in the oviduct; the ripe ovum is elliptical in shape, and is rendered opaque by the granules of food-yolk. Segmentation is complete, and at its end the ovum consists of a number of large endoderm cells scattered irregularly within the egg-membrane, while the ectoderm cells form a mosaic which is closely applied to the membrane on one side. After the endoderm cells have grown together, the ectoderm rests on them like a cap, then grows around and completely incloses them except at one point, which is the blastopore. A cavity next appears in the centre of the endoderm cells, and the blastopore elongates; at its hinder end there is an opacity—the primitive streak. The mesoderm arises from the proliferation of the undifferentiated cells of the streak, and grows forwards in the form of two ventro-lateral bands; these divide transversely from before backwards into somites; the blastopore begins to divide into mouth and anus, and the primitive streak becomes marked by the primitive groove.

The ectoderm, except where it gives rise to the nervous system, is always unilaminate; the entire central nervous system developes from continuous ventrolateral thickenings of the ectoderm. In front of the mouth they are enormously developed, but they never separate from the ectoderm to which they owe their origin, as the latter is invaginated in the form of two longitudinal furrows, which become deeper and close in exactly the same way as the medullary groove of a vertebrate embryo. The two closed vesicles thus formed become the cerebral ganglia.

The body-cavity is very complicated and divided into several parts; the cavities in the legs are derived from those of the somites; where the former communicate with the exterior they give rise to the segmental organs, which, therefore, in *Peripatus*, as in Elasmobranchs, are direct modifications of parts of the primitive body-cavity.

In a later communication† Mr. Sedgwick enters into further details. He finds that the "testes" of Balfour are seminal vesicles, and the true testes the so-called "prostates." The ovary is really paired and consists of two tubes closely applied together; the ova are derivates of the epithelial lining of these tubes; the ovaries always contain spermatozoa; the male deposits little oval spermatophores quite casually on any part of the body of the female, for example, they have been observed on the head. But it is quite unknown how they make their way into the ovaries.

* Proc. Roy. Soc., xxxviii. (1885) pp. 354–61.
† Quart. Journ. Micr. Sci., xxv. (1885) pp. 449–56 (2 pls.).

### δ. Arachnida.

**Season Dimorphism in Spiders.***—The researches of Weismann into the phenomenon known as seasonal dimorphism among butterflies are well known; something of the same kind is stated by Dr. F. Dahl to occur in spiders. In an earlier communication this author had pointed out the fact that *Micrommata virescens* and *M. ornata* were simply two broods of the same species; he now adduces another instance in *Meta segmentata* and *M. Mengei*, stating his reasons for believing them to be respectively spring and summer broods of the same species.

**Sarcoptidæ.**†—The first part of M. E. L. Trouessart's 'Les Sarcoptides plumicoles ou Analgésinés,' embraces an account of *Pterolichus* and its allies, worked out with the aid of M. P. Mégnin. These mites live as commensals on the plumage of birds, feeding upon the oily substance excreted by the skin, not annoying the birds themselves. Several new genera and many new species are described, and illustrated. About 150 species will be described, taken from birds brought from different parts of the world.‡

### ε. Crustacea.

**Morphology of Crustacea.**§—Professor C. Claus discusses the morphology of various parts of the Crustacean body.

After some notes on the antennæ, mandibles, and paragnaths, Dr. Claus discusses the maxillæ, the characters of which in the Malacostraca seem to show that that group cannot, as Häckel and Dohrn think, be derived from the Phyllopoda. He holds to his view that the maxillipedes are not to be distinguished from the succeeding thoracic appendages, and cites Boas as supporting him.

Since the publication of his last essay on the Crustacea, Professor Huxley has published his well-known investigation into the gills of the Crustacea; Claus, however, defers the consideration of the question whether the gills have been derived from ancestral annelids, or whether they are to be regarded as having been independently developed by the Protostraca, contenting himself with saying that there is not yet sufficient evidence to justify an answer in the direction of the former view. The difference in the insertion of the gills must not be supposed to be any evidence that they are morphologically different; it is probable that they were primitively all placed on the basal joint of the appendages. A number of branchial formulæ are given.

After some notes on *Nebalia* and its relations to the Malacostraca, the author passes to the significance of the *Zoea* and the *Nauplius*. If the genetic relations between Annelids and Arthropods are indisputable (as the metamerism of the body, the similarity in method of development of the metameres at the hinder end, the resemblance in the nervous system, the segmental organs (*Peripatus*) and so on seem to show) it follows that the stem-form of the Protostraca must have been a many-jointed annelid-like organism the extremities of which

* Zool. Anzeig., viii. (1885) pp. 376-7.

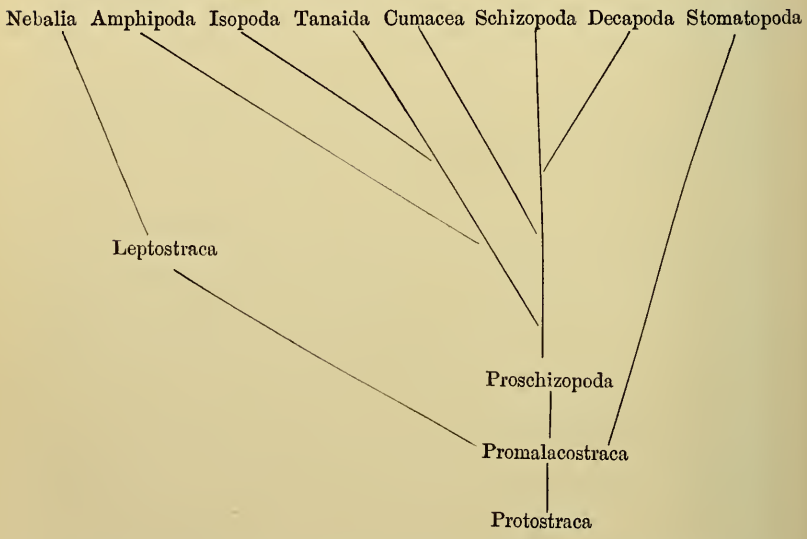
† Trouessart, E. L., 'Les Sarcoptides plumicoles ou Analgésinés. 1e partie, Les Ptérolichés (en collaboration avec M. P. Mégnin.),' 84 pp., 7 figs., and 2 pls., 8vo, Paris, 1885.

‡ See Amer. Natural., xix. (1885) p. 608.

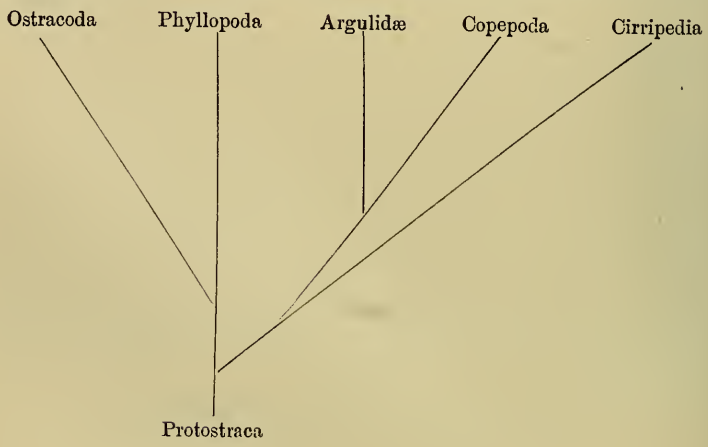
§ Arbeit. Zool.-Zoot. Inst. Wien, vi. (1885) pp. 1–108 (6 pls.).

were beginning to take on the characters of an arthropod; the Nauplius would then be an altered larval form of the annelid phylum; Claus has already directed attention to the likeness between a Nauplius and a trochophore-larva provided with a trunk-segment, while Dohrn has completely given up the old "Nauplius-theory." Hatschek has rightly pointed out that the larvæ of arthropods must be referred to the larvæ of annelids; though the Nauplius is unsegmented externally its body has the value of metameres.

Prof. Claus' views on the interrelationships of the Malacostraca are best shown by his own table:—




The lines of descent of the groups of the Entomostraca are thus indicated:



**Development of Astacus.***—The early stages in the development of *A. leptodactylus* are, according to M. W. Schimkewitsch, as follows. The germinal disk lies on the upper surface of the egg and is unsegmented; the protoplasmic mass becomes divided into two, each with a nucleus; it then becomes further divided but the boundaries of the cells are lost; later the portion of the yolk corresponding to the segmented germinal disk becomes divided into pyramids which do not extend as far as the centre of the ovum. Comparing the segmentation of *Astacus* with *Palæmon*, it appears that while in the latter the segmentation of the yolk keeps pace with the segmentation of the germinal disk, in *Astacus* the segmentation of the yolk does not commence until after the segmentation of the germinal disk is completed.

**Extraction of Uric Acid Crystals from the Green Gland of Astacus fluviatilis.**†—Dr. A. B. Griffiths describes a chemical investigation of the green gland of *Astacus fluviatilis* resulting in the extraction of uric acid crystals from its secretion. This investigation proves that the so-called green gland is a true urinary organ, its secretion containing uric acid and very small traces of the base guanin; the green gland is, therefore, physiologically the kidney of the animal.

**Parasites of Mæna vulgaris.**‡—M. R. Saint-Loup describes shortly, under the name of *Anilocra edwardsii*, a new isopodous parasite which is to be found attached to the caudal fin of *Mæna vulgaris;* it is distinguished from *A. mediterranea* by the greater length of the second pair of antennæ; the eyes do not atrophy in the adult.

On the sides of the allied *Smaris vulgaris* and in its pharynx there lives a Crustacean very like *Cymothoe œstrus*, which is interesting from the fact that the young have the same arrangement of pigment as was noticed by van Beneden in a species of *Oniscus*.

*Mæna* is also infested by a polystomatous Trematode, to which the author gives the name of *Choricotyle marionis;* it is, perhaps, most interesting on account of the fact that the characteristic "chitinous" hooks on its suckers do not present with picric acid the reactions of chitin.

**Nervous System of Apus.**§—Mr. P. Pelseneer has made a careful investigation of the nervous system of *Apus*, with the special object of answering certain questions which, in his essay on that form, Prof. Ray Lankester had propounded.

The first of these may be thus stated: Does the swelling from which the antennary nerves issue arise from the fusion of the first and second ganglia; or have the ganglia of these two appendages disappeared? Mr. Pelseneer finds that the elongated ganglionic swelling does not represent a fusion, and that the two pairs of antennary ganglia are still very distinct; nor, as has been thought, has the maxillipede-ganglion not disappeared.

* Zool. Anzeig., viii. (1885) pp. 303–4.
† Proc. Roy. Soc., xxxviii. (1885) pp 187–8.
‡ Comptes Rendus, ci. (1885) pp. 175 and 6.
§ Quart. Journ. Micr. Sci., xxv. (1885) pp. 433–41 (1 pl.)

With regard to the claims of the pair of postœsophageal ganglia which lie anteriorly to the mandibular to be regarded as the first ganglia of the abdominal cord, Mr. Pelseneer concludes that it is not a segmental, but only an adventitious ganglion; its lateral position proves this, and it seems clear that it is enteric rather than somatic.

To answer the question whether, to use the language of Lankester, the brain of *Apus* is a syncerebrum or an archicerebrum, it is necessary to study its histological structure; the investigation justified the former view, for a study of successive transverse sections showed that the primitive cephalic ganglia end a little after the middle of the brain. Towards the edge of the latter a second pair of groups of large pyriform cells are to be seen; these are the true second ganglia, which belong to the first antennary pair, or first pair of the abdominal cord.

The author comes to the conclusion that both pairs of antennæ are metastomial; a comparison of a number of Crustacea shows us that from those with the most primitive nervous system to the highest forms there are a great many intermediate stages between the condition in which the nerves of the two pairs of antennæ come out of the cord, and that in which these nerves come out of the brain. The final conclusion arrived at is that among the Crustacea there are no forms with an archicerebrum; the classification of brains of Crustacea suggested by Packard is rejected.

**Embryology of Limulus polyphemus.*** — Dr. A. S. Packard describes the embryology of *Limulus polyphemus* at the stage when the oval blastodermic disk, with the six pairs of the cephalic appendages, is distinctly formed; the mouth is seen in a position in front of the first pair of appendages, and from it the primitive streak passes back to the posterior margin of the blastodermic disk or "ventral plate."†

The following conclusions are drawn from the observations. The fact that the embryo *Limulus* had at first no abdominal appendages (uropoda), whereas there are temporary abdominal appendages in the tracheates, shows that *Limulus* has little in common with the Arachnida, Myriopoda, or Hexapoda. On the other hand, in the embryo Crustacea the cephalic limbs are first indicated, the uropods not appearing until after the Crustacea leave the egg. These facts indicate that *Limulus* probably descended from a type in which there were cephalic appendages only and no abdominal appendages. The absence of a serous membrane, of an amnion, and of procephalic lobes, of temporary embryonic abdominal appendages, also of protozonites, tend to prove that the embryo of *Limulus* has little in common with that of Tracheata. On the other hand, the earlier stages in the embryology of *Limulus* resemble those of Crustacea in the absence of the procephalic lobes; and in the primitive development of cephalic appendages alone. The comparatively early appearance of the branchiæ of *Limulus* shows that it probably never had any genetic connection with a tracheate arthropod.

* Amer. Nat., xix. (1885) pp. 722–7 (1 pl.).

† See Mem. Boston Soc. Nat. Hist., 1872, figs. 12–15, pls. 3 and 4.

The embryology of *Limulus* is a very primitive type standing nearer the branchiate arthropods than the tracheate, and on the whole should be regarded as a generalized or a composite form, which with its fossil allies, the Euripterida and Trilobita, form a class by themselves with a superficial resemblance to the Arachnida. The ultimate origin of *Limulus* from the same stock as that which gave rise to the modern annelids seems not improbable.

**Crustacea of Lake Baikal.***—Dr. B. Dybowski reports on the large number of Crustacea which, as compared with members of other groups, are to be found in Lake Baikal; there were found 200 species of Crustacea, 40 of molluscs, 20 of worms, 4 of sponges, 22 of fishes, and 1 mammal. Of the Crustacea the Amphipoda are much the most abundant.

The author here limits himself to an account of the Isopodous genus *Asellus*, of the four species of which two are new—*A. angarensis* and *A. baicalensis;* the two new species are described in great detail.

**New Crustacean.**†—Mr. Sidney I. Smith describes a new genus of Crustacea from a single female specimen taken in the Caribbean sea.

*Eunephrops* n. gen. agrees with *Homarus* and differs from *Nephrops* and *Nephropsis* in the number and arrangement of the branchiæ, and in the evenly swollen branchial regions; it agrees with *Nephros* and *Homarus* and differs from *Nephrosis* in possessing antennal scales and well-developed eyes; it agrees with *Nephrosis* and differs from *Homarus* and *Nephros* in having very large antennal spines, and in being without any spine on the second segment of the peduncle of the antenna; and it agrees with *Nephros* and differs from *Homarus* and *Nephrosis* in having slender and carinated chelæ. The species is named *E. Bairdii.*

## Vermes.

**Organization of the Hirudinea.**‡—M. R. Saint-Loup finds that with regard to the nervous system of the Hirudinea, the nervous system is always formed in the same way; there is always a connective cord surrounding the œsophagus, the two halves of which form on the ventral surface of the body a double nerve-cord; the ganglia on their course are formed by a fibrous band and six nerve-capsules regularly disposed and containing unipolar nerve-cells. On each side there are given off two lateral nerves which may be fused into a common trunk and have on their course accessory nerve-cells. Closely applied, and more or less fused ganglia form the chief part of the subœsophageal and of the posterior nerve-mass; in the former there are three or four, and in the latter a larger but variable number. The nerves of the cephalic region must be regarded as taking their

* Bull. Soc. Nat. Mosc., 1884 (1885) pp. 17–57 (3 pls.).
† Proc. U.S. Nat. Museum, viii. (1885) pp. 167–70.
‡ Ann. Sci. Nat. Zool., xviii. (1884) Art. 2, 127 pp. (8 pls.).

origin from the subœsophageal fibrous band. The intermediate nerve is probably the prolongation, in the ventral chain of the appendages, of the great sympathetic.

The circulatory apparatus is on various types, and between these there are intermediate stages: *A*. A dorso-ventral circulatory system identical with that found in most Annelids, and co-existing with, but not in communication with, the general body-cavity; *B*. A dorso-ventral circulatory system in direct communication with the cœlom, represented by the system of lateral vessels; the development of the varicose plexus in the hinder region of the body (*Nephelis*) tends to make the communication between the two systems less direct; *C*. A dorso-ventral system communicating very vaguely with the system of the lateral vessels, and having the varicose plexus so largely developed as to tend to separate the two systems.

The nephridia undergo modifications which are intimately associated with those of the circulatory apparatus; in case *A* they consist of simple tubes which put the cœlom into communication with the exterior; in *B* the tube of epiblastic origin is associated with the "cupules rouges" or annexes of the system of lateral vessels; in *C* the segmental organs have no direct relation to the lateral vessels, their glandular tissue being penetrated by capillaries.

In the digestive tract a region behind the stomach is of a different histological structure, and is to be considered as the chief seat of the chemical changes. The Hirudinea eliminate yellowish-brown spherules under the form of pigmentary granulations; this the author calls the pigmentary function.

The genital organs of different species may be compared, and it is possible to follow those combinations of the constituent parts which produce different appearances. The glands attached to the receptaculum penis of the leech have unknown functions; in the ovaries it is possible to distinguish the germigenous and vitellogenous portions; the ova may arise directly from the walls of the ovary or on buds; a mass of egg-cells and a fused mass of vitelline cells may become isolated and have the appearance of a spermatophore. The spermatozoa seem to be developed in essentially the same way as in those animals in which their genesis has been investigated.

**Development of the Head of Polygordius.*** — Dr. B. Hatschek finds that the lateral nerves in the head of *Polygordius* extend into the postoral region and are identical with the œsophageal commissure; this, therefore, is developed before the rudiment of the ventral medulla becomes apparent. The fibrils which belong to the ventral longitudinal muscular band of the head appear before the cephalic vesicle has attained its highest development, and at the same time as that of the first appearance of muscular fibrils in the trunk. From the former a delicate fibril extends into the head; it lies close to the ectoderm and alongside the outer margin of the delicate œsophageal commissure; later on, fresh fibrils are added on, and the whole becomes broader and longer. The dorsal longitudinal muscular bundles

* Arbeit. Zool.-Zoot. Inst. Wien, vi. (1885) pp. 109–120 (1 pl.).

of the head similarly appear as processes of the dorsal bundles of the trunk.

Hatschek reminds the reader that in his early essays on the development of the nervous system of Annelids he has thus described it. There first arises an anterior ectodermal thickening which extends backwards in the form of a cord on either side of the mouth, then forming the œsophageal commissure; and that then the process of thickening goes on continuously in a backward direction, whence results the formation of the two lateral cords of the ventral medulla. This statement, which was based on observations made on *Criodrilus*, has been controverted by Kleinenberg, who has studied *Lumbricus*. Hatschek, however, has found a confirmation of his views in the developmental history of *Polygordius* and of *Echiurus*. He thinks that the commissure is developed before the ventral medulla not only in Annelids, but also in the trochophor-larvæ of molluscs. Where there are no larvæ, but a direct development, there may be cases in which the œsophageal commissure only secondarily unites the ventral cord and the frontal plate. Even if Kleinenberg's observations are correct we have still to face the question as to which mode of development is the more primitive. Hatschek thinks that described by himself to be so, inasmuch as the phylogenetic origin of separate nerve-centres, not connected with one another by nervous connections, is highly improbable; and Kleinenberg himself seems to have felt the difficulty.

The author again disagrees with Kleinenberg as to the derivation of the mesodermal structures of the head from the ectoderm; he finds that they are developed from the mesoderm of the trunk. In *Polygordius* only the structures of the parietal lamella grow into the head, and even then do not form a continuous layer, but appear as separate processes of the muscular areas of the trunk. Balfour attached great importance to Kleinenberg's observation that in the head of *Lumbricus* a separate mesodermal cavity appears on either side, and that these are connected with the corresponding cavity of the first primitive segment; we may suppose that, phylogenetically, two processes of the cœlomatic sacs grow into the head, but against this we have to put the anatomical relations of the cephalic cavity in the Archiannelids. In these there is no dorsal or ventral mesentery in the head, and the cephalic cavity is separated from that of the first metamere by a septum; so that the conditions must be secondary and not primitive.

**Development of Nematodes.***—M. P. Hallez has a note on the development of *Ascaris megalocephala*, the ova of which can be very easily cultivated; development is effected in from 15 to 25 days, and takes place more rapidly in damp air or oxygen than in water. In distilled water, carbonic acid, hydrogen, or nitrogen it is slower. Moderate elevation of the temperature aids development.

The first segmentation-furrow is near the second polar globule; in stage 2 there is an ectodermal cell which is distinguished as 1 and a meso-endo-dermic cell *c*. 1 gives rise to 2 and *c* to *c'*. The form

* Comptes Rendus, ci. (1885) pp. 170-2.

of the egg is now that of a T. 1 gives rise to 3 and 2 to 4; *e* and *e'* then divide and give rise to *m* and *m'*; the three germinal layers are now formed. In the 12-stage there are four new ectodermic cells, and in the 16-stage two more endodermic and two more mesodermic cells. In the 24-stage there are eight new ectodermic cells; the last right and left are the two caudal cells of Goette. The blastosphere has a small segmentation-cavity; invagination commences in the 24-stage.

**Development of Sphærularia bombi.*** — Dr. R. Leuckart confirms the opinion of Schneider that the supposed female of *S. bombi* is merely the protruded sexual apparatus of the female, and that the latter is not, as was believed by Lubbock the male; further observations, which are detailed, appear to show that the parasites make their way into the bee at the commencement of its hibernation, and that the fully-formed *Sphærularia* (female) is only found in the queen. Copulation takes place during the free living stage of the worm.

**New Bothriocephalus.†**—Prof. J. Leidy describes a new species of *Bothriocephalus* or *Dibothrium* from a trout (*Salvelinus* sp. ?). The worm is apparently different from either the *D. infundibuliforme* or *D. proboscideum* found in *Salmo savelinus*, *S. salar*, *S. trutta*, &c. Prof. Leidy proposes to name it *B. cestus*.

**Circulatory and Nephridial Apparatus of the Nemertea.‡**—Mr. A. C. Oudemans recognizes three types of vascular system in the Nemertinea; in the "palæo-type" there are two longitudinal blood-spaces which communicate above the sheath of the proboscis, and are lacunar in the cephalic and œsophageal regions; in the tail they communicate above the intestine; the vessels in the tail of *Carinella* form a loop above the intestine; in *Carinoma* there are lacunar spaces above the proctodœum. Some forms have two other vessels in the œsophageal region and in the sheath of the proboscis, but their connections with the vascular system were only rarely made out. In the "schizo-type," which not only obtains in the Schizonemertinea, but is approached in the palæonemertine families Valenciniidæ and Poliidæ, there are, in the head, lacunar spaces which communicate both above and below the proboscidian sheath; there are, also, lacunar spaces in the œsophageal region which coalesce on the ventral side; in the rest of the body we may distinguish three longitudinal, connected by transverse vessels; in the tail the communication is supra-intestinal. The third or "hoplo-type" is distinguished by the possession of a closed vascular system; with the exception of *Amphiporus hastatus* the head contains two vessels which communicate in front, forming a vascular loop above the proboscidian sheath; these vessels also communicate within the cerebral ring, but beneath it; from this point down to the tail three longitudinal vessels occur, of which the median vessel in the œsophageal region often lies partly in the proboscidian sheath. The cephalic loop may form branches (e. g. *Malaco-*

* Zool. Anzeig., viii. (1885) pp. 273–7, 358.
† Proc. Acad. Nat. Sci. Philad., 1885, pp. 122–3.
‡ Quart. Journ. Micr. Sci.—Suppl., 1885, pp. 1–80 (3 pls.).

*bdella*); in the four just named, branches rise from the longitudinal vessels during sexual maturity, and the posterior sucker contains a number of vascular branches.

In all the Nemertinea the most anterior point of communication of the vascular spaces lies above the proboscidian sheath, the hindmost above the intestine; in all the blood-spaces are throughout clothed internally with a layer of epithelium, which is always succeeded by a layer of hyaline basal tissue.

The nephridia of *Carinella* are formed by a portion of the lateral vessels, which is distinctly a portion of the blood-space; a portion of the walls becomes a gland, the function of which appears to be that of conveying the superfluous material from the blood towards a reservoir, the portion separated from the blood-vessel. On each reservoir an excretory duct is developed, and the two so formed lie nearly on the same transverse plane so that, were the animal segmented, they would be found in the same segment. The nephridia of *Carinella* are, clearly, very primitive in character.

In *Carinoma* the nephridial system is more highly developed; there is no nephridial gland, but the function of removing the waste products is transferred to the canals of the system itself; the secretion does not seem to be removed periodically, but constantly, inasmuch as each epithelio-glandular cell is provided with a long cilium which has an outward direction; traces of the blood-vessel may be still detected: the two excretory ducts lie in the same transverse planes.

In the "schizo-type" we may distinguish two longitudinal and a number of transverse canals, so that the arrangement is segmental; the lower the type the more numerous are the paired ducts.

In the Hoplonemertinea we again meet with several degrees of complexity in the nephridial system; from a longitudinal canal on either side there are given off a number of small canals, which send their excretory ducts outwards; these may be two or more in number, and they vary as to the position which they occupy in the body.

"The nephridial system of all the Nemertea consists of one or more canals, directly communicating or not with the vascular system, provided or not with cilia, and communicating with the exterior by means of excretory ducts. These excretory ducts all lie above the nerve-trunks." The two cæcal vessels of the palæo-type, the part of the median vessel in the proboscidian sheath of the other types, and the "membranaceous sacs" have the function of respiring, feeding, and excreting the fluid of the proboscidian sheath.

**Development of Monopora vivipara.*** — Prof. W. Salensky's studies on this Nemertean have induced him to establish a new genus for the species which was regarded by Uljanin as a *Borlasia;* the differences between it and other Nemertines are pointed out. Its most striking characteristic is the opening of the proboscis and the œsophagus at a common orifice—the *atrium prostomiale.*

The ovisacs were found to be derived from the connective tissue

* Arch. de Biol., v. (1885) pp. 517-71 (3 pls.).

which invests the nerve-cord, and appear in the form of a mass of similar cells; these cells subsequently become differentiated into ovular and epithelial cells; and, later on, the ovisac becomes hollow, and, changing its position, makes its way towards the epidermis. The male reproductive organs have an analogous structure to the female.

The ova are exceedingly small and very transparent, and observations on the early stages are somewhat incomplete; towards the end of the period of segmentation the macromeres and micromeres cease to have a different appearance, and we get a well-marked archiblastula, such as has been seen in other Nemertines. The mesoderm appears directly after the formation of the blastula, and calls to mind the phenomena seen in *Lineus lacteus*. The blastopore is circular in form, but the gastrula is not radially symmetrical; the former closes without leaving any sign either of mouth or anus. The external form of the larva now undergoes some changes, and the proboscis begins to be developed from the ectoderm. This precocious development of the proboscis and its sheath agrees in all that is known as to the development of this organ in *Pilidium*. The endoderm now consists of cells which are provided with prolongations which penetrate into the digestive cavity, interlace, and completely fill it. Later on the endodermal cells take on again the form of an epithelial layer investing a large digestive cavity.

In later stages it is found that the epidermis is completely developed from the ectoderm, and during its development undergoes only insignificant changes; the cells elongate and become cylindrical and, later, divide into two layers; those of the outer are ciliated. The cephalic gland is seen to be nothing but a well-developed mass of ectodermic glandules; it later divides into a ventral and a dorsal portion.

The nervous system appears as two thickenings of the ectoderm which make their way into the body but are still connected with the outer germinal layer; these are the first signs of the cephalic ganglia. They very soon separate from the ectoderm, and are connected with one another by a commissure which corresponds to the ventral commissure of the adult. In very young embryos the posterior extremities of the ganglia begin to elongate, and we have here the first signs of the lateral nerves; they grow from before backwards, and soon reach the hinder end of the body. In structure they closely resemble the ganglia.

It seems safe to conclude that in *Monopora vivipara* the cephalic ganglia and the ventral commissure arise from two ectodermal thickenings at the anterior end of the embryo; that the dorsal commissure is probably derived from the union of the dorsal lobes above the proboscis; and that the lateral nerves appear as prolongations of the cephalic ganglia. The author then discusses the homology of the nervous system of Nemertines with that of Annelids, and, after considering the results of various observers, gives his own views in the following comparative table:—

| Nemertines. | Annelids. |
|---|---|
| Cephalic ganglia. | Cephalic ganglia. |
| Ventral commissure. | Dorsal commissure. |
| Dorsal „ | 0 |
| Lateral nerves. | Circumœsophageal commissures. |
| 0 | Ventral ganglionic chain. |

The proboscis and its associated parts are compared with homologous parts in those Rhabdocœla that have a proboscis.

| Rhabdocœla. | Nemertinea. |
|---|---|
| Pouch of proboscis. | Vestibule of proboscis. |
| Epithelium of proboscis. | Epithelium of proboscis. |
| Internal layer of muscular investment. | Muscular layer of proboscis. |
| External layer of muscular investment. | Walls of the sheath of proboscis. |
| Radial muscles of muscular investment. | Muscular band. |

The essay concludes with an account of the digestive tract; after the closure of the blastopore it is a closed sac, the œsophagus is of ectodermal origin, and the anus is very late in appearing.

**Nephridia of Acanthodrilus sp.***—Mr. F. E. Beddard records certain peculiarities in the nephridia of a new species of *Acanthodrilus* inhabiting New Zealand. In this worm as in *Plutellus*, described by M. Perrier, the nephridial orifices alternate in position from segment to segment; further evidence of their being the remains of two distinct series, each one corresponding to a pair of setæ, is afforded by the fact that they differ morphologically; the nephridia associated with the ventral setæ are furnished with a large diverticulum near to the external orifice of which the glandular tube opens; the dorsal nephridia are furnished with a long muscular duct and a very minute diverticulum, situated on the dorsal side of the external orifice.

**Nephridia of Microstoma lineare.**†—Dr. O. Zacharias describes the nephridia of this Planarian, which have been hitherto overlooked or incompletely studied. On either side of the body is a canal, which gives off branches converging towards the middle line and united by finer canaliculi, and forming a subcutaneous network which is stronger on the ventral than on the dorsal side.

**Fresh-water Monotidæ.**‡—Dr. G. Duplessis-Gouret records the occurrence of a marine form of Planarian, originally described as a new genus, but now known to be a species of *Monotus* (*M. morgiensis*) from the lake of Geneva. This species is nearly allied to *M. relictus*, discovered by Zacharias in a mountain lake in Silesia. The occurrence of these marine forms in fresh water points to the fact that they are the remnants of a marine fauna gradually destroyed by the cutting-

* Zool. Anzeig., viii. (1885) pp. 289–90.
† Ibid., pp. 316–21. ‡ Ibid., pp. 291–3.

off of portions of the sea, which subsequently became fresh water; parallel instances are *Mysis relicta* of the Scandinavian lakes, and *Sphæroma fossarum* in Italy.

**Action of Sodium Chloride on Cercariæ.***—M. E. Perroncito has conducted a number of experiments upon the vitality of Cercariæ and encysted larvæ from *Lymnæa palustris;* he discovered that a solution of salt of even ·65 per cent. was sufficient to destroy these creatures, though the time necessary to effect their destruction was naturally longer in proportion to the weakness of the solution; desiccation was also absolutely fatal. These facts are clearly of importance, not merely from a scientific but from an economical point of view. Simple drainage, combined with the use of salt, is sufficient to free pasturage from the larval parasites.

**New Species of Myzostoma.†**—Prof. L. v. Graff describes a new species of *Myzostoma* (*M. cirripedium*) found attached to *Metacrinus rotundus*. Its external form resembles that of *M. Wyville-Thomsoni* Graff.

**Pelagic and Fresh-water Rotatoria.‡**—Dr. O. E. Imhof records the presence of several marine rotifers from the deep waters of the Swiss lakes. In an earlier communication *Anuræa spinosa* and *A. longispina* were mentioned as occurring in the deep water of lakes; these have been stated by Crisp not to be new species, but severally identical with *A. longispina* Kellicott and *A. cochlearis* Gosse, and Zacharias has further confirmed this opinion that *A. longispina* = *A. cochlearis;* a closer examination has convinced Imhof that the species are distinct, as are also *A. spinosa* and *A. longispina*. *A. tuberosa*, a new form, is recorded from the Eibsee, in Bavaria, and *A. intermedia* from the Staffelsee. The Königsee is inhabited by another marine form, *A. aculeata* var. *regalis*. The following marine species are also recorded from various lakes: *Triarthra longiseta*, *Polyarthra platyptera*, *Synchæta pectinata*, *Monocerca cornuta*, *Euchlanis* sp., *Motommata tigris*, *Philodina aculeata*, *Euchlanis lynceus*, *Rotifer* sp., *Colurus caudatus*.

### Echinodermata.

**Vascular System of Echinoids.§**—Dr. P. Herbert Carpenter discusses the answer recently given by Kochler to his criticisms on that author's account of the vascular system of Echinoids; Carpenter still doubts the accuracy of Prof. Perrier's statements as to the relation of the "ovoid gland" with the exterior, basing his objections on the theoretical ground that there should be similarity of structure among Echinoderms, and that the water-vascular and blood-vascular systems of Asterids have been shown to be fundamentally independent of each other; and on the practical ground that investigations by means of injections are not so likely to be trustworthy as those made on sections; the French observers have used the former, Ludwig the

* Arch. Ital. de Biol., vi. (1884) pp. 154–6.
† Trans. Linn. Soc. Lond. (Zool.), ii. (1885) pp. 444–6 (1 fig. of a pl.).
‡ Zool. Anzeig., viii. (1885) pp. 322–5.
§ Quart. Jour. Micr. Sci.—Suppl., 1885, pp. 139–55.

latter method, and the definite statements of the German investigator as to the madreporic plate being in connection with the water-vascular system alone, have never been contradicted. The author allows that he has never thought of looking for the connection between the vascular apparatus and the ambulacral canals that has been recently stated to exist, by Perrier, but he more than doubts its existence.

**Ambulacra of Echinoderms.***—In a short critical note by M. E. Perrier on the results arrived at by Niemiec from the study of the ambulacra of the Echinoidea, he contends that these results are not in contradiction to his own, and that the general statement to the effect that it is possible to distinguish the regular from the irregular urchins by the form of the calcareous parts of the ambulacra remains true.

**Anatomy of Dorocidaris.†**—M. Prouho finds that in *Dorocidaris* both the intestinal siphon and collateral vessel, which are present in *Echinus*, are wanting. The former, however, he considers may be represented in a rudimentary state, by a kind of groove resulting from a junction of the walls of the intestine along its first flexure, as this canal occupies exactly the place of the intestinal siphon, and is not met with in Echinoderms possessing the latter organ.

**"Tag" of Cœlopleurus Maillardi.‡**—Prof. P. M. Duncan describes the "tag" of *Cœlopleurus Maillardi* Mich. The tissue on the "tag" was separated and mounted. The base of the structure is a reticulate, perforate, and more or less broadly spiculate calcareous layer or layers, and the nucleated soft structures environ the hard parts. The surface consists of connective tissue, minute nucleated cells showing evidences of cilia, and extremely fine nerve-filaments. In three places this common ectodermal structure became thick and rose into three small bodies, each of which has a broad base and a surface of digitiform and sometimes ragged processes. The surface of each of the bodies is highly nucleated, but no trace exists of a central canal, and, indeed, the appearance given is that of solidity. There does not appear to be any connection between the bodies on the tag and the water-system of the ambulacra, and probably they act as respiratory organs by increasing the surface of the common derm.

**New Species of Metacrinus.§**—Dr. P. H. Carpenter describes three new species of *Metacrinus*. *M. rotundus* n. sp. is distinguished by well-defined characters from the various types of *Metacrinus* dredged by the 'Challenger,' and like *M. Moseleyi* it occupies an intermediate position between the two groups into which most species of the genus naturally fall—those with four radials of which the second is a syzygy, and those with six radials of which both the second and fourth are syzygies. *M. superbus* n. sp. is the largest recent Pentacrinite yet seen. *M. Stewarti* n. sp. is described from a stem-fragment, which, however has well-defined characters.

* Recueil Zool. Suisse, ii. (1885) pp. 357–61.
† Comptes Rendus, c. (1885) pp. 121–6.
‡ Ann. and Mag. Nat. Hist., xvi. (1885) pp. 88–9.
§ Trans. Linn. Soc. Lond. (Zool.), ii. (1885) pp. 435–44 (3 pls.).

### Cœlenterata.

**Adamsia palliata.***—M. Faurot has studied *Adamsia palliata*, which has been long known to have a symbiotic relation to *Eupagurus prideauxi*. Great as may be the alteration in the form of an adult *Adamsia* its anatomical structure is morphologically the same as that of other Actiniæ, and especially of *Sagartia parasitica*. The deformation undergone by the animal is due to the considerable expansion of the foot, which affects the lower part of the column; this expansion is so considerable in an adult animal as to bring the foot and the wall of the column into parallel planes for a considerable distance; from this it results that the true gastric canals are formed by the elongation of the folds in a horizontal direction. Fertilization takes place within the body, and a gastrula is formed; fixation takes place when there is a larva with eight tentacles. The Actinia, on attaining a certain size on the inner edge of the shell of a Gastropod, extends to right and left in such a way as to follow its outer border without covering it in any way, and it thus excellently shelters the *Pagurus*.

### Porifera.

**Cœlenterate Nature of Sponges.**†—Dr. W. Marshall defends the cœlenterate nature of sponges against Schultze, Sollas, and others; he thinks that there is no phylogenetic connection between the Flagellata and the flagellate cells of sponges, but that both are adaptations. He discusses the characters of the radial symmetry of the Cœlenterata, and appears to regard it as being mostly due to their mode of life. He insists on the ancestors of sponges having been at least diploblastic, and, apparently, radially symmetrical; they had an oral orifice and a gastric cavity from which the gastric canals passed off centrifugally to open to the exterior after passing through the ectoderm; such creatures are, in his judgment, true Cœlenterates.

**Circulation in Spongida.**‡—Mr. H. Carter makes a further contribution to this subject. In a former communication, from a study "of the minute portion of *Spongilla* developed from a statoblast," it was inferred that the water entered through the holes of the investing membrane to the so-called cavities of this membrane, and thence into the ampullaceous sacs; during an interval of about fifteen minutes there is a cessation of the circulation, the tubular process of the vent is retracted; after this interval the process is again pushed out, and the water passes from the ampullæ through the large canals of the excretory system to the vent, and so to the exterior; it was not plain, however, how the carmine particles got from the cavity of the investing membrane through the parenchyma. In two new species, *Geelongia vasiformis* and *Hircinia intertexta*, which are briefly described, the arrangement of the fibres and excretory canals is different; in the former they are perpendicular to the planes of the wall, in the

* Comptes Rendus, ci. (1885) pp. 173–4.
† Jenaisch. Zeitschr. f. Naturwiss., xviii. (1885) pp. 868–80.
‡ Ann. and Mag. Nat. Hist., xv. (1885) pp. 117–22 (1 pl.).

latter they are parallel to them; hence in the former the great excretory canal runs from the subdermal cavities to the vents, while in the latter they run under the subdermal cavities; the excretory canals are furnished with circular folds, and consist of a layer of epithelium, and beneath of "? muscular fibrillæ," partly longitudinal and partly transverse"; the action therefore upon the contents will be like that of the human intestine, and tend to drive them along the tube.

**Development of Spongilla.***—A further communication on this subject by Dr. A. Goette is the fourth of his series of notes on the development of *Spongilla;* he criticizes the result of Dr. W. Marshall in the following points. The gemmulæ do not arise from special "trophophores," but from a portion of the parenchym, together with the neighbouring ciliated chambers and canals; the gemmulæ do not consist of three layers; the cavity of the young sponge has been stated by Marshall to commence with a central excavation from which the canals grow out; in reality it would seem that the cavities appear separately, and that the ciliated chambers are not outgrowths of, and have no relation to the rest. *Spongilla lacustris* has no seasonal alternation of generations.

**New Fresh-water Sponge.**†—Mr. E. Potts describes under the name of *Heteromeyenia pictonensis*, a new sponge from Nova Scotia; it is closely allied to *H. Ryderii*, but differs in the characters of the birotulate spicules, which are as follows: "Shafts mostly smooth, though sometimes bearing a single spine, irregularly cylindrical, but rapidly widening to support the rotules, which are large, umbonate, nearly flat, and finely lacinulate at their margins, occasionally bearing spines."

### Protozoa.

**Protozoa.**‡—Prof. E. Ray Lankester has a very fully illustrated article on the Protozoa, in the course of which he discusses a number of interesting points.

With reference to the nature of the first protoplasm which was evolved from not-living matter, he expresses his belief that it was without chlorophyll, or in other words, did not possess the power of feeding on carbonic acid. Apart from their elaborate fructification, the Myxetozoa represent more closely than any other living forms the original ancestors of the whole organic world. "Thus then we are led to entertain the paradox that though the animal is dependent on the plant for its food, yet the animal preceded the plant in evolution."

The Protozoon-cell-individual is then compared with the typical cell of animal and vegetable tissues; a nucleus is thought to be probably always present.

* Zool. Anzeig., viii. (1885) pp. 377–80.
† Ann. and Mag. Nat. Hist., xv. (1885) pp. 425–6.
‡ Encycl. Brit., vol. xix. (1885) pp. 830–66.

The following classification is adopted :—

PROTOZOA.

| *Sections.* | | |
|---|---|---|
| | | Grade A. Gymnomyxa. |
| Proteana .. .. | Class | I. Proteomyxa. *Vampyrella*, *Protomyxa*. |
| Plasmodiata .. .. | „ | II. Mycetozoa. *Eumycetozoa* of Zopf. |
| Lobosa .. .. .. | „ | III. Lobosa. *Amœba*, *Arcella*. |
| Filosa .. .. .. | „ | IV. Labyrinthulidea. *Labyrinthula*, *Chlamydomyxa*. |
| | „ | V. Heliozoa. *Actinophrys*. |
| | „ | VI. Reticularia. *Gromia*, *Globigerina*. |
| | „ | VII. Radiolaria. *Thalassicolla*, *Acanthometra*. |
| | | Grade B. Corticata. |
| Lipostoma .. .. | „ | I. Sporozoa. *Gregarina*, *Coccidium*. |
| Stomatophora .. | „ | II. Flagellata. *Monas*, *Euglena*, *Volvox*. |
| | „ | III. Dinoflagellata. *Prorocentrum*, *Ceratium*. |
| | „ | IV. Rhynchoflagellata. *Noctiluca*. |
| | „ | V. Ciliata. *Vorticella*, *Stentor*. |
| | „ | VI. Acinetaria. *Acineta*, *Dendrosoma*. |

**Chemical Composition of Zoocytium of Ophrydium versatile.*** Dr W. D. Halliburton has investigated the chemical nature of the jelly, mucilaginous investing matrix, or zoocytium which is exuded by the colonial ciliated protozoon *O. versatile*. The lumps of jelly were about an inch in diameter, firm, colourless, and transparent. On the surface were green patches due to chlorophyll.

The substance resembles vegetable cellulose in its general properties, and only differs by being less easily converted into sugar; herein it resembles tunicin, or the substance of which the test of the Tunicata is formed. Dr. Halliburton directs attention to the fact that we have here an animal in which chlorophyll and cellulose coexist.

**Freia Ampulla O. F. Müll., the Flask-animalcule.†**—Prof. K. Möbius, after a description of the infusorian, says that in many capsules there is, at the side of the hind-body of a perfectly developed individual, a young animal without funnel-lobes, nearly uniformly rounded off anteriorly and posteriorly, and produced by fission from the body of the parent animal. This, when it is still connected with its parent only by a slender cord, stretches the fore part of the body out of the capsule, tears itself free, and swims away, carried along by fine cilia which cover the whole body in close longitudinal series. At the anterior extremity rudiments of pectinellæ already show themselves, and a slight notch is the beginning of the formation of the funnel-lobes. After the young animal has swum about freely for a time, it attaches itself to some firm support and secretes the material of the capsule as a transparent mass, thicker behind than before, where it is not yet turned out as in mature individuals.

**Anoplophrya circulans.‡**—A new parasitic infusorian allied to *Opalina* is described under the above name, by Prof. E. G. Balbiani,

* Quart. Journ. Micr. Sci., xxv. (1885) pp. 445–7.

† Schriften Naturw. Ver. Schleswig-Holstein, vi. (1885). See Ann. and Mag. Nat. Hist., xvi. (1885) pp. 154–5.

‡ Recueil Zool. Suisse, ii. (1885) pp. 277–305 (1 pl.).

from the blood of *Asellus aquaticus;* it is the first example of a ciliated infusorian living in the blood of its host, and circulating with the blood. The parasite does not, however, spend its entire existence within the body of its host; in the water containing *Aselli* infected with the parasite, a number of infusoria were observed which appeared to be identical with the individuals contained in the blood of their host; the liberation of these is certainly due on occasions to the rupture of the terminal portion of the antennæ, and possibly always so; these organs being long and delicate are more liable to such fractures than any other part of the body; it is interesting to note that the parasites make use of an accidental lesion as a natural way to leave the body of their host. The majority of the thus liberated parasites die, but a good many survive; these become encysted on a filament of *Conferva* or similar locality; even the body of an *Asellus* is occasionally fixed upon. It is not, however, certain how the parasites regain the body of their host.

M. A. Schneider also describes* this infusorian, more especially in regard to its method of reproduction.

Conjugation takes place between the small ovoid individuals which, instead of simply coupling, unite by temporary fusion of the protoplasm. Before this fusion or at the moment that it takes place, the nucleus and nucleolus, with which each is provided, undergo modifications. The nucleus of the one elongates and extends for half its length into the protoplasm of the other, which in its turn also sends a portion of its nucleus to its neighbour. The two nuclei form, at this moment, two parallel transverse bands, proceeding without solution of continuity from the centre of one individual to that of the other. The nucleoli are divided, and each individual has four. The author is unable to say whether any exchange of these nucleoli takes place. At the close of the conjugation each individual has six globules, two large and four small: the former representing two halves of the nucleus, of different origin; the latter are the nucleoli. The two large globules amalgamate and constitute the new nucleus, and one of the small ones persists as nucleolus; the other three are reabsorbed.

**New Vorticella.**†—Dr. A. C. Stokes describes a new species of *Vorticella* found in the cedar swamps of New Jersey. *V. limnetis* n. sp. is remarkable for the peculiar twisted appearance of the sheath of the pedicle, a characteristic which it has in common with *V. octava* Stokes; but apart from its smooth cuticular surface, it is easily distinguished from that species by the much smaller body, and the greater abundance of the spirals and the consequent shortness of their curves.

**Difflugia cratera.**‡—Several species of animals belonging to marine genera have lately been discovered in the deep waters of certain fresh-water lakes in Switzerland. Among Infusoria, *Tintin-*

* Comptes Rendus, c. (1885) pp. 1552–3.
† The Microscope, v. (1885) pp. 145–6 (1 fig.).
‡ Zool. Anzeig., viii. (1885) pp. 293–4.

*nidium fluviatile* and *T. semiciliatum* and *Tintinnus subulatus* are at present the only examples known of such a change of habitat—no doubt produced by geological changes. Dr. O. E. Imhof records a fourth Tintinnodea from the lake of Zurich, which is apparently identical with Leidy's *Difflugia cratera*, and which he names *Codonella cratera*.

**New Type of Sarcosporidia.***—M. R. Blanchard has found in a *Macropus penicillatus* small white spots in the large intestine; these were seen to be cysts, each of which was bounded by a delicate membrane, the rupture of which allowed the escape of reniform corpuscles, altogether similar to what are ordinarily called psorosperms; they are granular, and often have at their ends a bright spot, but no nucleus could be detected. The author does not doubt that they are the equivalents of the falciform corpuscles of coccidia, and like them they exhibit amœboid movements. The numerous vesicles found in the cysts of the Sarcosporidia correspond, therefore, to the spores or pseudonavicellæ of coccidia, and they appear to be most nearly like those of *Klossia*, from which they differ only in secondary points, such as size and habitat. The smallest spores were found in the centre, and the largest at the periphery of the cyst, and the latter were found to be the more mature; they are from 9·8 to 12 $\mu$ long and 4 to 5·5 $\mu$ broad.

## BOTANY.

### A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

#### α. Anatomy.†

**Protoplasm in the Intercellular Spaces.‡**—From an examination of over 100 different species of plants, Prof. E. Russow concludes that air-containing intercellular spaces of schizogenous origin are always closed by a thin layer of protoplasm which can be revealed by treatment with iodine and sulphuric acid. He believes it must have some important function, perhaps for the absorption and condensation of certain gases in the intercellular spaces. He shows also that Schaarschmidt's statement § of the occasional presence of chlorophyll-grains in the intercellular spaces rests on erroneous observation.

**Forms of Cells.‖**—Prof. J. O. Hennum has made a series of experiments on the forms resulting when balls of moist clay are rolled

* Comptes Rendus, c. (1885) pp. 1599–1601.

† This subdivision contains (1) Cell-structure and Protoplasm (including the Nucleus and Cell-division); (2) Other Cell-contents (including the Cell-sap and Chlorophyll); (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ SB. Dorpat. Naturf. Gesell., vii. (1884) 15 pp. See Bot. Centralbl., xxii. (1885) p. 15. Cf. this Journal, iv. (1884) p. 404.

§ See this Journal, *ante*, p. 84.

‖ Arch. Math. og Naturvid., Kristiania, ix. (1884) pp. 301–404 (7 pls.). See Biol. Centralbl., ix. (1885) p. 199.

up in lycopodium-powder, either side by side or one over another, and then subjected to pressure in various directions. The forms resulting are described from a mathematical point of view in regard both to their surfaces and to their contents, and the laws thus obtained are then applied to account for the various forms of cells found in the animal and vegetable kingdoms.

**Structure of the Nucleolus.***—Dr. E. Zacharias has carefully examined the structure, properties, and functions of the nucleolus, taking as his chief illustration, on account of their size, the nucleoli from the inner layers of the wall of the ovary of the snowdrop. In uninjured cells in which the currents of protoplasm are still kept up, the nucleolus appears under water perfectly homogeneous, in contrast to the fine granulation of the rest of the nucleus. When, on the contrary, the cells have been ruptured, the entire mass of the nucleus except the nucleolus swells up, the latter forming a shining sharply defined body, which is usually soon expelled from the ruptured nucleus. In the nucleolus itself may be detected two substances of different appearance, a central mass of stronger refringency and vesicular character, surrounded by a homogeneous ground-substance. The same differentiation is produced by absolute alcohol. Carmine stains chiefly the central mass. Treated with ferrocyanide of potassium and chloride of iron, the nucleolus is coloured blue, and contracts, leaving a space between it and the ground-substance of the nucleus; the diameters of nucleolus, cavity, and nucleus, are about in the proportion of 3, 4, and 10. The nucleolus has the appearance under these circumstances of a fine-meshed framework with coloured strands. In artificially prepared gastric juice, the nucleolus becomes pale and swells up, while brightly shining granules of nuclein appear in the rest of the nucleus. Longer immersion causes the nucleus apparently to disappear, but it is again coloured blue by ferrocyanide of potassium and chloride of iron, though reduced to about one-third of its original size. Carmine does not stain it in this condition, and even a 10 per cent. solution of chloride of sodium causes no change.

Pieces of tissue heated for some days with 10 per cent. solution of chloride of sodium and then examined in alcohol, rendered the nuclei very pale, and showed that a large portion of their substance was removed. A solution of carmine in very dilute ammonia stains the nucleoli very rapidly and strongly; while in a strongly acid solution of carmine in acetic acid the nuclein body is very strongly stained, the nucleolus remaining quite uncoloured, pale, and swollen; after a time it takes some colour, but remains lighter than the rest of the nucleus. All these reactions show that the nucleolus consists mainly of albuminoids in addition to plastin, but that it contains no nuclein. The same properties were found in the nucleoli of many other plants, such as those of the bast-cells of *Cucurbita Pepo*, of the filaments of *Spirogyra*, and of the nuclei in the asci of *Peziza cinerea* and *vesiculosa*.

The nucleoli resemble the pyrenoids in consisting of albuminoids

* Bot. Ztg., xliii. (1885) pp. 257–65, 273–83, 289–96.

without any nuclein; but it is improbable that the latter contain plastin. They have a still closer affinity with the starch-generators in the epidermal cells of flowering plants, plastin being certainly present in these also. But the albuminoids of the starch-generators display different reactions from those of the nucleoli, deliquescing in water.

The nucleoli always disappear when the nucleus is about to divide; their disappearance and reappearance in the daughter-cells can be peculiarly well watched in living cells of *Chara*, especially in the growing apices of the rhizoids. In one instance the whole process of the division of a nucleus, and that of its daughter-nuclei was followed in the course of twenty-four hours. The nucleolus of the living nucleus is not homogeneous, but contains vacuoles varying in number and size; and the different parts also display different degrees of refringency. When the nucleus is about to divide, the nucleolus loses its sharpness, and undergoes slow and finally amœboid changes of form, at length entirely disappearing. At a later period several fresh nuclei are to be seen in the daughter-nuclei; and these almost immediately coalesce into one. During the coalescence these new nucleoli lose their sharpness, which they again rapidly regain later. The author has been unable definitely to determine what becomes of the substance of the nucleolus after its disappearance, and its relationship to the elements of the nuclear plate and to the spindle-fibres. Possibly the albuminoid substance only disappears, the framework of plastin remaining and passing into the daughter-nuclei, where it again takes up albuminoids.

Zacharias regards the statements of Strasburger and others as to the appearance of so-called "paranucleoli," and their expulsion from the nucleus, as resting on error, resulting partly from the exclusive use of hardened material.

The behaviour of the nucleoli is somewhat different in male and female sexual cells. While they are invariably present in the latter, they may disappear from the former before their complete development. This difference was displayed in *Chara*, *Marchantia*, and in several ferns. In the oosphere of flowering plants a nucleolus appears never to be wanting; while in the nucleus of the pollen-cell it is not to be detected immediately before impregnation. In the nucleus of vegetative cells it is always present.

No general statement can be made with regard to changes in the nucleolus as the cell becomes older; it seems sometimes to increase, sometimes to decrease in size; in some cases it undergoes alteration in form, while in other cases no change is apparent.

The author is unable to assign at present any physiological function to the nucleolus. At the same time he dissents from the view of Strasburger, Carnoy, and Pfitzner, that it is not the living substance of the nucleus, and can only be regarded as a reserve-substance.

**Chlorophyll and its Combinations.*** — Some investigations of M. Guignet seem to show that chlorophyll is contained in envelopes

* Comptes Rendus, c. (1885) pp. 434–7.

which are insoluble in petroleum ether, but soluble in alcohol. In pouring a solution in concentrated alcohol upon water, the chlorophyll is gradually precipitated by diffusion, but it takes the form of brown flakes, which appear completely changed. On replacing the water by alcohol at 50° the chlorophyll is precipitated in deep green flakes without any evidence of crystallization; but the product thus obtained is very impure. Chlorophyll is very stable in the presence of bases, behaving like a true acid and giving compounds which appear to be very well defined. In order to obtain in the crystalline state the combination of chlorophyll and soda, alcohol may be added to the aqueous solution of that compound. On evaporating over lime under a bell-glass, the lime absorbs aqueous vapour, and the alcohol becomes more and more concentrated until it deposits needles of a very deep green, which appear almost black; they are very soluble in water, and present all the characters of a perfectly definite compound.

**Crystals in the Leaves of Leguminosæ.***—Prof. J. P. Borodin has examined the distribution of the crystals of calcium oxalate in 660 species of Leguminosæ. In the Mimoseæ their occurrence is very constant, in the form of solitary crystals disposed parallel to the veins. In the Cæsalpinieæ the distribution is the same, but in addition there are clusters of crystals scattered through the parenchyma of the leaf. These occur again in the Rosaceæ, but not in the Papilionaceæ. In the Papilionaceæ there are three principal types:—(1) Crystals altogether wanting:—the Genisteæ, many Galegeæ, as *Astragalus* and *Colutea*, and some genera in other groups. (2) Clinorhombic crystals along the veins:—the Vicieæ and Trifolieæ; some Phaseoleæ and Galegeæ have clinorhombic crystals scattered through the parenchyma. (3) Clinorhombic crystals in groups in the epidermis:—*Dioclea* and *Canavalia;* in *Stylosanthes* the crystals lie in the membrane of the epidermis. When crystals are wanting in the leaves, they are deficient also in the stem.

**Secreting Canals of Plants.**†—In pursuance of previous investigations on the same subject,‡ M. P. van Tieghem gives details as to the nature and arrangement of the secreting canals in a large number of natural orders of Dicotyledons.

In the Labiatifloræ (suborder of Compositæ), when secreting canals occur, their structure and arrangement correspond to that in the suborders Radiifloræ and Tubulifloræ. In the Compositæ taken altogether, the secreting apparatus occupies two different regions according to its nature; when composed of oleiferous canals it belongs to the endoderm; when composed of laticiferous cells, whether isolated or forming a network, it belongs to the liber in the root, to the pericycle in the stem and leaves.

The Dipsacaceæ resemble the Tubulifloræ in the presence and the position of the lacticiferous cells, but differ from all Compositæ in

* SB. Internat. Congress f. Bot. u. Gartenbau, St. Petersburg, May 1884. See Bot. Centralbl., xxi. (1885) pp. 222 and 351.

† Ann. Sci. Nat.—Bot., i. (1885) pp. 5–96.

‡ See this Journal, iv. (1884) pp. 767, 770.

the nature of the pericycle of the stem and leaf, which is always reduced to a single layer of thin-walled cells.

The Umbelliferæ and Araliaceæ are characterized by the invariable presence of a secreting system of canals in the pericycle, frequently superposed on a second system situated in the parenchyma. If this character is adopted, the genera *Mastixia*, *Helwingia*, and *Curtisia* must be excluded from Araliaceæ. These two orders, together with the Pittosporeæ, constitute a group distinguished from the whole of the rest of the vegetable kingdom by the arrangement of the secreting canals in the root, and the displacement which this causes in the insertion of the secondary roots; the Pittosporeæ differing from the other two orders in their superior ovary. In this respect, however, *Ancistrocladus* furnishes a connecting link.

In the Clusiaceæ the embryo is abundantly provided with secreting canals, affording a remarkable example of a secretion produced abundantly in the embryonal condition. The Ternstrœmiaceæ are, as a rule, destitute of these structures, though the rule is not without exception. The Hypericaceæ are characterized by the presence of narrow oleiferous canals in the pericycle, whenever this remains parenchymatous, i. e. always in the root, as well as in the stem in the typical herbaceous species. In other respects this order shows close affinity to the Clusiaceæ. The resiniferous cavities of the Myrsinaceæ are localized in the stem and leaf, never occurring in the roots. The Dipterocarpeæ are distinguished by the presence of oleiferous canals, and by the exclusive localization of these canals in the primary and secondary wood.

Details are given with respect to the structure and arrangement of the secreting canals in some other less important natural orders, making 18 in all; and the results given in previous papers are again included.

**Peculiar Structures in the Flesh of the Date.***—Prof. W. A. Tichomirow describes structures in the flesh of the date, the nature of which he is not able to determine, similar to those found by Flückiger in the fruit of *Rhamnus cathartica*. They are insoluble in water, not doubly refractive, coloured yellow by iodine and sulphuric acid, cobalt-blue by chloride of iron, green or olive-green by Millon's reagent, olive-green by ammoniacal cupric oxide, blue-violet or red-violet by caustic potash.

**Anatomy of Euphorbiaceæ.**†—Herr F. Pax discusses this subject in relation to the classification of the genera in the order. Bicollateral vascular bundles are found in all the Crotoneæ; occasionally in all the rest of the groups except the Stenolobeæ, Phyllantheæ, and Bridelieæ. The Euphorbiaceæ may be divided into four groups according to the degree of development of the latex-vessels, viz. (1) Latex-vessels entirely wanting; the secretion being distributed

* SB. Internat. Congress f. Bot. u. Gartenbau, St. Petersburg, May 1884. See Bot. Centralbl., xxi. (1885) p. 222.

† Engler's Bot. Jahrb., v. pp. 384-421 (2 pls.). See Bot. Centralbl., xxi. (1885) p. 326.

through all the cells of the parenchymatous tissue; (2) Latex-tubes segmented, and the segments of equal length; (3) Latex-tubes segmented, with the segments of unequal length; and (4) Latex-tubes unsegmented; in the true Euphorbieæ.

**Anatomical Structure and Development of Ceratophyllum.*** — This is described in detail by Herr J. E. F. af Klercker, the point of chief interest determined being that the dermatogen always divides only by anticlinals, and, in young apices of stems, appears to possess only a three or four-edged initial, in older apices apparently several. As a rule the periblem and plerome have distinct initials, the latter in young stages only one, in older stages several. In exceptional cases a single group of initials gives birth to both periblem and plerome.

**Lenticels.†**—Dr. A. Zahlbruckner has examined the structure of the lenticels in leaves, with the view especially of determining the question whether they are completely closed in winter. For this purpose Stahl's apparatus was employed, and applied to the leaves of *Æsculus Hippocastanum* and *Ulmus effusa*, and with the result of showing that they are not completely closed, although their structure in this respect may be different from what it is in summer. In *Sambucus*, *Gleditschia*, and the lilac, the lenticels did not permit a greater quantity of air to pass through them when they had just emerged from the bud than in winter. Owing to the power of swelling of the substance which fills up the cells of the lenticels, they allow less water to pass through them when saturated with water than when dry. The author was able to establish fully the connection between the lenticels and the air-passages, not only of the bark, but of the wood, in consequence of which a complete circulation of air is kept up through the plant. In branches destitute of lenticels other means of aeration are present.

The special anatomical construction is described of the lenticels of *Rhus Coriaria* and *Euonymus verrucosus*, the former belonging to the type in which the cells are all densely filled with a corky substance; the latter to the type in which, in addition to the cells filled with corky substance, are others of a sclerenchymatous character with lignified walls, perforated by simple pores which connect them with the adjacent cells.

**Anatomy of the Wood of Conifers.‡**—Dr. P. Pfurtscheller describes the appearance of certain tracheids in the wood of *Abies excelsa*, *Picea vulgaris*, *Larix europæa*, *Abies Douglasii*, and other coniferous trees, almost wanting in *Abies pectinata*. This was a projection in the membrane in the form of a spiral thickening, erroneously described by some observers as a striation, with which it has in fact nothing to do. In some cases the author observed a striation on the same tracheid, and satisfied himself that the two structures were entirely unconnected with one another. This tendency to the formation of a

* SB. Bot. Sällsk. Stockholm, May 12, 1884. See Bot. Centralbl., xxi. (1885) p. 157.

† Verh. K. K. Zool.-Bot. Gesell. Wien, xxxiv. (1885) pp. 107-16.

‡ Ibid., pp. 535-42 (2 pls.).

spiral thickening of the wall is not confined to the tracheids, but extends also to the outer cells of the medullary rays of the first-formed annual ring. Here they are especially conspicuous on the horizontal walls, and therefore distinct on transverse section; and are found also in the later annual rings where there is no trace of spirally thickened tracheids. The spiral thickening was found most distinct in the tracheids of the yew and of *Abies Douglasii*.

**Comparative Anatomy of the Tissue of the Medullary Rays and Annual Zones of Growth in Conifers.***—Herr H. Fischer has made a careful study of this subject in the stem, root, and branches of *Pinus Abies*. Notwithstanding contrary statements of previous observers, he states that no absolute universal character by which the wood of the stem, root, and branch can be distinguished from one another is to be obtained from the relationship between the mean number and height of the medullary rays in the successive annual rings and the age of the ring. The stem and branch can, however, be distinguished by the different structure of their broad annual rings. In the stem these consist, as a rule, chiefly of summer-wood, in the branch chiefly of autumn-wood. In narrow annual rings in both stem and branch, the autumn-wood constitutes at least half the breadth, in the branch usually more. The stem, root, and branch are to be distinguished by the anatomical structure of their annual rings, according as they are wide or narrow. In narrow rings in the root, the summer-wood usually prevails; wide rings contain as a rule more summer-wood than rings in the stem of the same width. A prevalence of autumn-wood is sometimes seen in very young and narrow rings of older roots. There is only a gradual passage between the character of the wood in primary and secondary roots. The annual rings are usually well marked in the stem, root, and branches, the chief exceptions being furnished by the root.

**Behaviour of the Leaf-trace-bundles of Evergreen Plants as the stem increases in thickness.†**—Dr. O. Markfeldt has investigated the question, What becomes of the leaf-trace—the common bundles of vascular plants which, within the stem, represent the discernible trace of the leaves to which they belong—when a new annual ring is formed in each recurring vegetative period, in the case of those trees and shrubs which retain their leaves through the winter? His observations were chiefly directed to Gymnosperms and Dicotyledons, and with the following general results:—

All the Gymnosperms examined have a portion of the leaf-trace which runs through the cortex, parallel to the main axis of the stem or branch, and surrounded on its lower side by cambium. The portion of the leaf-trace which runs into the wood stands vertically to the axis, or nearly so, and is closely inclosed on its upper and inner sides by the wood. The annual increase in thickness of the stem or branch causes a rupture of the leaf-trace in the neighbourhood of the cambium, while at the same time new vascular elements are formed

* Flora, lxviii. (1885) pp. 263–294, 302–9, 313–24 (1 pl.).
† Ibid., pp. 33–9, 81–90, 99–113 (1 pl.).

from the leaf-trace cambium, which again unite together the two ruptured parts of the leaf-trace. This gives the appearance as if the rupture took place on the upper side only of the leaf-trace, while in fact it extends to the whole bundle formed during a period of vegetation. The space left vacant by the rupture of the leaf-trace is probably filled up by the cambium, perhaps with the assistance of the woody parenchyma which surrounds the leaf-trace. The cells thus formed, after their cell-walls have become thickened, constitute the companion-cells (*Begleitzellen*) which arise at a greater depth in the wood.

After the fall of the leaf the leaf-trace is completely ruptured, except in the case of the Araucarieæ, where the leaf-trace does not appear to be completely torn through, even in the oldest internodes of the main stem.

All the evergreen Dicotyledons examined, with the exception of *Aralia quinquefolia* and *Prunus Laurocerasus*, have a thin-walled tissue above the leaf-trace which separates it from the upper woody portion of the branch or stem. This tissue is in immediate connection with the pith, and consists of similar cells. The leaf-trace is in all cases curved outwards. In *Ilex Aquifolium* the leaf-trace is ruptured in the third year. In this case the space left vacant by the rupture is filled up by cells which resemble those of the pith-like tissue lying above the leaf-trace.

In all Dicotyledons which have a long portion of the leaf-trace running through the cortex, a rupture of the cambium takes place after the fall of the leaf. In *Camellia japonica* the leaf-scar arises so deep in the feebly developed cortex that there can hardly be said to be a cortical portion of the leaf-trace. Hence the whole of it is in this case concealed.

The same is true of the leaf-trace in deciduous as in evergreen Dicotyledons; after the fall of the leaf a rupture of the leaf-trace takes place at the cambium in those cases where it has a cortical portion.

**Gum-canals of the Sterculiaceæ.***—M. P. van Tieghem points out that the more or less abundant production of gum or mucilage is a common character of the Malvaceæ, Tiliaceæ, and Sterculiaceæ, which ought, he considers, to be treated rather as three tribes of one order than as distinct orders. But the mode of formation of the gum differs in the three groups. In the Malvaceæ and Tiliaceæ it is secreted in large isolated cells which sometimes coalesce; in the Sterculiaceæ in large schizogenous secreting canals. The cells which border these canals do not usually differ in any respect from the surrounding parenchyma, and may contain starch or calcium oxalate; sometimes they are smaller than the ordinary parenchymatous cells. These canals occur in the stem and leaves only, being entirely absent from the root. In the stem they are usually developed simultaneously in the cortex and in the pith; the rest of the stem being as a rule destitute of them. In the cortex they are arranged in

* Bull. Soc. Bot. France, xxxii. (1885) pp. 11–14.

a single circle in the median zone, their number amounting to 20, 40, or even 60; those of the pith are also most often in a single circle in the peripheral zone, and are always separated by some rows of medullary cells from the primary xylem of the vascular bundles; sometimes they form two concentric circles. In some genera the cortical canals are wanting. Those genera which have canals in both the cortex and the pith possess them besides in the external and internal parenchyma of the leaf-stalk; but when the cortex of the stem is destitute of these canals, so also is the external parenchyma of the leaf-stalk. The large starchy cotyledons of *Cola* and *Heritieria* contain no gum-canals; and in some genera of Sterculiaceæ they are entirely wanting even in the leaves and stem.

**Striated Woody Tissue.***—Herr F. v. Höhnel describes a peculiarity of the wood of a certain number of exotic trees belonging principally to the natural orders Leguminosæ, Bignoniaceæ, Simarubeæ, and Ebenaceæ, a striated appearance on longitudinal section due to the presence of horizontal rays. This results from the regular disposition of the medullary rays, which form so many parallel horizontal bands. In addition the tracheids, which constitute the greater part of the wood, are swollen in their middle and taper off at their two extremities; the median swellings which alone are punctated, are arranged in parallel lines, which further contributes to give the wood its striated appearance.

**Structure of Stem of Strychnos.†**—M. J. Hérail has investigated the peculiar structure of the stem of *Strychnos*, in the three species *S. triplinerve*, *brasiliense*, and *nux-vomica*, in which the ring of wood is traversed by light-coloured plates sometimes arranged regularly in a circle, sometimes irregularly in the woody mass, composed of sieve-tubes surrounded by parenchyma. M. Hérail shows that this structure is not due, as has been supposed, to an abnormal power of the cambium of producing both xylem and phloëm on one side; but that it, in the usual way, produces xylem only on one side and phloëm only on the other side. The peculiar appearance results from the cambium ceasing to produce xylem at the points where it produces phloëm; and this peculiarity persisting for an indefinite time, the result is that the xylem formed in all the other parts advances more and more upon the phloëm, which it appears ultimately to surround.

**Mechanical Tisssue-system.‡**—Dr. A. Tschirch proposes the following terminology for the various developments of this system. By the term sclereid he understands all thick-walled elements which cannot be included under specific mechanical cells, viz. bast-fibres, libriform, and collenchyma; hence all the cells formerly classed as sclerenchyma, except the stereids, collenchyma, and libriform cells. The sclereids must also be regarded as specifically mechanical cells,

* SB. K. Akad. Wiss. Wien, lxxxix. (1884) pp. 30–47. See Bull. Soc. Bot. France, xxxii. (1885) Rev. Bibl., p. 9.

† Bull. Soc. Bot. France, xxxii. (1885) pp. 92–5.

‡ Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 73–5.

and may be divided into Osteosclereids (bone-cells of *Hakea*, &c.), Astrosclereids (ophiure-cells of Jönsson), and Brachysclereids (stone-cells). Except in actual reserve-receptacles, as in seeds, the thickening of the wall is never effected by the storing-up of reserve-cellulose.

Sclereids are often employed in constructions for producing radial pressure, as the osteosclereids of the Proteaceæ, Restiaceæ, and *Thea*, and the brachysclereids in the palisade-layer of the testa of seeds. The mechanical contrivances in the bark of dicotyledonous trees are very various; and the sclereids here often perform a secondary function in protecting the sieve-structures. The "mixed ring" of *Quercus*, *Cinnamomum*, *Betula*, &c., is produced by thin- or thick-walled elements of the cortex becoming intercalated in cavities formed during the early years in the mechanical ring of the primary group of sclereids. The author is unable to explain the function of isolated sclereids or groups of them not connected with bast-cells. In the fruit of the Pomaceæ they may be the remains of walls previously continuous, though this will not explain the isolated clusters of stone-cells in older cortex, and the isolated sclereids in the pith of many plants.

**Structure and Function of the Aril in certain Leguminosæ.***—Herr E. Bachmann describes the appendage to the seeds known as the aril in *Sarothamnus scoparius* and some other Leguminosæ. Its purpose appears to be to cause in the ripe seed a detachment from the funicle, by means of a very large intercellular cavity, and thus to promote the dissemination of the seeds. A similar purpose is served by a totally different structure in the aril of species of *Vicia* and *Lathyrus;* the separation being caused here by a difference of tension between the cells of the aril and those of the seed itself.

**Leaves of Statice monopetala.†**—Dr. M. Woronin describes the structure of the leaves of this plant, in which the most noteworthy points are the following:—Among the otherwise very regular layers of palisade-cells immediately beneath the epidermis of the upper and under surfaces, are large much-branched sclerenchymatous cells, containing a colourless finely granular protoplasm, and sometimes a distinct nucleus. The leaves display a strong calcareous incrustation partly in the form of a thick and regular layer, partly in the form of separate scales of roundish outline, which, when violently removed, reveal beneath them remarkable glands consisting always of eight cells, by which the calcium carbonate appears to be separated.

**Absorbing Organs of Albuminous Seeds.‡**—Dr. M. Ebeling has investigated the process by which, in germinating seeds which have their food-material stored up in endosperm, the embryo obtains this food-material from the embryo. He finds that the various modes may be classified under the following types:—

In Cycadeæ and Monocotyledons the cotyledons remain permanently in the seed, and are destined for no purpose except the absorp-

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 25–9 (1 pl.).
† Bot. Ztg, xliii. (1885) pp. 177–85 (1 pl.).
‡ Flora, lxviii. (1885) pp. 179–202 (1 pl.).

tion of the endosperm, perishing after this is completed. In Liliaceæ, Juncaginæ, Irideæ, Amaryllideæ, and doubtfully in Cycadeæ, the cotyledon remains anatomically unchanged during germination, absorbing the endosperm through the ordinary epidermal cells which differ in no way from those of the young leaves.

In Gramineæ, Palmæ, Commelynaceæ, Cyperaceæ, and Juncaceæ, the cotyledon developes special organs or haustoria for the absorption of the endosperm. In grasses this is the scutellum, a shield-like organ, clothed with an epithelium composed of elongated thin-walled absorptive cells at right angles to the surface, from four to ten times as long as broad, and projecting into the endosperm like sacs. In Palms and Commelynaceæ, on the other hand, the absorptive organ is of the same shape as the seed, its periphery consisting of elongated thin-walled cells placed vertically to the surface, and from two to six times as long as broad. In Cyperaceæ and *Luzula* (Juncaceæ) the organ in question is of a filiform-cylindrical shape, continually renewing itself at the apex. The entire haustorium consists of elongated thin-walled cells, from four to six times as long as broad, and having their longer axis parallel to that of the organ. In *Juncus* the haustorium is pear-shaped; both the inner and the epidermal cells are elongated in a direction parallel to its longitudinal axis; the terminal cells at its apex being elongated radially and club-shaped.

A second type occurs in Dicotyledons and Coniferæ. The cotyledons remain only for a time in the seed, consuming the endosperm, after which they rupture the testa, emerge above the soil, and perform the function of assimilating organs, with the characters of ordinary leaves. Their epidermis consists of thin-walled cells, not specially elongated, but with the ordinary forms of young epidermal cells.

The main point of difference is that in Monocotyledons the cotyledon serves only for the absorption of the endosperm, and may develope into a special haustorium; while in Dicotyledons and Conifers the cotyledons serve in the first place for the absorption of the endosperm and afterwards for assimilation, when they assume the form of ordinary leaves.

**Embryo-sac of Santalum and Daphne.***—Prof. E. Strasburger has made further observations on the structure of the embryo-sac of *Santalum album* from Madras. In contrast to previous statements, he finds that the "egg-apparatus" follows the ordinary rule of possessing only a single ovum-cell and two synergidæ. A fallacious appearance is presented by the synergid-caps (or filiform apparatus) being strongly separated from the synergidæ themselves, and a ridge springing out from the wall of the embryo-sac between them. The pollen-tube forces its way between the two synergid-caps to the point of insertion of the ovum-cell, after which the egg-apparatus exhibits its ordinary changes. The formation of endosperm is commenced by the division of the secondary nucleus of the embryo-sac, and a transverse division of the embryo-sac itself beneath the swollen spot.

With regard to the embryo-sac of *Daphne*, Strasburger admits the

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 105–13 (1 pl.).

force of the objection taken by Prohaska to his previous interpretation of the peculiar structures found in it by this observer. He now considers that they are neither disorganized cells of the nucellus, endosperm-nuclei, nor cell-nuclei; and details observations made on *D. Blagayana*, *Mezereum*, and *Laureola*, which establish that they are vacuoles filled with a strongly refractive substance which is fixed by alcohol, corresponding to similar structures found in the ovum-cells of conifers.

**Morphology of the Receptacle.***—Sig. F. Baccarini infers, from an examination of the course of the fibrovascular bundles, that in the case of the inferior ovary of perigynous flowers, of which the Roseæ may be taken as the type, the cup-shaped receptacle is an axial organ, as is shown by the formation on its margin of the outer whorls of floral organs. When, in an inferior ovary, the placentation is axile, as in Pomaceæ and Myrtaceæ, the whole structure is of a compound character, consisting of two parts closely united to one another in growth, the outer of which is the widened receptacle, while the inner part is formed of the carpids, formed at the bottom of the axial cup. In the Cactaceæ the course of the fibrovascular bundles seems to show that the carpids, like the other appendicular organs of the flower, are inserted on the margin of the axial cup, but that the placentæ are formed in the hollow of this cup along the descending leaf-trace-bundles.

**Spur of Cucurbitaceæ.**†—In many germinating Cucurbitaceæ a kind of spur is formed on the tigellum which appears to have for its function the freeing of the seedling from the testa of the seed. Sig. A. Baldini has examined the structure of this organ, and finds that if its formation is prevented, the seeds germinate imperfectly and abnormally. The spur itself varies in form, but is always seated at the spot where the tigellum forms an angle with the root, on the side facing the substratum. In the course of its development it undergoes several changes of position; its apex finally bending and pressing against the testa, so that the seedling is at length forced out from its confinement within the latter.

In addition to its mechanical function, the author ascribes to this organ another connected with the life of the seedling. On the side of the spur which faces the root, when it is pressed closely against the testa, are a number of hairs altogether resembling in their nature root-hairs, which appear to absorb nutriment from the inner integument of the seed, and later from the soil; so that it may be regarded as an organ of nutrition. Morphologically he regards the spur as belonging to the tigellum rather than to the root.

**Anatomy of the Fruit of Ranunculaceæ.**‡—Dr. E. Adlerz finds in the fruit of Ranunculaceæ two kinds of mechanical and supporting

* Ann. R. Ist. Bot. Roma, i. (1884) pp. 66–85 (5 pls.). See Bot. Centralbl., xxi. (1885) p. 229.

† Ann. R. Ist. Bot. Roma, i. (1884) pp. 49–65. See Bot. Centralbl., xxi. (1885) p. 229.

‡ Adlerz, E., 'Bid. till fruktväggens anat. hos Ranunculaceæ,' 42 pp. (4 pls.), Orebro, 1884. See Bot. Centralbl., xxi. (1885) p. 330.

tissue:—(1) the sclerenchymatous strings which accompany the vascular bundles; (2) tissues of various kinds distinct from the vascular bundles. Some of these form the hardening layer, while others do not. The venation or distribution of the finer vascular bundles in the fruit of Ranunculaceæ also shows a number of variations.

**Anatomy of the Female Inflorescence of Dioon edule.***—Sig. G. Cugini furnishes a useful contribution to our knowledge of the reproductive organs of Gymnosperms. The axis of the female inflorescence of *Dioon edule* is composed of a nearly homogeneous parenchyma through which run the numerous gum-canals characteristic of the Cycadeæ, in a longitudinal direction, apparently without any order, and branching and anastomosing abundantly. Like the vascular bundles they curve to enter the ovuliferous leaves. They are full of a yellow gum which dries on exposure to the air, and is completely soluble in potash.

The fibrovascular bundles are arranged in a central cylinder surrounded by a circle of smaller bundles; the xylem and phloëm are side by side; between them is a woody parenchyma.

The lamina of the ovuliferous leaves has an epidermis composed of tabular cells, the lower surface alone being furnished with a few stomata. Beneath the epidermis is a hypoderma composed of two or three irregular layers of cells, and beneath this a thickish sclerenchymatous layer. The mesophyll is composed of large cells containing abundance of starch, and is penetrated by gum-canals and fibrovascular bundles.

Each leaf bears two horizontal or pendulous ovules, with a single integument prolonged into a micropylar canal; the nucellus, consisting of a single sac, was examined only in an unfertilized condition. From the arrangement of the fibrovascular bundles, the author concludes that the ovules are equivalents of lobes of leaves.

**Influence of the Medium on the Structure of Roots.†**—As the result of a series of experiments, M. J. Costantin has arrived at the conclusion that when a root developes in the air instead of the soil, the cortex is diminished in mass, while the pith is increased; the fibrovascular system, both cortical and central, is increased, together with the number of lignified vessels; and the endoderm-cells are rendered harder and less permeable. When, on the contrary, a root developes in water, the number of air-cavities is increased, both in the cortex and the pith, the latter is diminished in quantity, while the fibrovascular system is reduced. The changes effected by a change of medium of the root are in fact similar to those produced in the stem.

**Structure and Dehiscence of Anthers.‡**—M. Leclerc du Sablon repeats in further detail, giving a large number of illustrations, the

* Nuov. Giorn. Bot. Ital., xvii. (1885) pp. 29–43 (4 pls.).
† Ann. Sci. Nat.—Bot., i. (1885) pp. 135–82 (4 pls.).
‡ Ibid., pp. 97–134 (4 pls.).

results at which he has arrived * respecting the speciality in the structure of anthers which causes their dehiscence in different ways in different cases.

**Vegetative Organs of Urtica dioica.**†—Dr. A. Gravis takes the anatomy of the vegetative organs of the common nettle as a basis for a general and comparative study of the Urticaceæ. The minute structure of the stem, root, and leaf is worked out and exemplified under all modifications attendant upon age and biological conditions, and the importance of recognizing these conditions and states is insisted on. This treatise would be an excellent vade-mecum and guide for any student who wished to undertake serious work in vegetable histology. The style of exposition is as clear as are the illustrative figures.‡

**Anatomy of Peduncles compared with that of the Primary Axes and of Petioles.**§—M. E. Laborie is led to conclude from numerous researches that the organization of the floral axes differs very frequently from that of other portions of the plant.

Of the differences observable, the ones that may be termed *essential* are always found when the structure of the peduncles is not identical with that of the stem; the others, accessory in some sort, vary with the species. The former affect the constitution itself of the tissues or systems of tissue occurring in all the axes, and their relative importance. The latter are due to either the absence in the peduncle of some tissue which exists in the stem, or the presence of some elements which the stem does not possess. Thus as regards

A. *Essential Characters.*—There is generally observable in the peduncles (1) a great development of the bark (*Hibiscus syriacus*, *Antirrhinum majus*, &c.); (2) An organization of fibrovascular bundles, characterized (*a*) in its external portion by a frequent augmentation of the diameter of the fibres, independently of their number, which may be diminished (*Cornus sanguinea*, *Catalpa bignonioides*); or increased (*Lathyrus sylvestris*); (*b*) in its interior portion, by a very marked reduction of the number and size of the large vessels (*Dolichos sinensis*, *Vitis vinifera*, &c.). (3) Lastly the small size of the pith (*Aquilegia vulgaris*, *Gratiola officinalis*, *Quercus pedunculata*, &c.).

B. *Accessory Characters.*—Various tissues, constant elements of the stem, do not always recur in the peduncles. For instance, the disappearance in it is noticed of cork (*Lonicera alpigena*, *Ribes malvaceum*), of chlorophyll-cells (*Aristolochia sipho*), of the woody part of the vascular bundles (*Citrus Aurantium*, *Pastinaca pratensis* Jord.; *Maclura aurantiaca*, &c.), of sclerenchymatous cells which are often mixed with woody fibres (*Styphnolobium japonicum*). At times, lastly, the number of certain supplementary parts is diminished (reversed bundles of *Calycanthus macrophyllus*.) On the other hand, the peduncles of various species possess tissues or elements which are

* See this Journal, *ante*, p. 91.

† Gravis, A., 'Recherches Anatomiques sur les Organes Végétatifs de l'Urtica dioica,' 4to, Bruxelles, 1885, 256 pp. and 23 pls.

‡ See Amer. Journ. Sci., xxx. (1885) pp. 84–5.

§ Comptes Rendus, xcix. (1884) pp. 1086–8.

wanting in the stem; e. g. woody fibres (*Thymus vulgaris*); the special reticulate cells (*Acacia cultriformis*). These modifications sometimes correspond to the size of the floral organs, or to the size or consistency of the fruit; but most frequently they can only be connected with the function of those organs. In fact, on comparing the peduncles with the petioles, it is seen that the most marked and constant difference which distinguishes them is in the number and size of the large vessels of the wood; few and small in the former, numerous and large in the latter.

From the point of view of sexuality, the influence of the flower on the organization of the peduncles sometimes expresses itself in well-defined characters. Thus the peduncles of the female flowers of certain monœcious species always possess a thicker bark, and a better organized woody ring furnished with larger if not more numerous vessels, than the peduncles of the male flowers (*Castanea vulgaris*, *Juglans regia*, &c.) In short, the floral axes present modifications, more or less marked, which express in some sort the influence which the production of flowers exercises, and gives us, so to speak, the measure of its value. This influence may be nothing or at least may appear to be such. Often it does not extend beyond the immediate supports of the flower, or at least of the various members of the inflorescence (*Pavia rubra*, *Vitis vinifera*, &c.). And lastly, in some plants it makes itself felt as far as the branches which give rise to the floral axes, so as to provoke in them either a partial modification (*Ribes malvaceum*), or a complete differentiation (fruit-bearing branches of the pear and apple, of *Salisburia*, &c.).

**Wolffia microscopica.***—Herr F. Hegelmaier describes the structure and anatomy of this previously little-known species, the smallest of flowering plants, from India. Its most striking external peculiarity is the rhizoid or "radicula" of Griffith, a comparatively large conical protuberance from the lower surface of the plant, somewhat nearer to the base than the apex of the shoot, the purpose of which appears to be to enable the plant to float in a horizontal position. The author suggests that in the allied genus *Wolffiella* we may have a true example of apogamy, hitherto unknown in flowering plants, a continual non-sexual reproduction from generation to generation, without seeds being ever produced.

### β. Physiology.†

**Fertilization of Asclepias Cornuti.‡**—Mr. T. H. Corry describes in great detail the structure and development of the gynostemium and the mode of fertilization in this plant. Pollination takes place entirely by the agency of insects, and only in fine weather; and the author states that, as far as his observation goes, the flowers are absolutely sterile when pollinated artificially from pollinia extracted either from the same flower or from another of the same age. This is

* Bot. Ztg., xliii. (1885) pp. 241–9.

† This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Growth; (4) Respiration; (5) Movement; and (6) Chemical processes (including Fermentation).

‡ Trans. Linn. Soc. Lond.—Bot., ii. (1884) pp. 173–207 (3 pls.).

the case even though the pollinium may produce a skein of pollen-tubes which penetrate down into the interior of the style; and even when the tubes enter the ovary this is insufficient to ensure the production of an embryo.

**Blooming of Arum italicum.***—Herr G. Kraus describes the structure of the club-shaped appendage to the inflorescence of *Arum italicum*, and the remarkable changes which take place in its chemical constitution during blooming. In the course of a few hours this structure loses, on an average, about 74 per cent. of its dry weight, chiefly by the consumption of carbohydrates. Before blooming, about 66 per cent. of its dry substance consists of starch, which entirely disappears, as well as the sugar. These substances are not used up by the plant, but oxidized and exhaled. In five inflorescences an average temperature of 51·3° C. was observed during blossoming, or 35·9° above that of the surrounding air. *Arum maculatum* displays a similar elevation of temperature; *Calla ethiopica*, on the other hand, none at all.

**Influence of Electricity on the Growth of Plants.**†—Dr. A. Bronold finds that electricity has a threefold influence upon the growth of plants—as an illuminant; as decomposing the constituents of the soil; and as ozonizing the air. By the joint application of this triple agency to certain ornamental plants and to strawberries, he effected growth, strength, and health, exceeding by two or three times that obtained under natural cultivation; larger size and better development of flowers and fruits, without loss of flavour and odour; larger seeds, possessing greater germinative power; more complete assimilation of the plant-food in the soil, and freedom from vermin.

Prof. Holdefleiss ‡ has observed that beet seed, sown in a flower-pot so placed that the soil was exposed to the electric light, germinated two days earlier than similar seeds without the action of the electric light.

Herr Schöller § also testifies to the exceptional luxuriance of beets, in a plot of about two square metres, which had been struck by lightning.

**Respiration of Plants.**‖—MM. G. Bonnier and L. Mangin point out that hitherto the amount of oxygen given out by plants to the air has been supposed to represent the total result of the fixation of carbon. They show that this is not the case, but that at the same time that the carbon is assimilated by the chlorophyll, the protoplasm absorbs oxygen and emits carbonic acid. An analysis of the gas emitted by a plant, therefore, only represents the difference between the amount of oxygen disengaged by assimilation of carbon and the amount absorbed by respiration, and on the other hand, between the carbonic acid decomposed by assimilation and the carbonic acid produced by respiration.

* Abh. Naturf. Gesell. Halle, xvi. (1884) 102 pp. (3 pls.). See Bot. Centralbl., xxii. (1885) p. 163.

† Zeitschr. Land. Vereins in Bayern. See Journ. of Sci., vii. (1885) p. 248.

‡ Der Landwirth. See Journ. of Sci., vii. (1885) p. 248.

§ Ibid.

‖ Comptes Rendus, c. (1885) p. 1303.

Three methods are given for separating the result of the action of chlorophyll from that of respiration. One is by calculating the difference between the whole amount of gas emitted and absorbed by plants exposed to light, and the volume which they emit by respiration alone in the same light. A second method consists in suppressing assimilation by the use of chloroform or ether without altering the respiration. In the third method, two plants, of which the physiological identity has previously been ascertained, are exposed, the one to ordinary air, and the other under similar conditions except that a concentrated solution of barium hydrate is placed in the containing apparatus to absorb the carbonic acid formed. Under these circumstances an excess of oxygen is found in the apparatus without baryta, while in the apparatus containing it the carbonic acid when set free by hydrochloric acid is found to be in excess of that in the other vessel. The conclusion arrived at by the authors from these experiments is that the volume of oxygen disengaged by assimilation is greater than that contained in the carbonic acid decomposed.*

**Respiration of Plants at different seasons.**†— MM. G. Bonnier and L. Mangin give the following experimental results on this subject:—In any given stage of development, the proportion between the volume of carbonic acid given out and that of oxygen absorbed, is constant, whatever the temperature. This proportion remains also constant if the pressure of oxygen is diminished, and that of carbonic acid increased.

**Galvanotropism of Roots.**‡—Herr J. Brunchorst describes under this name the curvature in roots growing free in water caused by a galvanic current. Weaker currents cause curvatures which are concave on the side of the negative electrode; these he calls negative curvatures; while stronger currents cause curvatures which are concave on the side of the positive electrode; and these he calls positive curvatures. The point of passage from negative to positive curvatures varies greatly with different plants. Decapitated roots exhibited only positive curvatures.

**Movement of Water in Plants.**§—In support of Godlewski's view as to the cause of the ascent of water in plants,|| Herr J. M. Janse describes the following experiment. The central portions of long branches with abundance of leaves at their summit were placed in a water-bath without separating them from the plant. The portion immersed in water, from 15 to 20 cm. long, was heated for an hour to a temperature of 70° C. The result was that in *Fuchsia globosa* the leaves above the heated part began to wither the next day, and after five days were completely dried up. *Syringa vulgaris* held out somewhat longer, its leaves did not begin to wither till the fifth day, and were all dead in seventeen days. He concludes that the co-operation of the living elements of the wood is essential for the ascent of water

* See Bull. Torrey Bot. Club, xii. (1885) pp. 63–4.
† Bull. Soc. Bot. France, vii. (1885) pp. 175–80. See this Journal, *ante*, p. 679.
‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 204–19.
§ Maandbl. v. Natuurwet., 1885, pp. 11–24. See Bot. Ztg., xliii. (1885) p. 302.
|| See this Journal, *ante*, p. 490.

in trees; and that the medullary rays are especially adapted for driving up water to the highest branches.

**"Bleeding" of Parenchymatous Tissues.***—Dr. C. Kraus states that "bleeding" takes place from all parenchymatous tissues as the result of osmotic forces when the turgidity is sufficiently high, when there is no mechanical resistance, and when the parenchyma is in the right condition. The composition of the sap thus excreted varies, and is often different from that of the cell-sap. While the cell-sap is usually decidedly acid, the excreted fluid may be neutral or very slightly acid or even strongly alkaline; sometimes it is even more acid than the cell-sap. The bleeding is not brought about by transverse sections alone, but also by tangential and radial wounds. Bleeding often takes place from the leaves of cut branches, but usually only when the leaves are young; also from the surface of the epidermis of young roots; and acid drops have been observed to exude from the apex of root-hairs. The reaction of the parenchymatous sap appears to vary in the same plant.

**Physiological and Pathological Effect of Camphor on Plants.†**—Dr. A. Burgerstein has determined, from a large series of experiments, that when cut and withered shoots of various plants are placed in camphor-water, they recover more rapidly, and again become turgid sooner, than if placed in distilled water. At the same time camphor-water increases the transpiration from the shoot. If, however, the absorption of camphor-water is continued for a longer period, from two to five days, the plant is injured and at length killed. If made to swell in camphor-water, seeds will absorb water more rapidly and in greater quantity than if placed in distilled water.

**Chemical and Physiological Action of Light on Chlorophyll.‡**—M. C. Timiriazeff, in order to avoid errors due to the unequal dispersion of a prism, adopted the method of decomposing portions of the previously dispersed light. By means of the cylindrical lens and prism of small angle used in experiments on complementary colours, two images, complementary in colour, were thrown at the same time either on two test-tubes containing a 30 per cent. solution of carbonic anhydride in which was placed a small branch of *Elodea*, or on a plate coated with collodion containing a small quantity of chlorophyll. When the spectrum was divided into two equal parts with respect to the normal spectrum, the two images were of course respectively yellow and blue. The maximum chemical and physiological effect was exerted by the yellow, whilst the effect of the blue rays was scarcely appreciable. The blue-violet portion of the spectrum being cut off by a screen, the less refrangible portion was divided into two equal parts, red and greenish yellow. The maximum chemical and

* Bot. Centralbl., xxi. (1885) pp. 212-7, 245-9, 274-8, and 373; also Wollny's Forschr. a. d. Geb. d. Agriculturphys., vii. (1884) pp. 136-71. See this Journal, iv. (1881) pp. 591, 777.

† Verh. K. K. Zool.-Bot. Gesell. Wien, xxxiv. (1885) pp. 543-62.

‡ Comptes Rendus, c. (1885) pp. 851-4.

physiological effect was exerted by the red. By placing the prism in the greenish-yellow part of the spectrum, a greenish-yellow and a violet image were obtained. The latter contained all the rays absorbed by chlorophyll, whilst the former contained only the green which is reflected by vegetation. In this case the maximum effects were exerted by the violet.

It follows from these results that chlorophyll acts as a true sensitizer, undergoing decomposition itself, and promoting the decomposition of carbonic anhydride in those parts of the spectrum which it absorbs. The different rays absorbed by chlorophyll produce decomposition in very different degrees, the maximum decomposition coinciding in a remarkable manner with the maximum energy in the normal spectrum as measured by Langley and Abney. It would seem, therefore, that it is the amplitude rather than the period of the vibrations which brings about that disturbance of the carbonic anhydride molecule which finally results in its dissociation. The chemical action of light on the photographic plate seems to be strictly analogous to its physiological action on the living plant, provided that, as in the case of chlorophyll, the absorption phenomena are identical in both cases.

## B. CRYPTOGAMIA.

**Cell-wall-thickenings and Cellulin-grains in Chara and Vaucheria.***—Prof. G. Schaarschmidt has observed these structures in *Chara hispida* and *Vaucheria sessilis*. They are especially abundant on plants grown in a room. They are of various forms, cylindrical, conical, or ribbon-shaped, occasionally branched or united in groups, or of larger size and undulating, or very rarely empty and vesicular. They make their first appearance as small elevations on the inside of the cell-wall, often very closely packed; developing then into a cylindrical-conical form, manifesting a distinct lamination, and with either a "nucleus" or crevice near the base. The undulating thickenings are found especially in the antheridia and oogonia, on septa formed as the result of injury. The protoplasm collects in large quantities at the spots where these thickenings are taking place; it contains but a small number of chlorophyll-grains, and finally disappears with the exception of a very thin layer, which shows very beautifully the hyaloplasmatic membrane of the chlorophyll-grains. In *Vaucheria* and many other fresh-water algæ the cell-wall is impregnated with various incrusting substances of unknown composition.

These thickenings are regarded by the author as pathological products, and are often accompanied by abnormal structures such as, in *Vaucheria*, the septation of the filaments. The portions of protoplasm separated by transverse thickenings develope into gemmæ, or into a multicellular or branched septated form, the "conferva" and "cladophora" condition respectively. These forms are in no way connected with the *Gongrosira*-condition.

* Magy. Növén. Lapok., viii. pp. 1–13 (1 pl.). See Bot. Centralbl., xxii. (1885) p. 1.

Cellulin-grains were observed by the author in *Vaucheria sessilis* and *geminata*, but not with certainty in the living cells; best in preparations treated with hyperosmic acid, and then mounted in glycerin, after the cells have lain for a long time in alcohol. They vary in size from 4 to 14 $\mu$, and are of a compressed roundish form. The inner spongy mass of the young grains takes up pigments greedily, while the outer part is scarcely or not at all stained; nigrosin and rosanilin stain them most strongly. The inner portion is, however, coloured by an aqueous solution of eosin. They are remarkably insoluble in chlor-iodide of zinc, and in sulphuric acid unless very concentrated.

### Cryptogamia Vascularia.

**Apical Growth of the Root of Todea.***—M. P. Lachmann finds in the roots of *Todea barbara* a group of four initial cells, each with the form of a prism or of a four-sided truncated pyramid. The secondary roots proceed from a single cell of the endoderm of the adventitious roots, but in these also there is formed at an early period a group of four initials lying in a cross. The author regards this as establishing an additional point of union between the Osmundaceæ and Marattiaceæ.

**Prothallium of Lycopodium.†**—Dr. H. Bruchmann points out a remarkable difference between the prothallium of *Lycopodium annotinum*, observed by Fankhauser and himself, and that of *L. cernuum*, described by Treub. The latter is an erect cylindrical body growing above the surface of the soil and containing chlorophyll, with a leaf-like rim, beneath which are the archegonia and antheridia. The former is a prostrate underground tuber, entirely destitute of chlorophyll, and bearing antheridia and archegonia on the surface of special cushions inclosed by the margin of the prothallium. Neither form appears to be in any way abnormal, and the explanation suggested is that the European club-mosses have one type of prothallium, the tropical species another.

Another peculiarity of the prothallium of *Lycopodium*, as observed both by Treub and by Bruchmann, is the constant presence in its cells of an endophytic fungus, apparently an undescribed species of *Pythium*, resembling that described by Sadebeck in the prothallium of *Equisetum*. It appears to exercise very little injurious influence on the tissues. Bodies which were probably oogonia were detected by Bruchmann in some of the cells.

**Spores of Lycopodium.‡**—Mr. D. H. Galloway has made some measurements of the spores of *Lycopodium*, with the following results: He made careful measurements of 50 spores and found their average diameters to be 7/6000 in., the largest having a diameter of 8/6000 in., and the smallest 6/6000 in. It would therefore take 857 of them

* Bull. Mens. Soc Bot. Lyons, 1884, pp. 42-4. See Bot. Centralbl., xxi. (1885) p. 354.

† Bot. Centralbl., xxi. (1885) pp. 309-13. See this Journal, *ante*, p. 277.

‡ Bull. Torrey Bot. Club, xii. (1885) pp. 55-6, from 'Western Druggist.'

laid side by side to make an inch in length; to cover a square inch 734,449 would be required; and to fill the space of a cubic inch 629,422,793. Or in terms of the metric system, a row 1 cm. in length would contain 343 spores; a sq. cm. 117,649, and a c.cm. 40,353,607. On measuring the capacity of one of Powers and Weightman's dram morphine bottles he found that it was almost exactly 40 c.cm., therefore one of the bottles would contain 1,614,144,280 of these spores. The same bottle will hold 10,600 flax seeds, 350 cubeb berries, 250 grains of allspice, 66 *Cocculus Indicus* seeds, 20 nux vomica seeds, 200 canary seeds, 8400 dill seeds, 2900 grains of paradise, 1250 hemp seeds, 500 black pepper berries, 661 white pepper berries, 3250 stramonium seeds, and 100 pumpkin seeds. It will thus be seen that one hemp seed equals in size 1,291,315 lycopodium spores.

**Node of Equisetum.***—Mr. A. A. Crozier describes the structure of the node of *Equisetum arvense*. If a section is made lengthwise through a node of a fertile stem, each vascular bundle is seen to divide into two parts, each part uniting with a corresponding part of an adjacent bundle to form one of the bundles of the next internode. If the section be made radially through one of the teeth of the sheath or rudimentary leaves, a bundle is seen to pass down and unite in the node with one of the bundles of the stem. The bundle of the leaf is derived not by a simple separation of a portion of the outer phloëm, part of the bundle in the stem, but originates where that bundle begins to divide, and in such a manner that its vessels are continuous with the xylem of the divided bundle.

Each bundle of the stem, therefore, divides at the node into three parts—two lateral portions, each with xylem and phloëm, which by rearrangement continue the bundles of the stem, and a central part which bends outward into the leaf.

### Muscineæ.

**Development of the Sporangium of Frullania.**†— M. Leclerc du Sablon describes the development of this organ in the case of *F. dilatata*. In an early stage the organ is composed of cells more or less square and arranged regularly in two different directions. The upper part consists of two layers of cells forming a somewhat hemispherical surface, beneath which is the essential part of the sporangium, viz. a somewhat fusiform row of eight cells, distinguished by larger nuclei, and by their protoplasm being denser and taking a darker stain from hæmatoxylin. These are the source of both the spores and the elaters. Each of these cells divides into four by two vertical walls; the subsequent divisions being in a transverse direction. At a later period the nucleus is seen to divide in some of these cells, but not in others; and in such a way that a cell of each kind in one row alternates regularly with cells of the other kind in the adjacent rows; both kinds at the same time increasing in length. Those which do not divide are the mother-cells of the elaters; those

* Amer. Naturalist, xix. (1885) pp. 502–3 (2 figs).
† Bull. Soc. Bot. France, vii. (1885) pp. 187–91.

which do divide give birth to the mother-cells of the spores. In the formation of the latter no cell-wall is formed between the daughter-cells, which are separated only by mucilage; and this process is repeated many times; this gelatinous substance surrounding the mother-cells like a true membrane. Finally the spores surround themselves by a thick membrane. The elaters are also at an early stage surrounded by a thin gelatinous membrane like that of the spores; their protoplasmic contents gradually diminish, and are at least partly consumed in the formation of the spiral, the development of which resembles that of spiral vessels as described by Strasburger. By the time this spiral is completely developed, the protoplasm in the interior of the elater has entirely disappeared.

**Trochobryum, a new genus of Mosses.***—Herren J. Breidler and G. Beck give the following diagnosis of this new genus of Seligeriaceæ:—Dwarf plants, with the nearest affinity to the genus *Seligeria*. Leaves loosely areolated from a short base, subulate, with a long projecting mid-rib. Capsule seated on a thick seta, sub-spherical, thick-walled, with a short indistinct neck, depressed when dry; subdisciform or of a shallow funnel-shape when the operculum is removed. Peristome-teeth 16, equidistant, hygroscopic, rather broad, without any dividing line. Operculum adnate to the columella, apiculate. Calyptra hooded. The only species, *T. carniolicum*, is from calcareous rocks in Carniola.

## Algæ.

**Physiological Anatomy of Algæ.†**—Herr N. Wille has made observations on the elasticity of the tissue of the larger marine algæ, by means of which they are able to resist the traction and other distorting forces of large waves. The faculty of stretching he found to be very considerable in the larger Floridcæ, and still greater in the Laminaricæ, varying from 25 per cent. in *Porphyra vulgaris* to 48 per cent. in *Laminaria flexicaulis*. The "leaves" of seaweeds are almost invariably flexible; while on the other hand, the "stem" may have considerable firmness; and this firmness may be imparted in three different ways, viz.:—(1) by the whole of the interior being occupied by strongly thickened cells, as in *Ahnfeltia plicata;* (2) by incrustation, as in *Corallina officinalis;* (3) by columnar haptera, as in the Laminaricæ, where the walls of the outer cells are more strongly thickened than those of the central cells.

Contrivances to prevent traction are very common. The cell-walls towards the base of the stem are thicker in *Chorda filum*, while this organ itself is stouter in *Polysiphonia*. Rhizines are formed for the same purpose outside the membrane of the mother-plant, consisting of single rows of cells in *Cladophora ophiophila*, of plates of cells in *Monostroma orbiculatum;* or within the mother-plant, of rows of cells in *Cladophora rupestris* and *Bangia*, of plates of cells in *Porphyra*

* Verh. K. K. Zool.-Bot. Gesell. Wien, xxxiv. (1885) pp. 105–6 (1 pl.).

† SB. Bot. Sällsk. Stockholm, Nov. 19, 1884. See Bot. Centralbl., xxi. (1885) pp. 282 and 315.

*vulgaris*. "Hyphæ" for a similar purpose occur in the stem and mid-rib of the leaf in Fucaceæ. Strongly thickened mechanical cells are found in the centre of the organ in *Odonthalia dentata*, or forming a ring round the conducting tissue in *Cystoclonium purpurascens*. The vegetative branches are matted together into a felt-like structure in *Ectocarpus tomentosus*. Finally certain branches develope into a kind of tendril embracing other algæ, as in *Cystoclonium purpurascens* var. *cirrhosa*.

The same purpose is served in other ways by the whole thallus being expanded flat or united into a cushion, mucilaginous in *Calothrix scopulorum*, incrustaceous in *Melobesia*, or enveloped in a mucilaginous envelope in *Nemaleon multifidum*. The stem creeps and is fixed by haptera in *Polysiphonia rhizoides;* or the alga grows up among other more resistant species, by which it is protected, as for example *Ascophyllum bulbosum*.

The assimilating cells are distributed over the surface of the organ; but are sometimes, as in *Chordaria flagelliformis*, arranged in radial rows.

The conducting system consists largely of long and narrow hyphæ, the transverse walls of which are swollen quite after the manner of sieve-tubes and perforated by extremely fine orifices; and these conducting hyphæ are in communication throughout the plant.

**New Epiphytic Floridea.*** — Herr M. Möbius describes a minute epiphytic alga found on preserved specimens of *Centroceras clavulatum* (Ag. MS.) from Western Australia. It occurs on specimens from this locality only, and only on the tetrasporangia, in the form of a large central cell enclosed in a small-celled tissue. In the latter are found not only male and female organs, but also tetraspores, all on different individuals, but closely packed together on the same host. For this epiphyte the author proposes the name *Episporium Centroceratis*. The tetraspores are formed from simple swollen terminal cells, and are dispersed in large numbers among the superficial vegetative cells. They arise by tetrahedral division, and form a body of about 0·016 mm. diameter. The female specimens put out numerous trichogynes, but the development of the carpogenous cells and cystocarps is difficult to follow. The trichogyne is often of considerable length, and is seated on a trichophore composed of two or three smaller cells, which appear to arise from some larger carpogenous cells. The male individuals are densely covered on their surface by minute cells, about ·003 mm. in diameter, the antheridia, which spring singly or in pairs at the apex of a terminal cell of the thallus. While the form of the male and female organs of *Episporium* resembles in its general features that of other Florideæ, the structure of the thallus differs so widely from any hitherto known that it must be regarded as the type of a new section.

**Conjugation of Rhabdonema arcuatum.†**—Mr. T. H. Buffham describes the phenomena noticed in the process of conjugation of

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 77–80 (1 pl.).
† Journ. Quekett Micr. Club, ii. (1885) pp. 131–7 (2 pls.).

*Rhabdonema arcuatum.* The following are the salient features:—(1) The male frustules are the smaller in size, have the more definite arrangement of endochrome, and are the more readily detached. (2) The female frustules have slightly longer valves, more numerous annuli, and have always a wide band near the middle. (3) Conjugation is always polyandrous, and is effected by the male frustules attaching themselves indifferently to any part of the annuli of the female frustule. (4) The result of such conjugation is the production of one sporangial or zygospore-frustule if only the basal half of a female frustule persist; but if both halves persist, each will produce a sporangium—the two sporangia being in close apposition. (5) The sporangial or zygospore-frustule consists of two valves, without annuli, which have a length about thrice that of the valves of the female. With regard to the inducing causes of conjugation, it would appear that self-division, which gradually reduces the size of the bounding valves, has gone on so long that a new generation becomes necessary to maintain the size.

**Sections of Diatoms from the Jutland "Cementstein."***—M. W. Prinz criticizes at some length the opinions expressed in recent papers by MM. Grunow, Deby, Cox, and Flögel, calling in question the results of the researches undertaken by M. Van Ermengem and himself concerning the structure of the valves of diatoms. He also describes from both a geological and a petrological point of view the Jutland "Cementstein," and the mode of occurrence in it of the diatoms as well as their state of preservation, which he maintains is one of absolutely perfect integrity. The question of illusory images and the visibility of the perforations of diatoms in the sections is discussed, with some observations on perforated and imperforated diatoms found in the rock. He also draws attention to a singular imperforate organism which, according to Dr. Van Heurck, is probably not a diatom, though, like certain diatoms, it is composed of two unequal valves fitting into each other.

**Phytophagous Fishes as Disseminators of Algæ.†**—Sig. A. Piccone finds in the digestive organs of *Box Salpa*, portions of as many as eighteen species of seaweed, some of them in a fruiting condition, the spores or conceptacles of which are evacuated with the fæces; and he concludes that this is of great importance in the dissemination of the species concerned.

### Lichenes.

**Formation of Thalli on the Apothecia of Peltidea aphthosa.‡**—Dr. M. Fünfstück describes specimens of this lichen from various localities in which the apothecia, when they had attained a certain stage of development, were covered on their back by small, wrinkled thallus-scales. A transverse section through an apothecium in which these scales had not yet made their appearance, reveals, in the medul-

* Bull. Soc. Belge Micr., xi. (1885) pp. 147–93 (4 pls.).
† Nuov. Giorn. Bot. Ital., xvii. (1885) pp. 150–8.
‡ Ber. Deutsch. Bot. Gesell., ii. (1884) pp. 447–52 (1 pl.).

lary tissue beneath the fructification, scattered groups of gonidia which are larger and of lighter colour than the normal gonidia of the thallus, and which might easily be mistaken for cephalodia. They are, in fact, derived from the normal gonidial layer, and, under favourable conditions, become gradually transformed into the scales in question. They should strictly be regarded as a part of the fructification. In *Peltidea aphthosa* the apothecia have a different origin from that in the nearly related genus *Peltigera*, viz. from immediately beneath the gonidial layer. The endogenous origin of this peculiar thallus-formation can be proved by following it out from the first isolation of the gonidia to their complete differentiation into cortical, gonidial, and medullary layers. No similar formation was observed in *Peltidea venosa*.

### Fungi.

**Thermotropism of the Roots of Æthalium septicum.*** — Dr. J. Wortmann has further investigated this phenomenon, first observed by Stahl, and finds the optimum temperature for its manifestation to lie between 35° and 40° C. With exposure to unequal temperature above 36°, he finds the plasmodia to be negatively, while below this limit they are positively thermotropic; both kinds being thus capable of being induced on the same plasmodium. This phenomenon he compares to that of *Phycomyces*, the fructification of which is negatively, while the mycelium is positively geotropic. The thermotropic phenomena of plasmodia are closely analogous to those of roots.

**Plasmodiophora Alni.**†—Dr. H. Möller has further investigated the peculiar swellings caused by this parasitic fungus (*Schinzia Alni* Wor.) on the roots of the alder, which he finds on almost every specimen examined of both *Alnus glutinosa* and *incana*. The protoplasm of the parasite is imbedded in a sac of the protoplasm of the host, and this protoplasmic envelope is connected by several strings with the parietal protoplasm. The protoplasm of the host remains comparatively unaffected; and hence the small amount of damage done by the parasite. Both in this and other points, the physiological processes present a great resemblance to those of *Plasmodiophora Brassicæ*.

**Nutrition of Trees by means of Underground Fungi.**‡—Herr B. Frank has made the remarkable discovery that the roots of certain trees are unable to derive nutriment directly from the soil, but do this entirely by means of a mass of fungus-hyphæ which entirely invests the root, and to which he gives the name *Mycorhiza*. If the absorbing organs of our native oaks, beeches, hornbeams, chestnuts, or hazels are examined, they are found to consist of a nucleus, the true root, and a cortex organically associated with it in growth, composed entirely of fungus-hyphæ, completely enveloping the whole

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 117–20.
† Ibid., pp. 102–5 (4 figs.). See also pp. 177–8.
‡ Ibid., pp. 128–45 (1 pl.).

of the root, even the growing point. The structure of this latter is that of a sclerotium; it is composed of a dense mass of hyphæ varying in diameter from 0·0024 to 0·01 mm., usually in several layers, from which other endophytic hyphæ penetrate into the root between the epidermal cells, which are still slenderer than those of the envelope. By this structure the formation of root-hairs by the tree is entirely prevented, and it is through it alone that it is able to absorb nutriment out of the soil. It makes its appearance first on the lateral roots of very young seedlings, and is constantly being replaced by fresh formations on older roots.

Dr. Frank found this structure invariably on every root examined on every tree belonging to the Cupuliferæ, also occasionally on Salicaceæ and Coniferæ, but never on woody plants belonging to other natural orders, or on any herbaceous plants. It is quite independent of the nature of the soil, and its specific character has not been determined. He regards the phenomenon as an example of symbiosis comparable in all essential points to that of lichens, the mycorhiza corresponding to the fungal element in the lichen, the tree itself to the algal gonidia.

Dr. M. Woronin * confirms these statements in relation to Coniferæ, Salicineæ, and some other trees. He regards the phenomenon rather as an instance of parasitism than of symbiosis, and thinks it probable that the parasitic fungus is a *Boletus*. He claims the priority of this observation for F. Kamienski.

**Composition and Spore-cultivation of Merulius lacrymans.**†—Prof. Poleck has investigated the mode of operation of the mycelium of this fungus, which, known as dry-rot, is so destructive to timber, especially that of Conifers. The proportion of water varies from 48 to 68·4 per cent. The amount of ash is large, varying from 6·33 to 9·66 per cent. The composition of this ash varies within rather wide limits; but there was always found a large proportion of phosphates. As an average it may be stated that of the dry weight about 4·9 per cent. is nitrogen, and 13 per cent. oil; there are also several acids and traces of an alkaloid. The author states that the action of the mycelium on the wood consists in removing its mineral constituents, thus destroying its solidity, and rendering it liable to the attacks of other agents. The richer the wood in phosphoric acid and salts of potash, the more energetically is it liable to be attacked by the fungus. When once desiccated the mycelium has no power of resuscitation. Mycelial filaments have been measured from 5 to 6 metres in length.

Prof. Poleck has been the first to succeed in inducing the spores of *Merulius lacrymans* to germinate on their natural substratum, and to follow out their development, which is described in detail.

**Germination of the Spores of Merulius lacrymans.**‡—Prof. R. Hartig has been able to effect this in gelatin moistened with the

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 205–6.

† Bot. Centralbl., xxii. (1885) pp. 151–6, 182–6, 213–7 (2 figs.).

‡ SB. Bot. Ver. München, Dec. 10, 1884. See Bot. Centralbl., xxi. (1885) p. 155.

juice of fruit with addition of urine or of ammonia and potassium carbonate. He notes also the absorption of the mineral constituents of the walls of the wood-cells when in immediate contact with the hyphæ of the fungus, while the organic constituents are dissolved only by the ferment excreted.

**New Chytridiaceæ.***—Since publishing his monograph of the Chytridiaceæ,† Dr. C. Fisch has observed two new forms, one of which deviates in several particulars from the typical structure of *Chytridium*. It was found as a parasite on *Mesocarpus*, in the form of small flask-shaped brownish receptacles, in length about half the diameter of the *Mesocarpus*-filament. These are zoosporangia, with brownish thick wall, not coloured by iodine. From the point of attachment to the host proceeds an extremely fine mycelial filament, which penetrates the *Mesocarpus*-cell, usually only reaching about its centre. The contents of the zoosporangium consist of rather coarse-grained protoplasm, in which no nucleus was detected. The formation of the zoospores is preceded by various changes in this protoplasm. The zoospores are rarely more than eight in number, and agree in their structure with those of *Reessia*. They are rather large, composed of finely granular protoplasm, imbedded in which is an evident nucleus or nuclear structure. A single cilium springs from the somewhat narrower anterior end. These zoospores move about rapidly in the sporangium before the latter suddenly bursts by the separation of a circular lid. After moving about rapidly for a considerable time in the water, a pair of zoospores approach one another by their ciliated ends, and coalesce completely. The resulting zygote contains at first two nuclei, which soon coalesce into one. It then surrounds itself with a cell-wall, and attaches itself to a *Mesocarpus*-filament. By means of a small appendage which pierces the wall of the host-cell, the zygote empties its contents into the latter, and rapidly grows to a large cell with membrane in two layers, the typical resting-spore of *Chytridium*. These germinate after a short period of repose, and again produce zoospores.

The second new species is a *Reessia*, near to *R. amœboides*, and parasitic on a large *Cladophora*.

The three genera *Reessia*, *Chytridium*, *Rhizidium*, present a series in which the first species here described, perhaps the type of a new genus, presents a connecting link. It is a typical *Euchytridium*, in which the sexual function has not been lost. In the form and behaviour of the zoospores it is closely allied to *Reessia*; while in the structure and germination of the resting-spores, and in the development of the zoosporangium and of the mycelial appendage, it is a typical *Chytridium*.

**Nowakowskia, a new Genus of Chytridiaceæ.**‡ — Sig. A. Borzì finds a parasitic fungus on *Hormotheca*, a new genus of algæ, in such

* SB. Phys.-med. Soc. Erlangen, xvi. (1884) p. 101 *et seq.* See Bot. Centralbl., xxi. (1885) p. 167.

† See this Journal, iv. (1884) p. 938.

‡ Bot. Centralbl., xxii. (1885) pp. 23-6 (1 pl.).

quantities as completely to destroy it, and proposes for it the name *Nowakowskia Hormothecæ*. It lives on the germinating zoospores of its host, the contents of which it appropriates by means of very slender rhizoid-like appendages, usually 3–5 in number, attached to its periphery. It grows free in the surrounding medium in the form of a small ball of greyish protoplasm, inclosed in a delicate membrane which is coloured blue by tincture of iodine. The protoplasm is of a very finely granular structure, is stained yellow by picric acid, and contains minute strongly refractive corpuscles. The size of these bodies varies considerably, from 4 to 6 $\mu$. The rhizoid-like appendages are extremely delicate, and only visible under a high power, and appear to be composed of dense, homogeneous, strongly refractive protoplasm, extremely receptive to pigments, without, as far as could be detected, any membrane.

The development of *Nowakowskia* is extremely simple, and closely resembles that of *Polyphagus Euglenæ*. After absorbing a sufficient amount of food-material by means of its appendages, and attaining its full size, it transforms itself directly and completely into a zoosporangium; the zoospores being formed by the appearance of a number of shining spherical particles, round which the whole of the protoplasm collects and breaks up into as many minute portions. As soon as the zoospores begin to be formed, the wall of the zoosporangium begins to be absorbed and become indistinguishable, finally disappearing altogether, and the mass of zoospores then swarms in the fluid, without the individuals at first separating from one another, the motion resembling that of a colony of *Volvox*. The zoospores, which do not exceed 1 $\mu$ in their longest diameter, finally separate; their form is then somewhat hourglass-shaped, rounded at both ends and somewhat constricted in the middle. In the anterior end, which terminates in a single very long and extremely slender cilium, is a drop of oil. After moving about very actively for a few minutes, the zoospores come to rest. They germinate free in the water, and only reach their host by putting out in its direction the very fine rhizoid-like appendages. The entire transformation into a zoosporangium occupies from four to six hours. No sexual reproduction could be detected with certainty.

Borzì considers *Nowakowskia* as most nearly related to *Obelidium* and *Rhizidium* on the one hand, to *Polyphagus* on the other hand.

**New Fungus-parasite on the Rose.***—Herr J. Eriksson describes a disease to which *Rosa rubrifolia* is subject in the neighbourhood of Stockholm, due to the æcidial form of *Phragmidium subcorticum*, which attacks the leaves, leaf-stalks, and flower-stalks of both first and second year's shoots. The mycelium appears to hibernate in the stem.

**Mycological Monstrosities.†**—M. E. Heckel describes two cases of monstrosity in fungi. In the first case, a specimen of *Lactarius deliciosus*, the margin of the pileus was non-adherent to the stem at

* SB. Bot. Sallsk. Stockholm, Sept. 27, 1884. See Bot. Centralbl., xxi. (1885) p. 221.

† Comptes Rendus, xcix. (1884) pp. 1088–90.

only one point of the periphery; throughout the rest of its circumference it formed one substance with the stem.

The normal hymenial lamellæ were entirely suppressed, while the hyphæ of the pileus bore the lamellæ united into a compact mass by their free margins and by several points of their parallel faces; thus leaving between them free spaces, few in number, in which the terminations of the hyphæ were crowned by perfectly normal spores. The cavities being closed-in, dissemination of the spores was absolutely impossible.

The second instance was *Polyporus betulinus*. Composed of two parts dissimilar in appearance and specifically distinct, although juxtaposed on the same plane and united at their margins, the monstrosity is formed by a single pileus whose substance has been constricted at one point. Whilst the second part is perfectly normal, the first presents a singular teratological alteration. Both the surfaces are covered with spores. On the upper surface the tubes are long and inclined, with denticulated and torn edges. On the lower surface, they are vertical and short; both bear normal spores. The former disposition of the tubes evidently has for its object a more efficacious protection of the spores which are more exposed to exterior agencies. This monstrosity is of double interest: first, it testifies to the experimental value of researches into the abnormal formation of spores; second, it shows that fungi, even of the higher orders, are endowed with great plasticity of form, receiving promptly the impression of the plexus of surrounding forces.

**Some Remarkable Moulds.*** — Dr. M. C. Cooke gives full descriptions of some remarkable moulds, brief diagnoses of which have been previously published,† viz.:—*Basidiella sphærocarpa* Cooke; *Sterigmatocystis ferruginea* Cooke, and *Aspergillus nigricans* Cooke. He also describes *Polyactis deprædans* Cooke MS., that grows on the leaves of *Acer pseudo-platanus*, and *Polyactis truncata* Cooke,‡ likewise previously described.

**Pneumonomycosis of Birds.**§—Hearing that near Berlin many geese were dying of a disease the duration of which was short and the cause unknown, Dr. Schütz requested the owner of the birds to send a body for examination. This disclosed a pneumonomycosis. Its specific nature was determined by breeding at temperature of 30° C. on bread-paste. The usual precautions were taken, and in 24 hours a layer of *Aspergillus fumigatus* was formed. In the subsequent inoculation process it had to be borne in mind that at the post-mortem examination the crop was found to be in direct communication with a cavity in the right lung, hence the original infection focus could only be determined by experiment. The fungi were bred in agar-agar and in bread-paste at a temperature of 30°. The usual sterilizing precautions were taken, and in four days a luxuriant fungous growth

* Journ. Quekett Micr. Club, ii. (1885) pp. 138–43 (2 pls.).
† Grevillea, vi. pp. 118 and 127, viii. p. 95.
‡ Bommer's 'Champignons de Bruxelles,' p. 137.
§ MT. Reichsgesundheitsamte, ii. (1884) p. 208.

appeared. The fungi thus obtained were mixed with (*a*) soft bread and with (*b*) dry oats. The bread was given to pigeons, the oats to geese. The pigeons were fed by stuffing a piece of the bread mixed with fungus down their throats for six consecutive days. The geese were allowed to dispose of as many infected oats as they pleased. The first goose died on the sixteenth day, and as no result was evident on post-mortem examination, recourse was had to infection by inhalation. The *Aspergillus fumigatus* grown in the flasks was dried under a bell-jar and then placed in a glass vessel inside which a pigeon could stand easily. The glass jar was shaken several times in order to raise a cloud of the fungi. The pigeon died on the third day. From the diseased parts of the lungs of this pigeon bread-paste was inoculated and *Aspergillus fumigatus* appeared. The remaining parts of the lungs were hardened, and on microscopical examination an extraordinary quantity of the fungus was found. In further experiments only a few spores were introduced into the glass jar and the pigeon was only allowed to remain five minutes. Under these conditions the animal did not die so soon, and the fungi spread from the lungs to other organs. Exactly the same results ensued when small birds were used. *Aspergillus niger* gave similar results. *A. glaucus* only acted as a foreign body in the lung.

## Protophyta.

**Ferments.***—Dr. E. C. Hansen publishes a few further observations on the development of *Saccharomyces*.

Under certain conditions structures arise consisting of a gelatinous network in the spaces of which the *Saccharomyces*-cells are found; but they are sometimes taken up into the network itself, which is not coloured blue by iodine. This occurs not only in both forms of *S. cerevisiæ*, but also in species belonging to the groups *Pastorianus* and *ellipsoideus*. The yeast used for the observation of this structure was obtained from pure cultures in sterilized nutrient solutions, beer-wort, or a mixture of saccharose and yeast-water; but it occurs also in practice in breweries.

When the spores in a *Saccharomyces*-cell are preparing for germination, they swell up strongly. In certain species, when cultivated on blocks of gypsum, structures arise which present the appearance of septa. These are caused by the pressure which the swollen spores exercise on one another; the walls being brought into close combination with one another at the surfaces of contact.

*S. apiculatus*, although a ferment of alcoholic fermentation, is destitute of invertin, and cannot therefore ferment saccharose. Its ordinary habitat in summer is ripe fruits, and it is the only ferment that is found in nature. It appears to perish in less than twenty-four hours when removed from its nutrient substratum.

**Microphytes of Normal Human Epidermis.**†—Prof. G. Bizzozero describes various methods for observing the microphytes of the human

* Bot. Centralbl., xxi. (1885) pp. 181–4.

† Arch. Ital. de Biol., vi. (1884) pp. 194–206 (1 pl.).

epidermis, and gives an illustrated account of such parasites as he has observed. The parts of the body covered with hair are the most favourable localities for the growth of these organisms, of which three different kinds were noted. (1) Round cells, composed of a thick membrane, enclosing a homogeneous non-nucleated mass, which closely resembles a *Saccharomyces*, and may be termed *S. sphærica*. (2) Oval cells, smaller and paler than the preceding, which are named *S. ovalis*. (3) *Micrococci* and *Bacteria;* these latter abound in all parts of the body, and characteristic forms are found in different regions, being associated with local pathological conditions.

**Systematic Position of the Bacteria.***—In a review of recent works on Bacteria, Dr. C. Fisch shows that the assignment of the Schizomycetes to the Fungi does not rest on a sound morphological basis, the physiological resemblance in the absence of chlorophyll not being sufficient of itself to show a genetic affinity. The history of development furnishes conclusive evidence against the Schizomycetes being connected with the Fungi phylogenetically, either as an early form of development or as the result of retrogression. The nearest affinity of the Bacteria lies unquestionably with certain green organisms, *Nostoc*, *Oscillaria*, &c., included under the Schizophyceæ or Cyanophyceæ; and these form together a natural group of Schizophyta, with no close affinity to any group of Fungi. According to our present state of knowledge the Schizophyta must be regarded as displaying the nearest genetic affinity with the Flagellata.

**Influence of Oxygen on Fermentation by Schizomycetes.**†—Herr E. Buchner has experimented on the effect produced by free oxygen on the energy of the fermentation caused by the so-called "glycerin-ethyl-bacterium," *Bacterium Fitz*, distinguished by its very energetic fermentation of glycerin, chiefly into ethyl-alcohol, together with volatile and stable acids, carbon dioxide, and hydrogen. Three cultures of this ferment were prepared, one of which was retained as a control experiment, while through the other two streams of oxygen and hydrogen respectively were passed. After twenty-nine hours the fluid through which the oxygen had been passed was considerably more turbid than the two others. Microscopical examination showed the following results. The multiplication of *Bacterium Fitz* is promoted to an extraordinary degree by the presence of free oxygen. In cultures of the same extent and in the same time, the quantity of glycerin fermented is increased. Whether oxygen or hydrogen is passed through the culture, the formation of carbon dioxide given off remains nearly the same in proportion to the amount of glycerin fermented. The fermenting power of the individual Schizomycete is diminished by the presence of free oxygen.

**Cholera Bacillus.**—Mr. W. W. Cheyne gives‡ the results of his investigations at Paris during the epidemic of cholera, and afterwards

* Biol. Centralbl., v. (1885) pp. 97–102.

† SB. Bot. Ver. München, Jan. 14, 1885. See Bot. Centralbl., xxi. (1885) pp. 348 and 385.

‡ Brit. Med. Journ., 1885, April 25–May 23.

at his own laboratory. His conclusions are, that the comma bacillus was present, and generally in large numbers, in all the cases of cholera which were examined; that he has never met with the comma bacillus except in cholera, and that the other curved bacilli described (Finkler and Prior's, Lewis's, and Denike's or Flügge's), differ from it in important particulars.

Mr. Cheyne also combats Klein's arguments against the specific nature of the comma bacillus.

Dr. E. Van Ermengem has also published an elaborate report * to the Belgian Minister of the Interior, which is the most exhaustive that has yet appeared. He supports Koch's assertions.

**Etiology of Tuberculosis.**†—Dr. R. Koch sums up the results on this subject obtained by himself and others, adding some new observations.

The best mode of detecting the bacillus of tuberculosis is by the staining reaction with anilin according to the methods of Ehrlich and Rindfleisch. There is no other kind of bacterium with which it agrees in this respect except the lepra-bacilli, and from them it is distinguished by not taking up Weigert's nuclear-staining. The variability in the behaviour of this bacillus with staining reagents Dr. Koch believes to result from its being surrounded by a very thin envelope.

The separate individuals of the bacillus of tuberculosis are long very narrow rods, with no segmentation of any kind, but often with slight angles and curvings, and a tendency to spiral twisting, by which they are distinguished from many other bacilli otherwise resembling them in form, such as those of the septicæmia of mice.

They occur within the cells of the tubercular nodules; only in small numbers in the cheesy substance. The formation of spores is very frequent. When spores are about to be formed, the bacillus does not break up into separate segments, but from two to six ovate spores are formed in each, distinguished by their high refractive power.

Dr. Koch found the bacillus in the bodies after death of patients who had suffered from every kind of tubercular disease; and in especially large numbers in the sputum, where the formation of spores is particularly abundant, and where it retains its vitality for an extraordinary period. It occurs also in the excreta both of men and animals suffering from tubercular disease.

The culture of the bacillus of tuberculosis was carried out successfully on the solidified serum of the blood of oxen at a temperature of 37° C. The following are mentioned as special characters under cultivation:—(1) It does not cause the serum to deliquesce; (2) it spreads itself over the surface, lying loose upon it; (3) the individuals attach themselves to one another in large masses, which fall to the

* Ermengem, E. van, 'Recherches sur le Microbe du Choléra Asiatique,' Mém. Soc. Belge Micr., x. (1884) pp. 1–342 (13 pls.).

† MT. K. Reichsgesundheitsamte, Berlin, ii. (1884) pp. 1–88 (10 pls.). See Bot. Centralbl., xxi. (1885) p. 235. Cf. this Journal, ii. (1882) p. 385; iv. (1884) p. 787.

bottom; (4) the nutrient fluid always remains clear; (5) under low powers the young culture appears S-shaped and strongly swollen in the middle. It grows on all kinds of serum, but not on the white of egg.

Dr. Koch regards the bacillus of tuberculosis as a true parasite, in contrast to other pathogenous bacteria. It goes through its whole course of development, up to the production of spores within the body. He believes it has no genetic connection with any other form of bacterium.

**Development and Pathogenous Properties of a Bacterium.***—Herr G. Hauser describes a pathogenous bacterium obtained from the putrefaction of a calf's heart at 30° C. under ordinary conditions. An infusion after eight days showed a great quantity of bacteria, which, however, when cultivated in the ordinary way, did not exhibit any great power of causing deliquescence of the substratum. After exposure for another eight days to the ordinary temperature of a room there appeared in the infusion a bacterium which grew with extraordinary rapidity, causing rapid deliquescence of the gelatin on which it was cultivated.

After cultivation on gelatin for twelve hours, a great quantity of small oval bacteria were to be seen floating on the substratum, often linked together in pairs; the whole of the rest of the surface being completely covered by colonies of irregular form consisting of a single layer of well-developed rods and short filaments. These colonies were in continual rapid motion, some of the rods constantly leaving them in the form of an elongated well-defined group, which glided rapidly over the free surface of the gelatin, then joining with others or with another colony. Each of these groups consists of from three to five parallel rows of spindle-shaped rods. Their movements are very peculiar, resembling those of individual bacteria, and are in no way due to motions in the substratum. Other groups again did not become separated, but reunited themselves with the colony from which they had partially detached themselves.

The deliquescence of the gelatin by these bacteria took place very rapidly, being completed in from twelve to twenty-four hours, with the formation of a whitish sediment. In this condition it contained a number of minute bacteria endowed with a dancing movement, and closely resembling *Bacterium Termo*. When cultivated on gelatin, these developed gradually from shorter to longer rods and filaments, which swarmed over the entire surface of the nutrient gelatin, causing it to deliquesce. From these swarming colonies were developed longer filaments endowed with rapid motion, which gradually divided into shorter elements, and finally came to rest, passing then into an hour-glass-like form, from which were developed the peculiar colonies already described.

This peculiar bacterium causes very rapid decomposition in the flesh of animals, accompanied by the development of stinking gases; the products of decomposition appearing to have poisonous properties.

* SB. Phys.-med. Soc. Erlangen, 1884, pp. 156–71. See Biol. Centralbl., v. (1885) p. 36.

**Cornil and Babes' "Bacteria."***—With the object of presenting all the researches upon the bacteria in their proper light, the authors have produced a profusely illustrated book, containing all that is known in regard to Bacteria at the present time. The work begins with an introduction to the study of the pathogenic Bacteria, and a rapid summary of the beginning and progress of discovery in this direction is given. This is of special value to the student because of the copious references to original monographs that are made. The development of the Microscope for work of this kind, the discussions as to the specific nature of infectious disease, and the criticisms which bacteriology has undergone, are reviewed, and this is followed by the first part of the book proper. This is devoted to a consideration of the Schizomycetes in general. The various forms of the organisms are given and illustrated, and their methods of growth are treated at length. A full account of all the instruments and materials necessary for work in the observation of Bacteria, with the methods of employment, renders this part of the subject plain, while the discussion of the anilin colours conveys information not easy for the student to obtain elsewhere. The methods of culture are given in full.

The classifications of Cohn, Van Tieghem, and Rabenhorst are spoken of as the latest and best; and a complete list of all the pathogenic Bacteria, with their main characteristics, follows. The bone of contention, "the attenuation of virus," finds a place, and the various organisms with which experiments approaching success have been made are allowed to tell their story. Then the lesions occurring with the presence of pathogenic Bacteria occupy the authors' attention; and the modes of entrance, and disturbances of circulation and nutrition produced by them, are all placed before the reader in the plainest way. A discussion of the "experimental maladies" of Koch and others closes the first part of the work, which is followed by a complete bibliography of the important works upon Bacteria in general.

The second portion of the book is devoted to the special infectious diseases. Beginning with chicken-cholera and ending with leprosy, the results of all the investigations upon any disease suspected to be due to a micro-organism are dealt with in the most impartial manner. This includes not only the diseases of man, but also those of animals concerning which any evidence of their bacterial origin has been offered.†

* Cornil, A. V., and Babes, V., "Les Bactéries et leur rôle dans l'anatomie, et l'histologie pathologique des maladies infectieuses,' viii. and 696 pp., 27 pls. and figs., 8vo, Paris, 1885.

† Cf. Science, vi. (1885) pp. 77-8.

## MICROSCOPY.

### a. Instruments, Accessories, &c.*

**Deby's Twin Microscope.** — Mr. J. Deby, C.E., sends us the following description of a new selecting and mounting Microscope devised by him:—

"Being myself in the position of many other lovers of the Microscope in regard to the few occasional hours I can find time to spare for its enjoyable employment, I hope I may be rendering a service to some of my fellow-workers by publishing the description of a labour-saving selecting and mounting instrument which I recently designed for the purpose of making the most of my time, and which has been most carefully constructed for me by Messrs. Beck.

The Microscope, which I propose to call the "Twin Microscope," consists of the following parts (fig. 180):—

1. Two independent parallel tubes attached to the same stage; the axis of each of the tubes corresponding to the centre of one of the eyes of the observer. Each tube has its independent rack motion by a milled head.

2. Two mirrors, one for each tube, with swinging bars and usual motions.

3. A fixed stage of large size, with necessary clamps for holding two parallel glass slides, one under each of the tubes.

4. A movable substage, placed immediately below the upper stage, having a considerable range of rectangular mechanical motions by means of two milled heads.

5. A mechanical finger attached anteriorly to the movable substage. This finger is provided with universal motions by a ball-and-socket arrangement. It is suited for carrying a bristle-holder, needle-holder, or small scalpel. A small milled head permits of the rotation of these holders independently of the ball and socket which holds them.

6. Eye-pieces and objectives, either similar or dissimilar, for both the tubes.

The directions for the use of the instrument may be summed up as follows:—

*a.* Clamp a slide with the material to be operated upon under one of the tubes, and clamp another clean slide under the other tube.

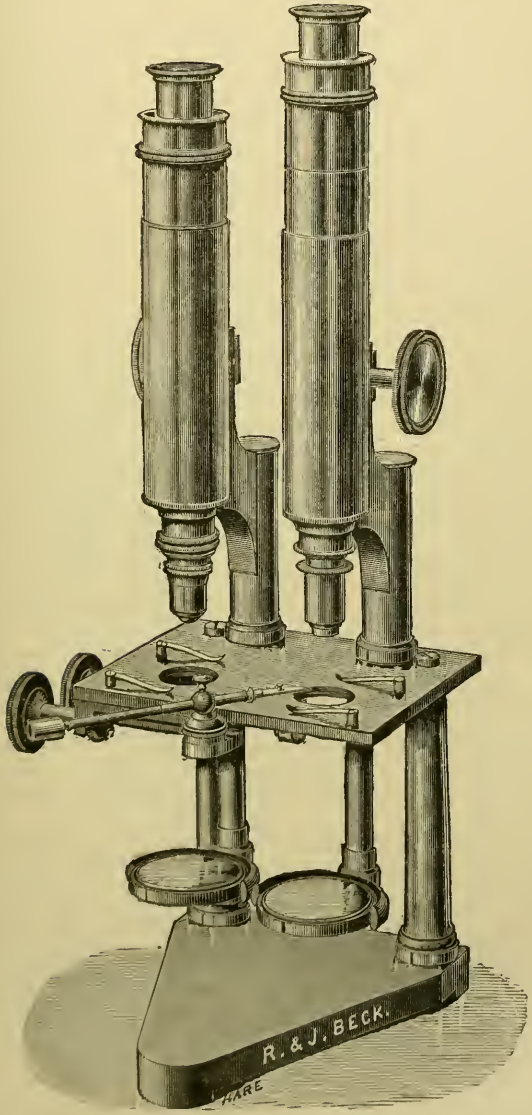
*b.* Dissect or pick-up the desired object from slide No. 1 by using one eye only, that over tube No. 1.

*c.* Close this eye and open the other, looking down the tube No. 2.

*d.* Swing the object rapidly round by means of the mechanical finger till it appears under the other eye.

* This subdivision is arranged in the following order:—(1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories: (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

Fig. 180.




Deby's Twin Microscope.

*e.* Lower the object till it nearly touches the slide, and by means of the mechanical motions of the substage place it exactly where it is wanted, when a slight touch at the lever-end of the bristle-holder will deposit it permanently.

*d.* Return the point of the bristle-holder to the first slide, and recommence the above operations as long as may be desired.

Objects may be searched for and selected under a low power, such as a 1 in., a 1/2 in., or a 2/3 in., and if very small may be deposited under the other tube under a 4/10 in., a 1/4 in., or a 1/5 in. Those who cannot use their eyes alternately, may shift one eye from one tube to the other with insignificant loss of time.

The principal advantages of the instrument consist in the rapidity with which it becomes possible to pick up and put down small objects, and in the great precision of the manipulations. By employing duplicate slides of a same material, one being placed under each of the tubes, it becomes easy to use the Microscope for comparative observations in polariscopy and spectroscopy by adapting the micro-polariscope or the micro-spectroscope to one tube alone, leaving the other to be used as an ordinary monocular Microscope. Many comparative and biological researches may also be conducted under the Microscope without the need of the frequent changes of lenses and shifting of the slides so irksome in many cases to the working naturalist.

For the dissection of minute animals or plants, for histological researches in general, in the hunt for nematodes or other minute forms of life, for the picking-up of desmids, diatoms, protophytes, &c., and for the grouping of these objects easily, rapidly, safely, and elegantly, I believe that the twin Microscope remains as yet unrivalled.

I sincerely hope that others may derive as much satisfaction from the use of the instrument as I have myself, and that it may lead to increased results both in useful and in beautiful work."

**Klein's Mineralogical and Petrological Microscopes.***—Prof. C. Klein in the instrument shown in fig. 181, has combined all the most valuable of the recent suggestions for this class of Microscope.

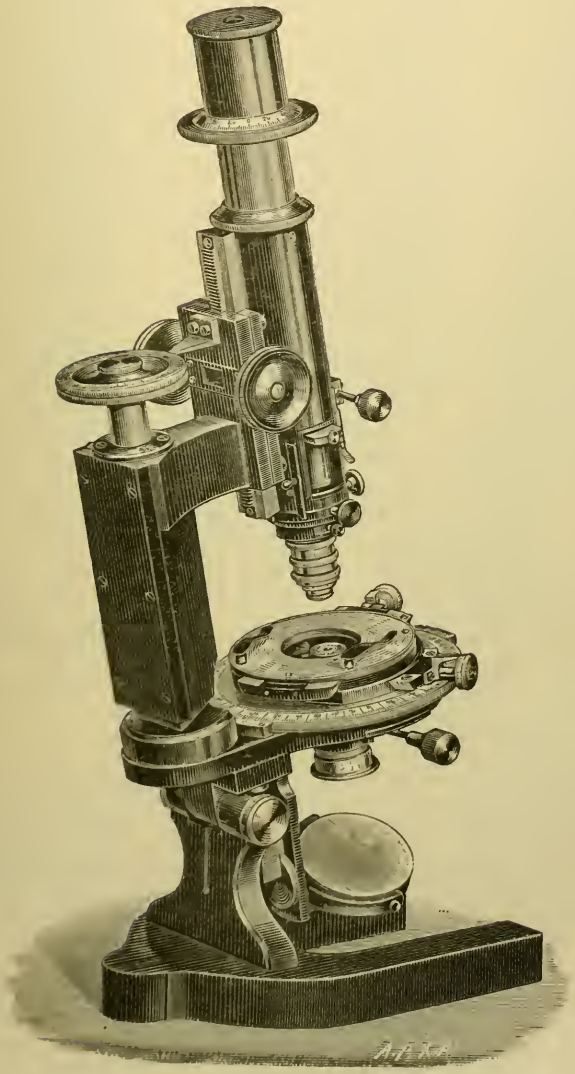
The body-tube has the arrangement of M. Bertrand's stand† for introducing above the objective a quartz plate, a quarter undulation plate, a Nicol prism, Bertrand lens, &c. The objective can be centered by two screws at the nose-piece. The stand can be inclined, and has both coarse and fine adjustments, the latter reading to 1/500 mm. The graduated stage can be moved in rectangular directions, and the amount of movement read to 1/100 mm. It can be rotated by rack-work or by the hand. The polarizer fits in a tube beneath the stage, and can be adjusted by rack and pinion.

Two smaller forms are shown in figs. 182 and 183.

* Nachr. K. Gesell. Wiss. Göttingen, 1884, pp. 436–43. The Microscopes are made by Messrs. Voigt and Hochgesang, of Göttingen.

† See this Journal, iii. (1883) p. 413.

Fig. 181.



Klein's Mineralogical and Petrological Microscope.

Fig. 182.

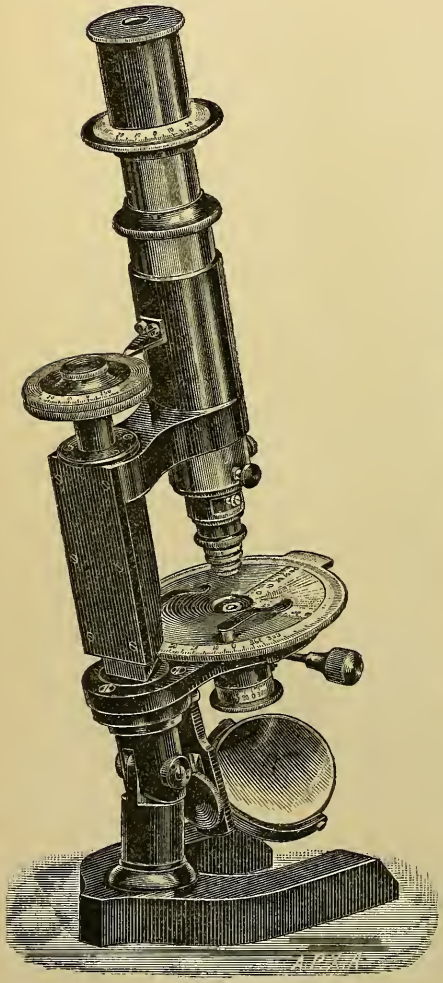
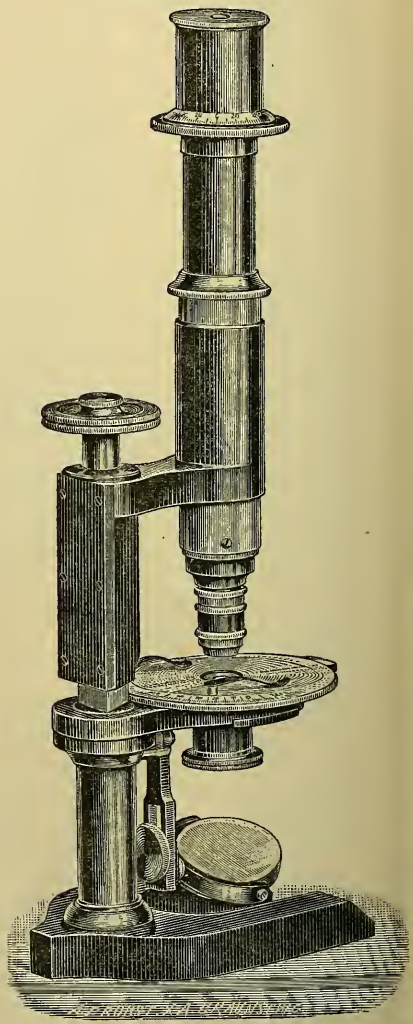
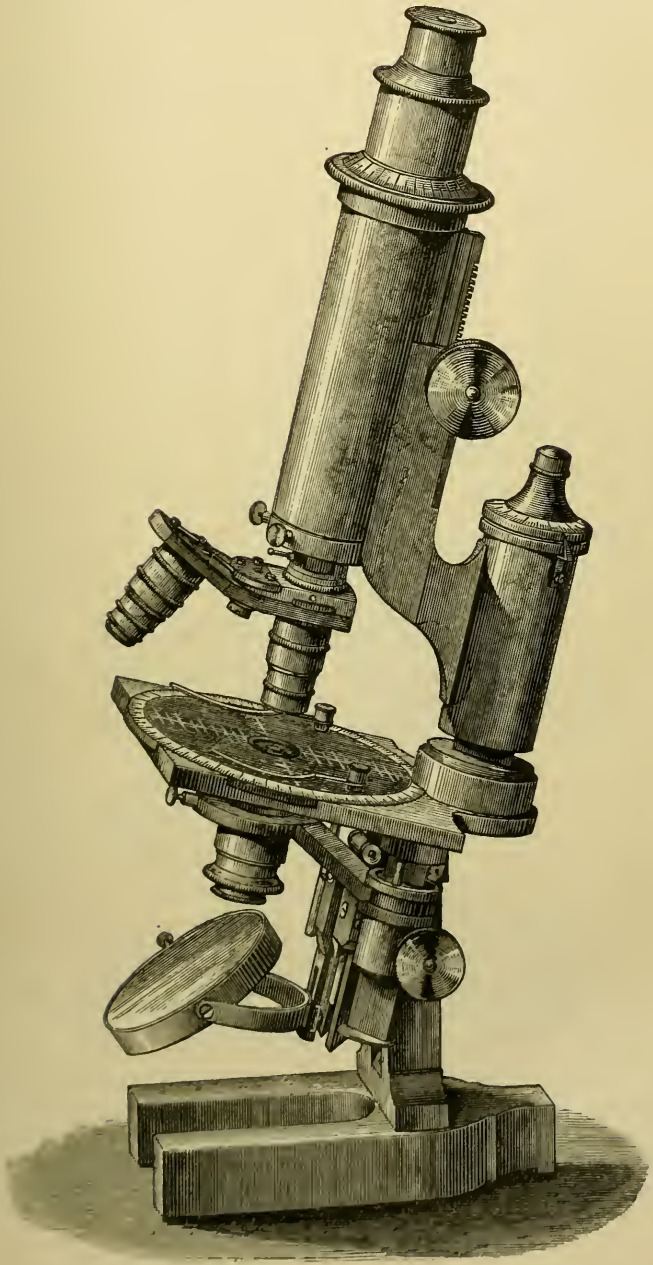


Fig. 183.



**Reichert's Mineralogical-Geological Microscope.**—This, fig. 184, in its general features resembles some of the forms already recorded, especially that of Dr. Zeiss. It differs from the latter, however, in the mode in which the quartz plate is inserted above the objective, and in the two millimetre graduations of the stage intersecting in the centre at right angles. The polarizer is on a movable arm so that it can be rapidly turned away. Each 90° of rotation of the analyser is marked by a spring catch.

Fig. 184.

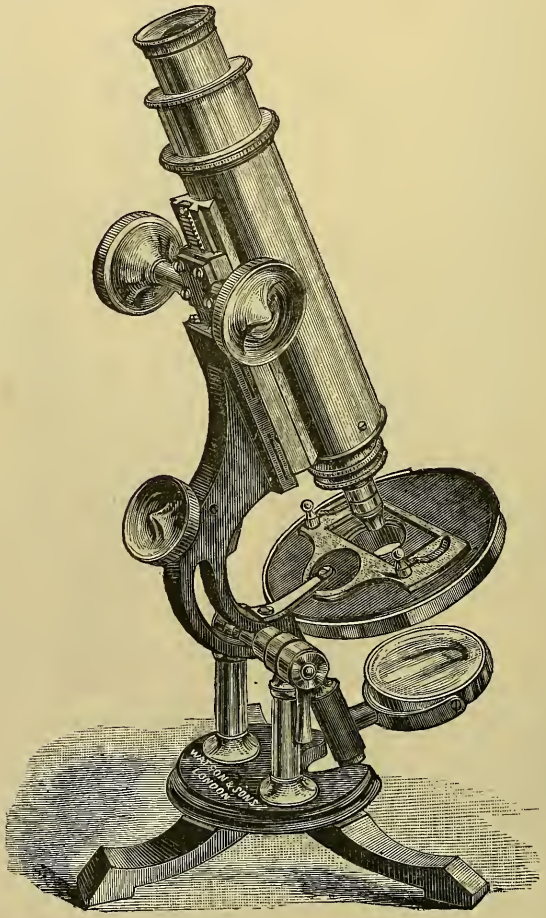


Reichert's Mineralogical-Geological Microscope.

**Watson-Wale Microscope.**—Fig. 185 shows a modification of G. Wale's "Working Microscope," * devised by Messrs. Watson and Sons.

Instead of the limb sliding between jaws, as in the original form, the new instrument has a slot cut through the limb, which slides on

Fig. 185.




the axis of inclination, a clamp-screw fixing it at the required position. The limb may also revolve on the inclining axis without sliding upward or downward, but in this case the instrument is less stable.

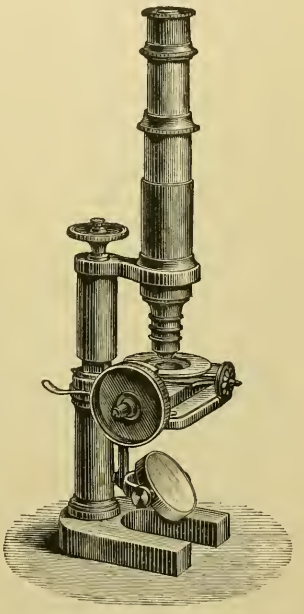
The "Zentmayer" system of fine adjustment is applied. The stage rotates completely and has a glass surface on which Tighl-

* See this Journal, iii. (1880) p. 1045.

mann's friction-stage works, and a rotating disk of diaphragms is fitted within the thickness of the stage. A substage-tube is applied beneath by means of a horizontal bayonet-joint.

**Schieck's Microscope with Screw Stage-Micrometer.**—The micrometer attached to this instrument (fig. 186) differs somewhat from English models in having a rotating plate* for the object, and a second movement from back to front, actuated by a screw at right angles to the motion of the micrometer-screw. The position of the object to be measured can thus be readily centered when the Microscope has no mechanical movements to the stage. The micrometer-screw registers 1/5 mm. to each revolution of the drum-head, the whole turns being read on an engraved scale on the edge of the moving plate, whilst the drum-head is graduated in 100 divisions, and by means of a fixed vernier tenths of these divisions can be read. (In the fig. one of the clips is shown turned back away from the stage.)

Fig. 186.



**Microtome-Microscope.**† — "Mr. "C. P. Hart described [to the Section "of Histology and Microscopy of the "American Association for the Ad- "vancement of Science] a clever "manner of making a Microscope into "a microtome, by using the tube to "carry the imbedded object, and the "movable stage to carry the razor; the object to be cut is moved by "the fine adjustment."

**Dubosc**q**'s Projection Microscope.**‡—MM. T. and A. Dubosc**q** describe their apparatus as follows: —

"This apparatus consists of a system of lenses, or condenser, to converge the illuminating rays and cause them to pass through an achromatic objective serving to project the images on a screen.

The novelty of our apparatus consists in the addition which we have made to the condenser for the projection of microscopic objects. There is a stage furnished with a lens which shortens the focus of the condenser and concentrates the greatest amount of light on the object.

* Zeiss's stage-micrometer (see this Journal, iii. (1883) p. 573) has a rotating plate, and we have seen a similar arrangement to the above on a Microscope constructed forty years ago by Plössl; we are informed, however, that the plan was originally devised by Schieck.

† Science, vi. (1885) p. 228.

‡ Comptes Rendus, ci. (1885) pp. 476–7.

Hitherto, projection Microscopes have given a relatively large magnifying power, but with a definition insufficient for the wants of science. This arises from the quality of the objectives which are employed, and also from the way in which the illumination is obtained. We have recognized that according to the dimensions of the microscopic objects to be projected and the magnification desired, it is necessary to vary the form of the convergent pencil which illuminates the object, consequently the focus of the additional lens must be modified. The apparatus is therefore provided with lenses of different foci to be used with the condenser, according to circumstances.

We have, morever, arranged to employ the objectives used for ordinary Microscopes. Thanks to these and to the perfection of our condensing system we are able to project microscopic objects with high powers and with a clearness as perfect as that obtained with the ordinary Microscope."

Polarizing prisms can be used, also a rotating stage, so that sections of rocks and crystals can be projected.

**"Twin" Simple Microscope.**—Fig. 187 shows a peculiar arrangement of two simple Microscopes mounted side by side on one plate. One of them is fitted with a power of about 1 in., and the other about 1/4 inch, and both have Lieberkühns. The object is held by forceps pivoted beneath the lens-carrier, so that it can be readily examined by either power without having to alter the lenses, as is ordinarily the case.

FIG. 187.

The instrument must have been made a considerable time, for we have seen an exactly similar one in the "Cabinet de Physique" of the University of Louvain, where we were informed it had been for upwards of 30 years. The workmanship suggests a French origin.

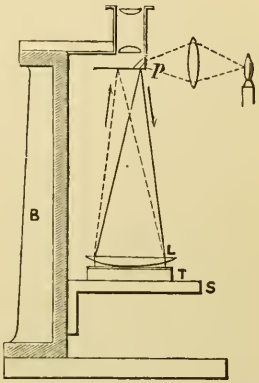
**Laurent's Apparatus for registering the Curvature and Refraction of Lenses.***—M. L. Laurent's apparatus consists of a vertical frame B (fig. 188), in which slides a rectangular carrier S controlled by a chain; the position of the carrier is shown by a vernier, and the lenses to be tested are placed on a plate rotating horizontally on the carrier. On the top of the frame is an eye-piece having a diaphragm (shown in front view at D, fig. 189) divided in two parts: the right half is covered by an illuminating prism; its horizontal face is silvered, and squares are ruled on the silver, which are viewed either by refraction or reflection; the image of the squares is seen in the plane of the diaphragm.

A plane plate of glass T is put on the carrier S, and the vernier is adjusted to zero at the point $p$ where the plane is seen to touch the squares. The lens L is placed on the plane; the light emerging

* Comptes Rendus, c. (1885) pp. 903–5 (4 figs.).

from the squares traverses the lens, is reflected on the plane and directed upwards again and focused in the plane of the diaphragm. The carrier is moved until the image is seen sharp in the eye-piece, and the focal plane of the lens L coincides with the plane of the diaphragm; the reading of the vernier is taken, allowance being made for the shape of the lens, its thickness, &c.

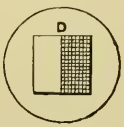
Fig. 188.




The image, consisting of luminous lines on a black ground, is easily seen; the light traverses the lens twice, and doubles its defects. The focus is very precise, so that by covering up portions with small screens, the variations in the curves can be estimated by the differences in their acuteness, and the sharpness will indicate the quality of the lens tested.

White or monochromatic light is used for illumination. Reflected light enables each surface to be tested separately, while the estimation of the combination of surfaces and media is effected by means of the refracted image.

Fig. 189.




Instructions are also given for using the apparatus for concave mirrors, diverging lenses, convex surfaces, spheres and cylindrical surfaces.

The author claims that the apparatus is an accurate focimeter, of general application to all *curved* surfaces; the precision may be carried to a high degree where necessary, and in ordinary cases it provides ready means of seeing at a glance and without preparation the *quality* of an optical system.

**Gundlach's Improved Objectives.*** — The Gundlach Optical Company are now making objectives "after the new principle discovered by Mr. Gundlach."†

"The water-immersion objectives have a very long working distance and the aberrations of higher order are corrected to a much higher degree than was heretofore possible in a water-immersion objective; hence, these objectives have a definition and resolving power found in oil-immersion objectives only. This series of objectives may therefore be regarded as a new improvement in the field of microscopic apparatus, a water-immersion objective of highest optical quality having also a long working distance."

**Series of Objectives.**—Mr. J. C. Stodder sends us the following note of the late R. B. Tolles's views of the best series of four or five objectives, to cover as far as possible the whole range of "general microscopy."

"For four only—3 in., 1 in. (30°), 4/10 in. (110° dry), 1/10 in.

* Amer. Mon. Micr. Journ., vi. (1885) pp. 130–1.

† See this Journal, *ante*, p. 705.

oil-glycerin-water immersion which will work through 1/100 in. covers, and with a balsam angle of not much less than 120° for best results. An excellent and useful lens to add to the above series would be a 1/5 in. (110° or 120° dry)."

**Right-angled Prism instead of a Plane Mirror.***—Mr. E. M. Nelson replies to Mr. G. Hunt's remarks † as follows:—"I can see no possible advantage in going to the expense of a right-angled prism, as in the commonest Microscopes I find the mirrors quite good enough. One mirror I have gave me four or five images of the flame, which would, of course, be fatal to good definition. This, however, was corrected by turning the mirror round in its cell until a point was found where all the images overlapped. Another mirror I have is a concave, of about 10 ft. focus. I find no difference for ordinary work. Any concavity in a plane mirror is bad, and ought to be avoided, because it shortens the focus of the condenser, which will be quite short enough, if it has any angle in it, without any further shortening.

I cannot say I can mention any definite object or object-glass in which I could perceive any difference with mirror or lamp direct. If any one is doing very special work, and fancies some error due to the mirror, then turn it aside, and use the lamp flame direct. I cannot see any advantage in a prism, which cannot possibly be so good as nothing at all. One special advantage in using the lamp flame direct is that one is not so liable to get the light out of centre. When a mirror or prism is used, a slight touch, or shake of the table even, is apt to throw it out of centre."

**Hélot-Trouvé apparatus for Electrical Illumination.‡**—Dr. H. Van Heurck observes that the electric illumination of the Microscope, hitherto little used, has just entered upon a new phase through the new and thoroughly practical Trouvé apparatus, which realizes all that can be desired for the most difficult investigations in microscopy and photo-microscopy.

The battery consists of a small ebonite box, fig. 190, 15 cm. × 10 cm. × 18 cm., the inside of which is divided for two-thirds of its height into six compartments, communicating at the bottom by a small aperture between each. The elements, each consisting of two rods of amalgamated zinc placed between three carbon rods, are attached to the cover, being coupled in tension, and may be let down into the liquid (potassium bichromate, sulphuric acid, and water) or withdrawn therefrom, or more or less immersed according to the power required at the time.

The illuminating apparatus (fig. 191 in section), attached to the front of the battery (fig. 190), or made to slide with universal joint on a standard (fig. 192), so as to throw its light in any direction desired, is the Hélot-Trouvé photophore, originally devised for surgical operations and the examination of the cavities of the body. The

* Engl. Mech., xli. (1885) p. 523.

† See this Journal, *ante*, p. 709.

‡ Heurck, H. Van, 'Synopsis des Diatomées de Belgique,' Texte, 1885, pp. 219–22 (3 figs.). See also Journ. Soc. Arts, xxxiii. (1885) p. 1005.

photophore consists of a nickelized brass tube, in which the incandescent lamp, of special form with a straight filament, occupies the

Fig. 190.

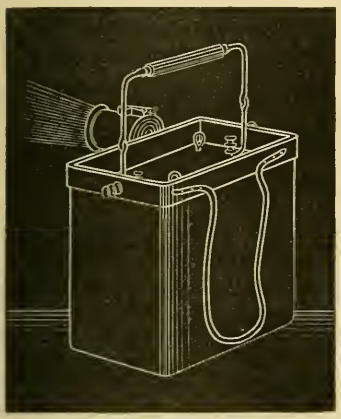


Fig. 191.

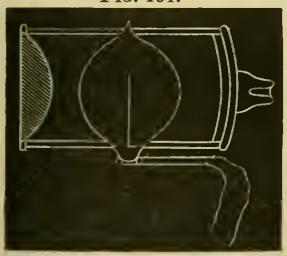
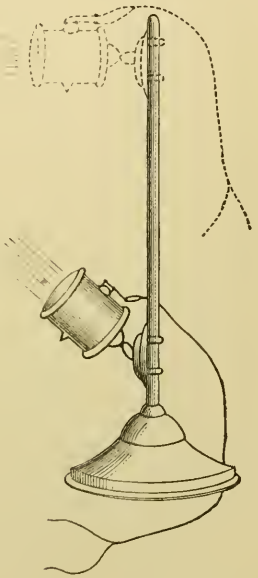


Fig. 192.



middle. At the back is a reflecting mirror, and at the front a condensing lens in an adjustable sliding tube, by which converging, diverging, or parallel rays may be obtained. As the light from the reflector might be objectionable in very delicate observations, a small blackened disk is added for covering the reflector, and a diaphragm may be placed on one or other side of the lens for intercepting the light from its margin.

The battery is capable of maintaining the lamp for two hours, producing a light which may be utilized in certain cases of photomicrography, but which is much too intense for ordinary microscopic research. By a slight modification of the battery, however, suggested by Dr. Van Heurck, by which only 4 or 5 of the elements are coupled, and the rest added as the battery becomes exhausted, or by employing a lamp of less power, the exact degree of light required may be obtained. The battery evolves no fumes, and the expense of maintenance is very slight, that is to say 1*d.* per hour, including loss of zinc, or less than a halfpenny an hour if the small Stearn lamp be used.

Dr. Van Heurck concludes as follows :—"It is seen then that the

electric light is really now brought to every one's door, and we cannot too strongly advise microscopists, especially diatomists, to whom the electric light is indispensable, to provide themselves with one of these apparatuses, the price of which is very moderate. An experience of more than three years has shown us that when the electric light has been once tried and the really marvellous facility noted with which it resolves at the very outset the most difficult details of structure, it cannot be given up again, and the expensive lamps with which we were so recently content are thrown aside."

**Illumination for Projection Microscopes.***—M. d'Arsonval describes an improvement in the illumination of projection apparatus by the employment of a petroleum lamp with three burners, of which the middle one heated by the two lateral ones "allows of an enormous intensity of light, augmented moreover by a reflector at the back." In addition to the fact that this apparatus gives an illumination nearly equal to that of the largest projection apparatus, it is much less costly. The use of napthalin increases still more the light and favourably modifies its nature.

MM. Malassez and Hénocque lay stress on "the enormous advantage to be obtained from naphthalin, which gives a white light, very useful for microscopical or spectroscopical examinations."

**Lantern Transparencies.**†—Mr. C. M. Vorce says that where a considerable number of lantern slides are desired, as for distribution among co-workers, they can be made considerably cheaper by the use of the carbon process than by using dry plates. The process is very cheap and not difficult of application; for the author's description of it the original must be referred to.

Lantern transparencies when prepared to show microscopic objects very highly magnified are best made from camera enlargements of a less highly magnified negative, as follows:—Prepare a negative showing the desired points by means of an objective of as low power as will clearly show all the desired details. This negative will be smaller than is required, but will be a better one than one made of the desired size by a higher power, because the penetration of the objective will give sharper projection than if a higher power were used. Place the negative in a copying camera and enlarge it to the desired size if possible; if not, a second enlargement would be required, but is seldom if ever necessary. The second plate, that is, the enlargement of the first negative, is a positive, and if well done may be mounted as a lantern slide; but first a negative is made from this by contact printing, and from this negative not only paper prints but other lantern positives may be made at will. It should be noted that if any retouching in the original negative is required it must be done with care and skill, as any errors would be exaggerated by the enlargement, but the enlarged positive may be freely retouched before being used for contact printing, and thus letters, figures, names, &c.,

* Journ. Soc. Scientifiques, i. (1885) p. 140. (Soc. de Biologie, 1885, March 21st.)

† Amer. Mon. Micr. Journ., vi. (1885) pp. 84–5.

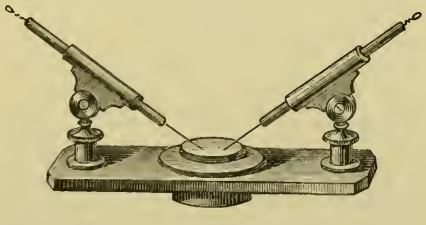
may be introduced into the lantern slides prepared from the last negative, which also may be retouched if necessary like any other negative. The superiority of such enlargements over negatives made originally of the same size is often very marked.

**Microscopical Electrical Apparatus.**—It appears to be but very rarely that in this country any use is made of the electric current in microscopical examinations. We have never seen any apparatus for the purpose in the hands of any English microscopist, and our text-books on the Microscope make no reference to the subject. Nearly all the standard German treatises, however, contain drawings of apparatus intended specially for use with the Microscope for observations on the influence of the electric current on blood, living tissues, microscopical organisms, &c., and from these and from English text-books on Physiology we have compiled the following summary of the various forms that have been devised. In regard to the utility of such investigations, Dr. Dippel says,* "The use of electric currents is not less important for many microscopical objects than the application of high temperatures. This physical reagent has in modern times acquired a high (if here and there exaggerated) importance, and scarcely any microscopist who concerns himself with the minute anatomy of plants and animals can afford to neglect its use."

The simplest apparatus† consists of two needles which can be readily joined to the wires of a battery and with which any given parts of the object can be touched. They can be hooked to be more readily attached.

*Plössl's Discharger*‡ (fig. 193) is simply the ordinary discharger reduced to microscopical dimensions. The conducting wires are con-

Fig. 193.



nected with the two platinum wires shown in the figure, the latter being insulated by being inclosed in capillary glass tubes which slide through sprung brass tubes attached to the upright supports by hinge joints, which can be rotated or set at different inclinations. The object is placed on the glass plate in the centre. The apparatus cannot, however, be conveniently made available for covered objects on account of the inclination at which the wires must be set, or for

* Dippel, L., 'Das Mikroskop und seine Anwendung,' 1882, p. 656.

† Robin, C., 'Traité du Microscope,' 1877, p. 679. See also Robin's remarks on the effect of electricity on the circulation of the blood, &c., ibid., pp. 680–1.

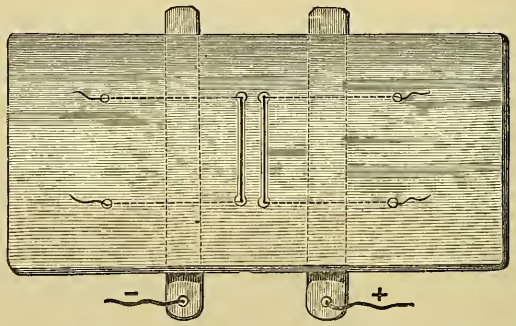
‡ Chevalier, A., 'L'Étudiant Micrographe,' 1865, pp. 141–2 (1 fig.). Dippel, op. cit., p. 656 (1 fig.). Harting, P., 'Das Mikroskop,' 1866, ii. p. 145, iii. p. 404.

high powers, and its use is practically therefore limited to large uncovered objects, such as the larger Infusoria, Rotatoria, &c.

*Schacht's* * plan was simply to cement two platinum wires to the slide extending beneath the cover-glass.

*Jendrássik and Mezey's* † (fig. 194) is now used in the Buda-Pest physiological laboratory. It consists of a slide which has two

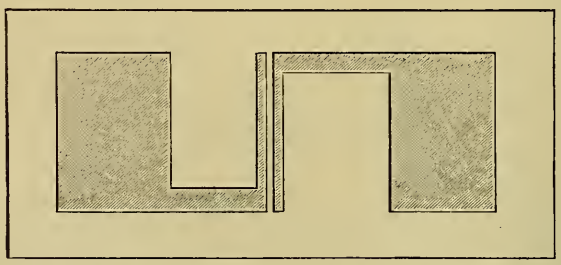
Fig. 194.




parallel grooves about 3·5 mm. apart. At both ends of these small holes are bored, through which thin platinum wire is passed, so as to fill the grooves and be in contact beneath with two metal plates attached to the stage of the Microscope; these plates are connected with the poles of a battery. The designers used this apparatus for the microscopical examination of the contraction of muscle-fibre.

Another plan ‡ is to take a piece of silvered looking-glass and remove the quicksilver in the centre, leaving two narrow strips.

Fig. 195.



*Kühne* § attached to the slide pieces of platinum foil of the form shown in fig. 195, placing upon them small leaden blocks which were connected by wires with the battery.

* Dippel, op. cit., pp. 656–7.

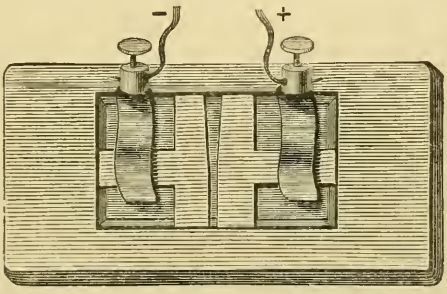
† Thanhoffer, L. v., 'Das Mikroskop und seine Anwendung,' 1880, pp. 91–2 (1 fig.). Dippel, op. cit., pp. 658–9 (1 fig.).

‡ Dippel, op. cit., p. 657.

§ Ibid., p. 657 (1 fig.).

*Thanhoffer's* * (fig. 196) was formerly much used in the laboratory of the Buda-Pest University, and has been somewhat modified to answer Prof. L. v. Thanhoffer's purpose. Two T-shaped strips of platinum are fixed to a small piece of glass by Canada balsam. To prevent their coming off, they are bent back and fastened to the other side of the glass. The slide thus prepared is placed in a wooden or

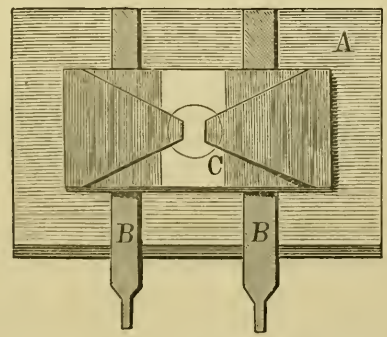
Fig. 196.




hard indiarubber frame. At one side of the frame two copper plates with copper screws are fixed. These plates, which are somewhat curved, lie upon the platinum strips. The poles of the battery are connected with the screws.

*Brücke's* † (fig. 197) consists of a plate of wood A with an opening in the centre, on either side of which copper bands B B are let in and

Fig. 197.




are connected with the poles of a battery. The slide C lies on these bands, and is covered at both ends, above and below, with tin-foil.

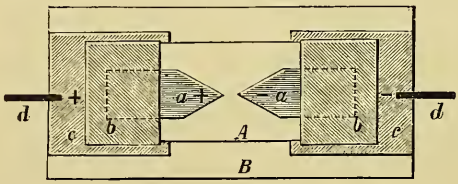
* Thanhoffer, op. cit., p. 91 (1 fig.). The name of the original designer is not given.

† Thanhoffer, op. cit., pp. 90–1 (1 fig.). Dippel, op. cit., p. 657 (1 fig.). Stricker's 'Manual of Human and Comparative Histology.' Transl. by Power, 1870, pp. xx.–xxii. (1 fig.).

The tin-foil on the upper surface ends in blunt points above the opening in the plate at a distance apart of about 5 mm. The object is laid on these points and covered with a cover-glass.

*Ströbelt's* * apparatus is described by him as follows:—Cut two pieces of tin-foil, *b b*, fig. 198, of about 20 mm. in breadth and 35 mm. in length, and place them upon the ends of a slide A so that their longest side is parallel with the shortest side of the slide, the ends being doubled underneath. If the tin-foil is not too thin it will adhere to the slide of itself; under these can be inserted other strips

Fig. 198.




of tin-foil with pointed ends *a a*, the distance of which from each other can be varied according to desire. The slide is placed upon a larger glass plate B, on which two strips of tin-foil *c c* are cemented, the latter being connected with the battery by the conducting wires *d d*.

The advantage claimed for this apparatus over the older forms, in which the strips of tin-foil *b b* and *a a* are formed of one piece cemented upon the slide, consists in the fact that (1) the space between the pointed ends *a a*—the positive and the negative poles—can be increased or diminished at pleasure; (2) tin-foil with blunter or sharper ends can be easily inserted; (3) the apparatus can be fixed on the same slide on which the object has been first examined, so that the frequently tiresome work of transferring it is avoided; and (4) when the influence of the electricity has been observed, the further treatment of the object and in many cases the mounting also can be done upon the same slide, after the tin-foil has been removed.

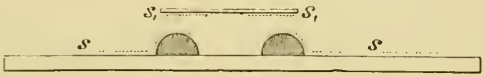
*Stricker* describes † his apparatus as follows:—"It is not practicable to carry out the examination of tissues under the influence of electrical currents with the same elegance of detail as can be accomplished when a simple slide only is employed. The single circumstance that the tin-foil in adhering to the glass makes the surface irregular and uneven renders it necessary that the sections of the preparation should be thicker, and proportionately interferes with the investigation by means of high powers. I endeavour therefore to combine my researches with electrical currents with those conducted in the gas-cell (made by forming a ring of putty on a slide with two tubes passing through it). By this means I am

* Zeitschr. f. Instrumentenk., ii. (1882) pp. 274–5 (1 fig.). Dippel, op. cit., p. 660 (1 fig.).

† Op. cit., p. xxiii.

able to avoid the inconvenience alluded to; for it is quite possible to place the electrodes in close proximity with the preparation which is on the inner side of the cover, and to examine it in consequence with high powers. I attach to each side of the slide a strip of tin-foill which passes over the putty and reaches its inner side (*s s*, fig. 199).

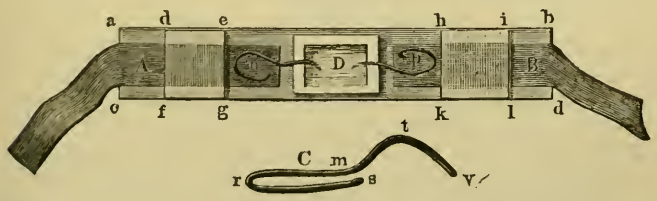
Fig. 199.




Cemented to the cover are also two small strips of tin-foil *s' s'*, which running in the axis of the cover, leave between them a space of a few millimetres in diameter. The object is placed at this spot, and the cover is so disposed on the wall of putty that the metallic strips of the cover lie on the strips covering the putty, and the cover is then firmly pressed down on the soft putty. The cell being now complete, the electric current is conducted by the strips of metal to the object, through which it passes at the same time; this lies immediately beneath the cover, and can therefore be examined with the highest powers. It is, moreover, no small advantage to combine the application of electricity with researches on the influence of gas, because we can neutralize or aid the effects of the current by the introduction of different gases."

*Harting's* * (fig. 200) is a glass slip *a b c d*, about 100 or 120 mm. long and 30 mm. wide, to which are attached by starch paste two pieces of somewhat narrower tin-foil A and B, with a space between them of about 25 or 30 mm. The tin-foil projects beyond the ends of the slip as shown in the figure. Over the tin-foil two thick cover-

Fig. 200.




glasses *d e f g* and *h i k l* are cemented by marine glue or a mixture of pitch or rosin for the stage clips to rest upon. The platinum wires *n* and *p* are loose, and are bent in the form shown at C. The part *m r s* rests on the tin-foil and the other curved portion *m t v* dips into the fluid in the cell D. They can be brought close together if required. If they are to be used for covered objects they must be bent so as to lie horizontally and be as thin as possible: the

* Harting, op. cit., ii. pp. 145-6 (1 fig.). Dippel, op. cit., pp. 657-8 (1 fig.). Frey, H., 'Das Mikroskop,' &c. Transl. by Cutter, 1880, p. 102 (1 fig.).

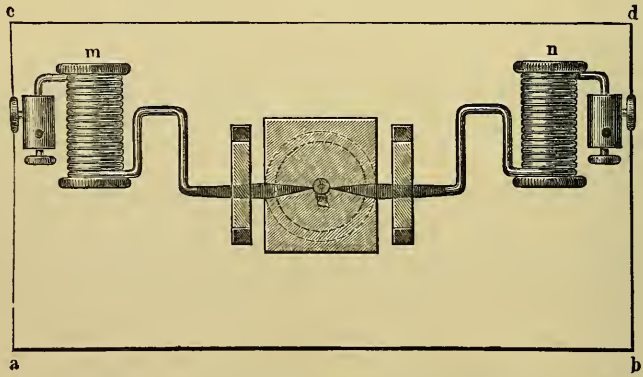
projecting ends of the tin-foil are connected with the wires of a battery.

For researches on blood-corpuscles Rollett * used a modification of this apparatus made by bringing the strips of tin-foil nearly to meet in the centre. The blood-corpuscles were placed between them and spread out so as to touch the margins.

*Dippel's* † (fig. 201) was devised to obviate the inconveniences of Harting's, attendant upon its length, and upon the fact that the connection with the battery wires is very loose, and that the bent wires are liable to be easily disturbed by the hands.

It consists of a not too thin glass plate *a b c d*, of the same size as the stage, on each side of which is fixed a small coil of covered copper wire (*m* and *n*), the wire being wound on glass tubes. The inner end of this wire is (to obtain greater facility of movement) bent at right angles in a horizontal plane, and the end either hammered

Fig. 201.




flat or soldered to a piece of platinum so as to allow it to lie easily under a cover-glass, and not to raise the latter so much that high powers cannot be used. In order to prevent the ends of the wires from shifting, and to enable them to be adjusted to the object, they are carried under two small strips of glass so that they cannot be easily moved. The free ends of the wires are attached to a holder which also receives the wire from the battery, both wires being fixed by screws.

The apparatus can either be held on the stage of the Microscope by the stage clamps, in which case it will be more or less movable, or it can be dropped into a brass frame having two pins beneath fitting into the holes for the spring clamps.

*Schäfer's* ‡ (figs. 202–4) does not differ essentially from some of those already described. The glass slide (fig. 202) has two strips

* SB. K. Akad. Wiss. Wien, l. (1865) p. 178.

† Dippel, op. cit., pp. 659–60 (1 fig.).

‡ Schäfer, E. A., 'A Course of Practical Histology,' 1877, pp. 37–9 (2 figs.).

of gold-leaf or tin-foil attached to it by shellac varnish, with pointed ends which almost meet in the middle of the slide. One strip passes

Fig. 202.

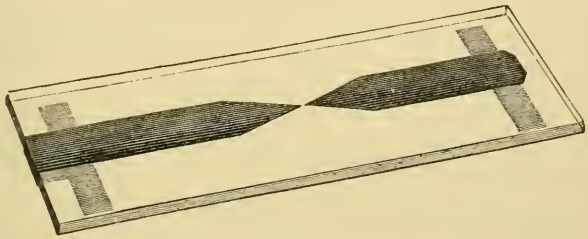


Fig. 203.

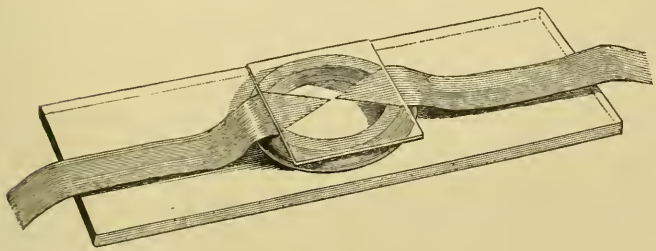
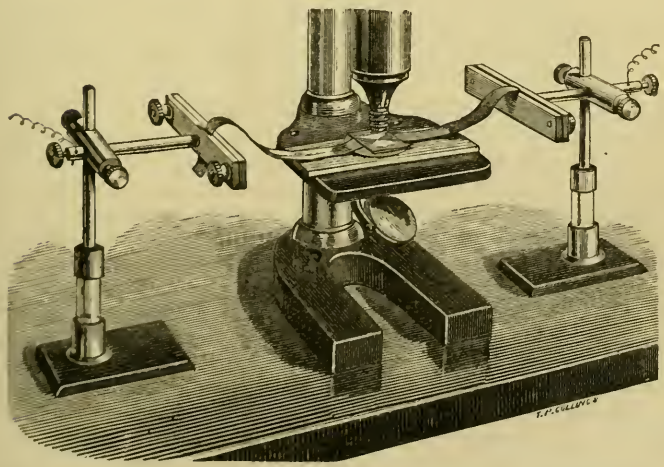


Fig. 204.



round to the under surface, where it rests on the brass stage of the Microscope, and the other is isolated from the stage and may be connected with the outer coating of a Leyden jar, the charge of which is made to pass between the points by connecting the knob of

the jar with the brasswork of the Microscope. On the right a small piece of the foil is fixed to the under surface of the slide, so that this end shall be level with the other.

Fig. 203 shows a combination of the apparatus with a moist chamber for the examination of blood. In this case the cover-glass has two strips of tin-foil cemented to its under surface, and the drop of blood being spread out in a thin layer between the points is quickly inverted over the ring of the cell.

The tin-foil slips are kept isolated by the glass slide from the brasswork of the Microscope, and their free ends are clamped to isolated metal supports as shown in fig. 204, and can be connected with a Leyden jar or an induction coil.

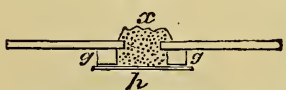
The ends of the wires or slips can also be made to dip into cups of mercury placed on the table, into which the terminal battery wires can also be led.

*Engelmann* * also devised an arrangement for electricity (figs. 205 and 206) in connection with his gas-chamber. The glass top is

Fig. 205


pierced with two apertures at $x$ $x$, through which is inserted clay steeped in 1 per cent. salt solution, so as to fill the space between the top and the glass plates $g$ $g$ and $h$ $h$ (which form a channel for it) and to extend to the sides of the drop suspended from the under surface of the cover-glass, which closes the aperture in the chamber. The points of the Du Bois non-polarizable electrodes are placed on $x$ $x$.

Fig. 206.




According to Rollett † it is advisable in using electrical discharges, that the tin-foil points should be 6 mm. apart. The Leyden jar should have a surface 500 sq. cm. and give a spark 1 mm. long.

Stricker also points out ‡ that the distance of the laminæ of tin-foil from one another is of importance in regard to the transmission of the current. As a general rule, they should not be separated from one another to a greater extent than a few millimetres. He prefers to see the two electrodes at the sides of the field, because then the position of the object in regard to them and to the middle line is simultaneously visible. It is a matter of very great moment to observe and distinguish between the effects of the current in the immediate neighbourhood of the poles and at some distance from them; for the effects of electrolysis are produced on breaking the current in the vicinity of the electrodes, and the tissues become altered, as

* Jenaisch. Zeitschr. f. Naturwiss., iv. (1868) pp 331–3, 385 *et seq.*

† Klein, Burdon-Sanderson, Foster, and Brunton, 'Handbook for the Physiological Laboratory,' 1873, p. 17.

‡ Op. cit., p. xxi.

they would be were they subjected to the action of weak acids or alkalies.

At parts more remote from the electrodes changes also occur which, however, are not so remarkable as those which are induced by the chemical processes above alluded to. The effects, which may be trusted as being really due to electricity, should occur quickly after the passage of the current, and not be limited to the part in the immediate neighbourhood of the electrodes. If the current be allowed to pass for some time, that is to say, for more than a few seconds, through the tissue, the products of electrolysis first extend over the whole surface lying between the electrodes, and then the intensity of the current becomes extraordinarily reduced, frequently indeed to zero, on account of the pole becoming covered with bubbles of gas. On this account the employment of constant currents for microscopic investigation is scarcely to be recommended, for with the closure of even very weak currents so violent a development of gas occurs, that but little confidence can be placed in the results that are observed to follow their passage. The amount of electrolysis that occurs with induction currents is much smaller, and they have therefore been most generally employed. The arrangement in which there is a single shock on opening and closing of the current is particularly advantageous. The shocks obtained from a Leyden jar are infinitely superior to the constant currents, because the instantaneity of the shock causes the disturbing influence of the evolution of gas bubbles to be altogether abolished.

With regard to induction currents, he also points out that on breaking the current, heat is developed in the tissue. If an uncovered drop of blood is under examination with strong ordinary lenses, these become dimmed at the instant of the passage of the current, but after a short period they again become clear. The preparation, however, very soon dries up. It is requisite in such cases to determine what are the effects of the sudden elevation of temperature, and what are those of the electric current alone.

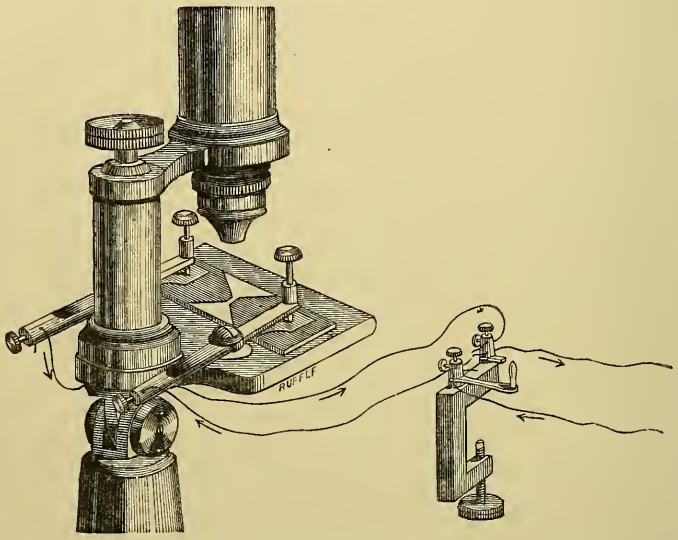
*Stricker's electrodes* * are shown in fig. 207. The slide (covered with tin-foil as previously described) is held in position by the electrodes, each of which is insulated by being screwed into an ivory knob let into the stage-plate of the Microscope. The electrodes are connected (with the interposition of a key) with the secondary coil of a Du Bois Reymond induction apparatus. In the woodcut the key is represented open.

Mr. R. T. Lewis states † that when investigating the disruptive effects of the electric spark—more especially with regard to the peculiar shape of the perforations made by it through various materials —many experiments were carried on upon the stage of the Microscope, and he found that a very simple and convenient method of holding and insulating the terminal wires was to pass each through a small glass tube held by a brass spring-clip, mounted upon a jointed pillar

* Klein, Burdon-Sanderson, Foster, and Brunton, 'Handbook for the Physiological Laboratory,' 1873, p. 17 (1 fig.). † Engl. Mech., xlii. (1885) p. 19.

at the corner of the stage in the same manner as the stage forceps. The pointed end of a glass dipping-tube answered the purpose admirably. When it was desired to pass sparks vertically through

Fig. 207.




an object in focus, a glass stage-plate was used. This consisted simply of two pieces of glass, about an inch longer than the brass stage, cemented together with a wire between them, the point of which turned up at right angles in the centre of a hole drilled through the upper plate. The other terminal, mounted as above, could then be adjusted over it in any required position. A small induction coil was used for the purpose, giving about a 1/2 in. spark with a single bichromate cell. If a Leyden jar was placed in the circuit, discharge sparks of much greater size and brilliancy were obtained, giving beautiful effects when viewed through the micro-spectroscope. "Caution is desirable in conducting experiments of this kind, since manipulation, during observations which engage the attention closely, is apt occasionally to produce very startling results."

**Apparatus for watching the phenomena that animals subjected to great pressure present.***—As previously recorded,† Dr. P. Regnard has experimented on the conditions of life at high pressure. With apparatus designed by M. Cailletet, he has subjected aquatic animals to enormous pressure, such as prevails in the depths of the ocean, and has examined the results when those inhabiting the surface are suddenly placed at great depths.

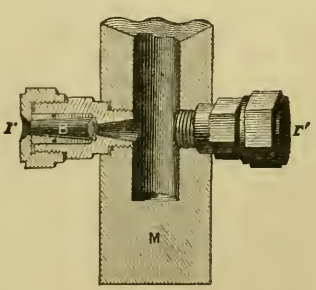
* Comptes Rendus, c. (1885) pp. 1243–4 (1 fig.). Nature, xxxii. (1885) pp. 399–400 (2 figs.), from 'La Nature.'

† See this Journal, iv. (1884) p. 362.

Since his first experiments Dr. Regnard has invented an ingenious method by which he can see, notwithstanding the great pressure, what goes on inside the apparatus. Hitherto the operator simply placed the animals on which he experimented in the iron block of the Cailletet pump, and subjected them to the pressure corresponding to a given depth; he then released them, sometimes very slowly (after several days), sometimes rapidly and even instantly, and examined, physiologically and microscopically, the effects produced. But all the intermediate stages between the introduction of the animals and the time they were taken out escaped the observer. Now, however, the apparatus shown in figs. 208 and 209 allows him to follow each minute the effects.

Two holes are pierced through the lower part of the Cailletet block M (fig. 208). In these are inserted two tubes at *r* and *r'*. These are hollow, and in each of them is solidly fixed a cone of quartz B, the end of which comes as far as the edges of the hole which is pierced in the screw-nut. A ray of light thrown in at the orifice *r* will thus traverse the apparatus and emerge at *r'*. Experiments have shown that the apparatus will resist easily a pressure of 650 atmospheres, which represents that of the greatest depths that have been dredged—about 6500 metres. Through one of the quartz cones are sent the concentrated rays of an electric lamp. These rays cross the block (full of water), and emerge on the opposite side, where they are received by an achromatic object-glass which projects them on a screen. The observer therefore works at a distance from the apparatus, where he is sheltered from all danger. The arrangement has another advantage. The orifice pierced at *r* is hardly half a centimetre in diameter, and small organisms can be experimented with in the vessel immersed in the block M, which are invisible to the naked eye. By projecting them with a lens they are so enlarged, and appear with such transparency, that we can follow on the screen the movements of their branchia, and even of their heart, during the experiment. In the experiment represented in fig. 209, one of the operators is occupied in regulating the electric lamp and in setting the Projection Microscope, while the other applies the pressure.

Fig. 208.




Dr. Regnard is pursuing his studies on life under high pressures. He showed last year that the unequal compressibility of the liquids and solids of the organisms caused the latter, after a long pressure, to be soaked with water, become turgid, and consequently lose their functions. But with the apparatus here described, he has been able to follow the phenomena which precede this. At the pressure of 1000 metres (about 200 atmospheres) the object shows inquietude; at 2000 metres it falls to the bottom of the vessel struggling; towards

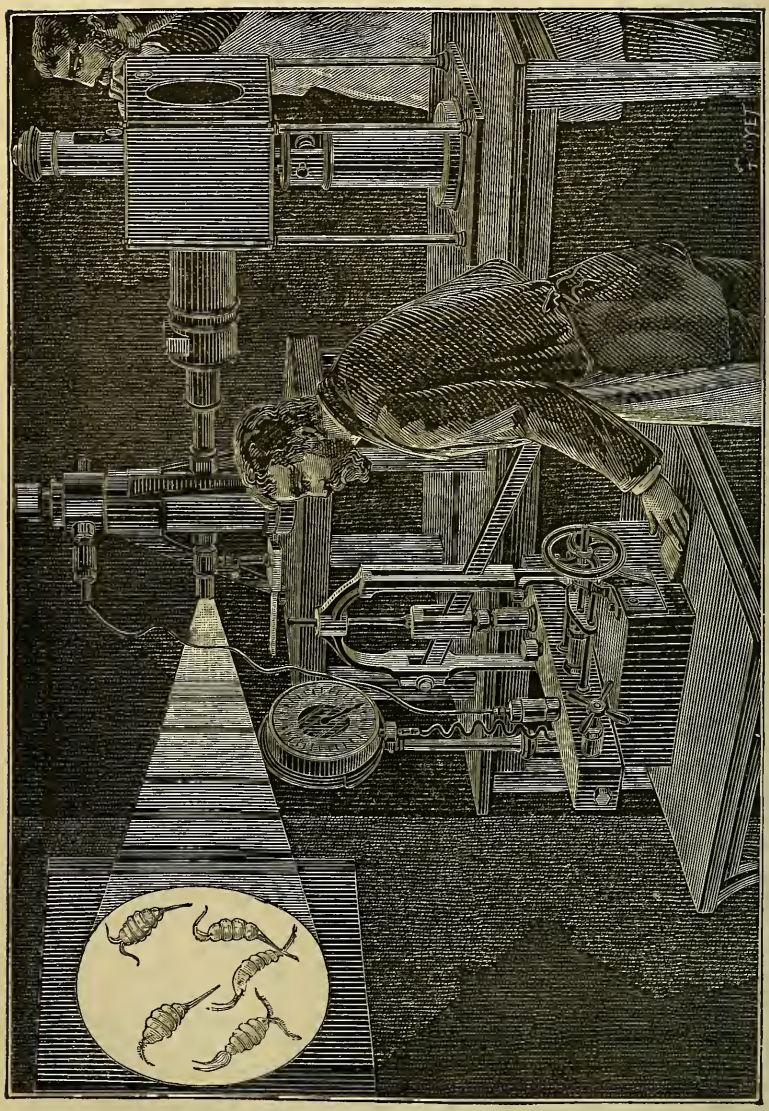
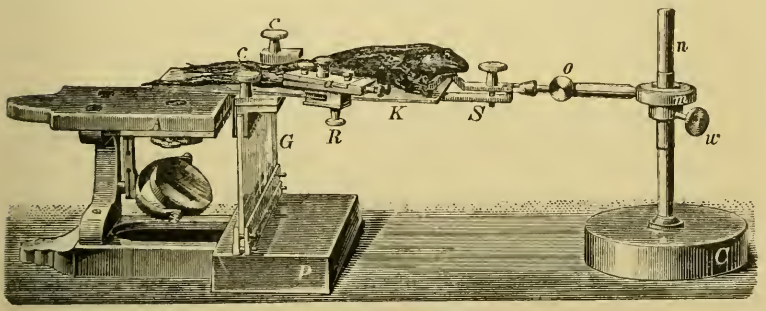


FIG. 209.—GENERAL VIEW OF DR. REGNARD'S APPARATUS.

4000 it remains inert and benumbed. When its normal pressure returns it recommences moving, unless the pressure has been prolonged and its tissues are soaked. This seems to show that the effect is a compression of the nervous system.

**Westien's apparatus for comparing symmetrical parts of the webs of the right and left feet of a frog.***—The apparatus of Herr H. Westien (fig. 210) consists of a glass plate holder C, the stand P, and the Microscope A (upper part omitted). The ring *m*, movable on the upright *n*, is fastened by the screw *w* and carries the bar *o*, to which the clamp S is attached. The glass plate K is clamped into this, and on it the frog is laid, and its extremities and toes fixed with threads which are fastened in holes bored in the glass plate.

Fig. 210.




The plate K rests on the glass-plate G, on which it can be easily and quickly pushed in a horizontal plane up to the clamps *c c* which are fastened on the upper border of the glass plate G. By proper adjustment of the glass plate K on a certain spot, e. g. a small artery of the left foot, the corresponding spot of the right foot can be placed in the field by pushing the plate up to the clamp *c*. The apparatus for producing stimuli *a* is attached to the glass plate K by the clamp R.

**Apparatus for Determining the Specific Gravity of Minute Objects under the Microscope.**†—Prof. W. J. Sollas found the difficulty of determining the specific gravity of calcareous sponge spicules by the method of weighing insuperable, as they are so small and so difficult to free completely from air, even with an air-pump. Sonstadt's solution appeared to offer the best chance of success; but here again the small size of the spicules was a difficulty. This, however, was overcome by adapting the Sonstadt method for use with the Microscope.

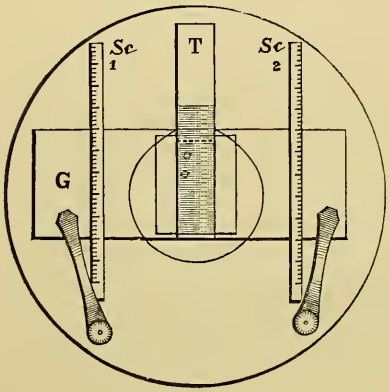
An ordinary collecting tube (fig. 211, T), about 2 in. long and 3/8 in. in diameter, was cemented with plenty of Canada balsam to a glass slide G. The object of using excess of balsam was to destroy

* Zeitschr. f. Instrumentenkunde, v. (1885) p. 198 (1 fig.)

† Scientif. Proc. R. Dublin Soc., 1885, pp. 374-92 (7 figs. and 1 pl.).

optically the curvature of the side of the bottle. As the refractive indices of Sonstadt's solution and balsam are not very different, this plan succeeded admirably. A thin cover-glass was similarly cemented to the opposite side (front face) of the bottle, which was thus optically flattened front and back. Some Sonstadt's solution (sp. gr. 2·77) being introduced, a fragment of aragonite (sp. gr. 2·9) was dropped in; it at once, of course, sank to the bottom. Next a piece of calcite (sp. gr. 2·7) was added; it floated on the surface. The spicules lying in water, were freed as far as possible from air by boiling, and with the air-pump. With a dipping-tube the water and spicules together were taken up and added to the top of the Sonstadt's solution, where they floated. The tube was then left to stand in order that diffusion might take place. After some hours the water and Sonstadt's solution had become gradually mixed, giving a column of fluid with a specific gravity of about 2·4 at the top and 2·77 at the bottom. The calcite and the spicules floated at different levels (the spicules being above) in layers of fluid having respectively the same specific gravity as themselves. A fragment of pure quartz (sp. gr. 2·65), and another of adularia felspar (sp. gr. 2·58) were next added; the quartz sank to a level below the spicules, the felspar remained above. As the contents of the tube could be easily examined under the Microscope with a 1 in. or even a 1/2 in. lens (Zeiss's C), one could make certain of the absence of air-bubbles, vacuoles, or other troubles; and as the spicules could be seen individually, it was possible to determine the specific gravity of a single one. The spicules did not all lie at exactly the same level, but formed a zone thickest towards the middle, and thinning off above and below; a few stragglers were seen at some distance on either side, but this was owing either to adhesion to the side of the tube, or attached impurities.

Fig. 211.

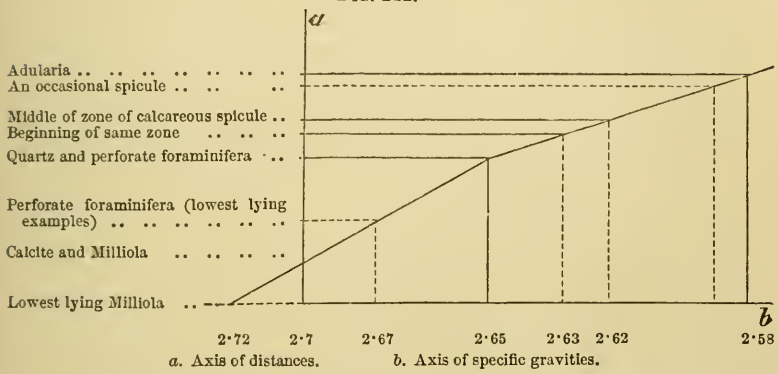



The specific gravity could now be exactly determined. Two rectangular axes are ruled, fig. 212; on one distances are taken to represent the densities of the calcite, quartz, and felspar; on the other the exact distances between the middle line of each fragment as it floats in the tube are measured off.

These distances were obtained by gumming two scales divided into millimetres on the stage of the Microscope at right angles to the glass slide carrying the experimental tube, i. e. parallel to this tube (fig. 211, $Sc_1$ and $Sc_2$). The calcite was brought into focus, and the position of one edge of the glass slide read off on the scales; the

slide was then moved down till the quartz came into view, and the position of the slide again read off on the scales. The object of

Fig. 212.




*a*. Axis of distances. *b*. Axis of specific gravities.

having two scales is obviously to ensure parallelism in the movements of the glass slide.

The specific gravities and distances being indicated on the rectangular axes, one constructs a curve which gives the change in density from one mineral to another in the tube.

The height of the zone of spicules being now indicated on the axis of distances, a line is drawn parallel to the other axis through it; from the point where it cuts the curve a perpendicular is let fall on the axis of specific gravities, and the point where it meets the axis gives the specific gravity. In this way the specific gravity of the spicules was determined to be from 2·61 to 2·63. They are plainly, therefore, not aragonite, and, arguing from the specific gravity alone, probably consist of calcite. The slight difference between it and them in specific gravity is no doubt due to the presence of organic matter; for within, a minute canal, filled with some kind of organic material, possibly spongin, occurs in the axis of the spicules; and without they are surrounded by a thin sheath of a probably similar material. Prof. Sollas finds by calculation that allowing for the organic matter a specific gravity of 1·5, it would require to be present to the extent of $6\frac{2}{3}$ per cent. to reduce the total specific gravity of the spicules from 2·7 (supposing them to consist chiefly of calcite) to 2·62, the density found.

**Keeping both Eyes open in Observation.***—Mr. E. M. Nelson considers that the unused eye should be shut when the weaker light is in the Microscope, both eyes being kept open only when the object is in the stronger light. Thus by diffused daylight the light in the instrument is the weaker, and the other eye must be shut. By artificial light in a dark room both eyes can be kept open. "One hour of steady hard work with the Microscope by diffused daylight

* Engl. Mech., xli. (1885) p. 523.

will tire you more than a whole day's work in a dark room by lamplight."

**Aperture Puzzles.**—Another puzzle turns on the statement sometimes made that it is not necessary to have an objective of 1·0 N.A. (180° air) to resolve 96,000 lines to the inch as shown by the Aperture Table; that it can be effected by a dry objective of say 0·50 N.A. (60° air).

The way in which this feat is supposed to be accomplished is by attaching a truncated cone A to the cover-glass as shown in fig. 213, the connection being made by balsam, oil, &c. Here the first diffrac-

Fig. 213.

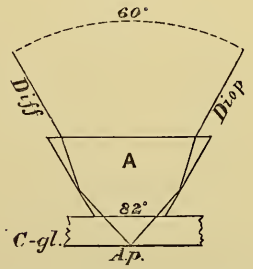
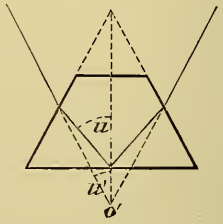



Fig. 214.




tion spectrum and the dioptric beam which leave the object (*Amphipleura pellucida*) at an angle of 82° *in glass* emerge from the cone at an angle of only say 60° in air, and are therefore collected by a dry objective of approximately that aperture.

The explanation simply is that by connecting the cone with the cover-glass we have an immersion objective, with the difference that (1) instead of using a hemispherical piece of glass to cause a pencil of 82° in the glass to emerge as one of moderate air angle, to be taken up by a dry objective above it, a conical one has been substituted, and that (2) in place of attaching the extra piece of glass once for all to the rest of the optical combination, as in an ordinary immersion objective, it has to be attached to each slide examined, at a great sacrifice of convenience! The cone has, moreover, the disadvantage, as compared with the hemisphere, that whilst the latter will readily collect to a focus the whole pencil of 82°, and thus allows of the real delineation of all kinds of objects, the cone will only collect two very narrow partial pencils of equal and opposite obliquities and will not bring these to a proper focus. The problem is in fact only another mode of stating the old mare's-nest of the "hemisphere puzzle," disguised by the substitution of a truncated cone for the hemisphere.

The same effect, though with more dispersion, can be obtained by refraction (instead of reflection) through a truncated prism of isosceles section and suitable inclination of the refracting faces (fig. 214), and whatever form is employed the only essential conditions are that two infinitely narrow beams (the incident beam and the first diffraction pencil) shall have equal and opposite inclinations $u$ to the axis within the front medium, and that they should be deflected, by

refraction or reflection, in such a way that they emerge into air under equal and opposite inclinations $u'$, smaller than the semi-angle of aperture of the dry objective above, which is focused to the point $o'$ of vertical intersection of the two beams. Every device which conforms to these conditions will act as an immersion front-lens in regard to the particular pair of beams in question.

The conical or prismatic front will, moreover, like the hemisphere, increase the power of the optical combination. This power may be determined by the formula $N = \frac{n \sin u}{\sin u'}$ where $n$ is the index of the glass front, $u$ the internal angle of obliquity, and $u'$ the angle of obliquity after emergence into air. In the ratio of the quotient N to unity the power of the objective will be increased (or its focal length diminished) in regard to the delineation of the particular set of lines from which the two opposite pencils originate. For any other set, of different closeness, $u$ and $u'$ will require different values, and the power of the same cone or prism will be different.

**The 'Times' on the Microscope.**—The following leading article appeared in the 'Times' of the 26th August:—

"We publish this morning an article descriptive of some of the progress which has been made during late years in the construction and cheapening of Microscopes and of their accessory apparatus—a progress so marked that it has become time for all who are engaged in the work of instruction to consider carefully to what extent the improved instruments of the present day can be employed for the furtherance of the general work of teaching. If we may adopt Paley's definition of education, as 'comprising every preparation that is made in our youth for the sequel of our lives,' we shall be prone to admit that few of these preparations can be of greater importance, or of greater ultimate utility, than the training of the eye to observe natural phenomena, and the training of the mind to appreciate the meaning of these phenomena and their relations to one another. It was a great day during the childhood of many who have now passed the meridian of life when the lecturer with an oxy-hydrogen Microscope was announced as being about to exhibit and to discourse at the town hall; and the huge transparency in which the insect life of a drop of water was displayed in full activity became a wellspring of new thoughts and of increased mental activity to nearly all of those who gazed in wonder at the presentment of rapid movement, of abounding life, and of continual destruction. The sight which was then to be seen only on rare occasions, and as a sort of entertainment, is now at the daily command of every school-master, or of every parent who can spare only a small amount of money, and who possesses sufficient intelligence and manual dexterity to learn the use of the instrument which, more than any other, has led to increased knowledge of the structure of man and animals, and to modern improvements in the healing art. The powers now at the disposal of the *savant* far surpass any which were attainable only a few years ago; but the use of these high powers requires the devotion

of much of a lifetime to the study of learning how to see, and how to interpret what is seen. No persons are more certain to fall into gross errors than the untrained possessors of powerful Microscopes; and the conduct of actual research, of the business of carrying knowledge a step in advance of its former boundaries, must always be limited to the few. When, in 1854, the late Dr. William Budd announced that cholera was dependent upon the presence of a minute intestinal fungus, there were probably not three observers in England who were capable of pronouncing a trustworthy opinion as to whether a given speck was a microscopic fungus or not; and there was little doubt that the so-called 'fungi' of many persons were nothing more than fine particles of chalk, derived from medicine which had been administered to the patient. Since that time vast strides have been made in the methods of conducting such investigations, together with corresponding improvements in the instruments by which they are conducted; and almost every beginner now thinks himself qualified to prattle about microbes. In the case, unfortunately, of those who may be presumed to be the most skilled observers, talk and observation do not always seem to be conducive to agreement.

It is not, however, for the sake of prosecuting original inquiry, but for the sake of making known to the young what has already been established, that the Microscope should commend itself to educationists. It reveals and displays plainly to the sense of sight two great facts—the fact of the wonderful complexity and beauty of the structure of the smallest and apparently the most insignificant creatures, and the fact that all living things of appreciable magnitude, whether they be plants or animals, are built up by the aggregation of myriads of minute organisms or cells, each of which possesses independent life, and each of which fulfils a purpose in the corporate body by its own inherent and independent activity. If a Microscope is given to children as a toy, and if all that is done for them is to permit them to look through it at something the nature of which they do not understand, it will do them no more good than seeing a conjuring trick, perhaps hardly so much; but if children are encouraged to examine first the more simple vegetable structures, making their own sections and proceeding gradually from low powers to higher ones, from coarse to minute and complex structure, they can hardly fail, if capable of enlightenment at all, to obtain such new notions of the universe in which they live as will never wholly cease to influence their minds. The lore actually gained may perhaps be comparatively small; but the true gain will be in the power to think about occurrences, to discover real resemblances between things which are externally different, and to perform that wonderful work of ratiocination through which two ideas, similar or contrasted, become the parents of a third. It is difficult to believe that a child who was not only permitted to work with a Microscope, but who was assisted to do so in a rational way, encouraged to collect his own objects, to examine them in his own fashion, to try to overcome his own difficulties and doubts, would ever grow up into an entirely stupid man or woman. There are but few who are gifted with the infinite patience

and the love of truth for its own sake which form the raw material, so to speak, of the philosopher; but the instances are at least equally few in which the lessons in observation and reflection, which even a small Microscope is calculated to afford, would not serve to raise the mind of the user to a higher level, and to develop a higher degree of intelligence than could have been obtained without such help.

In a few very good schools, chiefly for the children of the more wealthy classes, natural history teaching by the aid of Microscopes is systematically conducted, the classes collecting their own specimens, and being expected to give the best account they can of them before being assisted towards a better one by the teacher. Our argument is that all this should be done much more widely and generally; education, in fact, being made to advance along a road which is rendered comparatively smooth by the perfection of modern appliances. The tasks of school, in too many cases, appeal to the memory rather than to the understanding, and cultivate stupidity rather than intelligence. It is impossible to doubt that much which is taught, say in Board schools, might be relinquished without any appreciable loss to the intellectual development of the scholars, and that by such relinquishment time might be gained for instruction of a more fruitful kind. As for the material, even in towns, it is present in immeasurable abundance. There is a legend that an ardent naturalist once determined to write a complete account of the plants and animals which he found in the garden of Lincoln's-inn-fields, but that the magnitude of the task was such as to place insuperable obstacles in the way of its accomplishment. An attempted history of the insect life alone was abandoned for the same reason; and a second Gilbert White might have found ample occupation in observing and recording the habits of the various denizens of the narrow space. It is, perhaps, too much to hope that the officials of a public department will ever so far emancipate themselves from the trammels of routine as to take the initiative in the promotion of better nature teaching; but it is not impossible that they might learn to follow if they were clearly shown the way. The parochial clergy in old times were the pioneers of improvement on all educational questions; and there is no reason why they should not seek to regain something of the leadership which has to so great an extent slipped away from their grasp. Could they not, especially in rural districts and in country towns, do something towards the promotion of a reform which would render the younger members of their congregations more observant, more thoughtful, more careful of animal life, less ready to be over sure about problems the solutions of which are not yet known to mankind, but on which so many people are prone to be dogmatic in precise proportion to their ignorance? The modern Microscope might form one of many levers by which the minds of future generations might be guided towards the attainment of knowledge and the cultivation of modesty and charity."

The article referred to was as follows (under the head of "Recent Microscopical Science"):—

"A glance at the Journal of the Royal Microscopical Society,

which is edited by Mr. Frank Crisp, with the assistance of several Fellows of the Society, shows that activity in microscopic science is incessant. Last year the Journal included 1008 pages of matter, most of it consisting of summaries giving the essential features of all important papers bearing on microscopical science published throughout the world. This year 756 pages of the Journal have already been issued, and students who use the Microscope are thus better off than the devotees of most other departments of science. It is to be noted as to the Microscope itself, that improvement is not now rapid as regards fundamental principles and their application to the less powerful lenses with which the average student is chiefly concerned, but that considerable advances have been made in the last few years in the theory and practice of the construction of lenses of high powers. Thus under the eye of a skilled observer an excellent objective of 1/10 in. focal length will now accomplish as much as or more than an objective of 1/25 in. not many years ago; while those now made of the very high power signified by 1/50 in. focal length, and capable of magnifying from 2000 to 10,000 diameters, according to the eye-piece used, greatly surpass in all important qualities lenses of the same power sold by the best makers less than five years ago. Moreover, for some kinds of work the adoption of the principle of immersing the surface of the objective in distilled water or in very pure oil has proved of great value. Thus many delicate points of detailed structure, formerly discoverable only by the most persistent efforts and careful manipulation, can now be demonstrated with comparative readiness.

It is obvious that if the educative influence of microscopical study is to be very widely diffused, much depends upon the cheapening of good apparatus. This is especially the case if schools are to employ to any considerable extent recent biological methods. Cheap forms of Microscope have hitherto been more or less unsatisfactory. Either they were cumbrous to work, they readily got out of order, they became unsteady, or they did not long continue to magnify clearly or without introducing inopportune colours into the field of view. All the leading makers, however, have recently brought out cheap instruments of improved construction. Among others, Messrs. Beck, whose name stands high for finish and reliability of workmanship, have recently brought out a so-called 'Star' Microscope, which combines solidity and steadiness with good magnifying powers (1 in. and 1/4 in. in focal length respectively), suitable for average students and for research within limits. The tube can be inclined at any angle, there is a fine adjustment, the stand is solid and firm, and a diaphragm with apertures of various diameters under the stage can be rotated so as to regulate the admission of light.

Marked improvements continue to be made in the lantern Microscopes used for magnifying objects for public lectures and demonstrations. Mr. Lewis Wright has brought to great perfection a lantern Microscope which throws large-sized and exceedingly clear views of minute objects on to a screen free from distortion or colour. Structures so complex as the minute anatomy of the human tongue, the

wood of an elm tree, and even the circulation of the blood in the web of a living frog can be exhibited with perfect sharpness of definition up to the very margin of the illuminated field of view. The importance of this for scientific lecturing is evident.

In no department of microscopic work has more ingenuity recently been applied than in the construction of microtomes. These are instruments for cutting numerous very thin sections of substances parallel to one another, either for distribution to large classes or for obtaining successive adjacent portions of a structure, so as to secure an exhaustive examination of it. The somewhat complex instrument devised a couple of years ago by Messrs. Caldwell and Threlfall, of Caius College, Cambridge, and manufactured by the Cambridge Scientific Instrument Company, was made to deliver its thin sections in a continuous riband at the rate of 100 per minute, or even twice as many when a water motor was used. They were delivered in consecutive order and with the same side upwards. Uniform thinness could also be obtained by an ingenious screw. The great novelty of the instrument consisted in the use of an endless band to receive the sections as they came from the razor. When imbedded in suitable material the sections adhered to one another and came off the razor in a continuous riband. As soon as a sufficient length was cut, the end was picked up by a needle or scalpel and placed on the band, which was adjusted so as to be moved forward, at each throw of the object-carrier, through a distance equal to the breadth of the surface which was being cut.

Many persons were soon at work to improve and simplify this method and to reduce its cost. This object seems to have been best accomplished by the Cambridge Instrument Company itself. Its improved instrument is called the rocking microtome, a rotary instead of a sliding motion of parts having been employed. Its cost is less than one-sixth of that of the original instrument, and instead of being lifted on to a continuous silk band, the riband of sections falls by its own weight directly from the razor on to a sheet of paper, or on to the glass slide on which the sections are to be finally mounted. Sections as thin as the 1/40,000 of an inch are said to be obtained by this plan. It is much easier to work, is less liable to get out of order, easily packed, and very portable.

One result of the increased facility of instruction and study in microscopical science appears to be the rapid multiplication of memoirs and papers dealing with isolated portions of subjects. We do not note in this country that the number of men of real power who devote themselves to these studies and patiently elaborate systems and build up sure edifices of enlightenment increases very greatly. Rather there is a multiplication of men of the second or third rank, who catch the jargon of the reigning school, make respectable researches on a few points, and become absorbed in teaching or in other money-earning pursuits. There is a fashion in microscopy as in other things, and it is the fashion to study bacteria and bacilli, just as it formerly was the thing to pore delightedly over test-slides of diatoms. The bacteria will yield a more fruitful harvest, certainly,

in the hands of scientific workers, but the path is toilsome and the goal distant. There is reason in this devotion. When we know the very little, how it lives and moves, and what it can do, we shall be much more ready to comprehend how similarly minute elements combined work in larger organisms."

AGEN, F. D'.—**Microscopical.**

[As to air-bubbles in the back combinations of objectives. Also as to the resolution of *A. pellucida* by a dry 1/5 in. of 135°. (Cf. *ante*, p. 726.)]

*Engl. Mech.*, XLII. (1885) p. 37.

**American Association for the Advancement of Science.**

[Remarks on the abolition of the Section of Histology and Microscopy. "This anomalous Section finding its end near, proceeded with dignity to request the Association to kill it: the request has been granted." "This change has been urged for some time by those who do not think a special science of Microscopy exists, but that the Microscope is a tool used by scientific men in various branches." "It is to be hoped that Dr. Minot's suggestion of forming a Microscopical Club within the Association will be carried out, to insure the cultivation of technique among the members interested."]

*The Microscope*, V. (1885) pp. 181–2.

See also *Amer. Mon. Micr. Journ.*, VI. (1885) p. 175.

**American Society of Microscopists.**—Our Eighth Annual Meeting.

[Urging that papers, speeches, and sessions should be short. "We must insist upon being relieved and upon relieving our fellow-sufferers from the lengthy uninteresting papers read by parties who have become monomaniacs on their pet subjects."]

*The Microscope*, V. (1885) pp. 180 and 181.

See also *Amer. Mon. Micr. Journ.*, VI. (1885) p. 157, and *Micr. Bulletin* (Queen's), II. (1885) p. 25.

" " " Report of Cleveland Meeting. (*In part.*)

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 165–7, 175.

AMYOT, T. E.—**Direct Vision Microscopes.** [*Post.*]

*Sci.-Gossip*, 1885, pp. 201–2 (1 fig.).

ARSONVAL, D'.—**Simplification des Appareils à projection.** (Simplification of projection apparatus.) [*Supra*, p. 866.]

*Journ. Soc. Scientifiques*, I. (1885) p. 140.

(*Soc. de Biologie*, 21st March.)

BANKS, C. W.—**Electric spark under the Microscope.**

[Mr. Banks showed, under the Microscope, the electric spark in its passage between the terminals of a 1/4 in. spark induction-coil attached to a Grenet bichromate solution battery. Two vulcanite slides had been prepared, on which were fastened adjustable platinum strips connected with the battery wires and terminating in brushes of platinum wires of extreme tenuity. The electric fluid, in its passage from one terminal to the other, formed a very attractive object under the Microscope. One of the slides was used to show the effect on the electric spark of interposing films of soot of different thicknesses. In its passage through these the current was deflected into meandering lines, around which scintillated showers of sparks. The particles of soot could be seen arranging themselves in symmetrical groupings around the terminals.]

*Proc. San Francisco Micr. Soc.*, June 10th, 1885.

See *Micr. Bulletin* (Queen's), II. (1885) p. 30.

BAUSCH, E.—**Manipulation of the Microscope.**

[Contains chapters on Simple Microscopes, The Compound Microscope, Objectives and Eye-pieces, Requisites for work, How to work, Advanced Manipulation, Substage Illumination, Care of a Microscope, and Considerations in testing Objectives.]

96 pp. and 27 figs., 8vo, Rochester, N.Y., 1885.

BEECHING, S.—**Amateur Lens-grinding.**
*Engl. Mech.*, XLI. (1885) pp. 498–9 (1 fig.).

BLES, E. J.—**Opaque Illumination.**
[Mainly an historical summary of the various appliances.]
*Trans. and Ann. Rep. Manchester Micr. Soc.*, 1884–5, pp. 23–6.

BURRILL, T. J.—**Photographs of *Amphipleura pellucida*.—New Heliostat.**
[Good photographs obtained by Dr. H. J. Detmers with a common coal-oil lamp.—Note of the construction of a new Heliostat of simple mechanism for photo-micrography.]
*Science*, VI. (1885) p. 228.

C., L. P. DE.—**Le Microscope grande modèle de Hartnack et Prazmowski.** (The large model Microscope of Hartnack and Prazmowski.)
[Description of it, with the modifications introduced by their successors Bézu, Hausser & Co.—principally an excentric diaphragm in place of a sliding one, and an adapter for changing objectives.]
*Journ. de Microgr.*, IX. (1885) pp. 262–3.

CAPLATZI, A.—See "Orderic Vital" and "Rector."

COOPER, W. A.—**Daylight v. Lamplight for microscopical observation.**
[Quotation of Dr. Carpenter's views in favour of daylight as against Mr. Nelson's.]
*Engl. Mech.*, XLI. (1885) p. 564.

DUBOSCQ, T. and A.—**Nouvel appareil de grandissement pour la projection, soit des tableaux de grandes dimensions, soit des objets microscopiques.** (New magnifying apparatus for the projection of large pictures or microscopic objects.) [*Supra*, p. 861.] *Comptes Rendus*, CI. (1885) pp. 476–7.

DUDLEY, P. H.—**Triceratium Davyanum.**
[3 photo-micrographs × 408, representing the diatom when viewed in 3 different focal planes.]
*Journ. N. York Micr. Soc.*, I. (1885) pp. 145–6, and p. 157 (3 photographs).

DURAND, W. F.—**A practical method of finding the optical centre of an objective and its focal length.** [*Post.*]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 141–5 (1 fig.).

**Dynamo-electric Machines.**
[Exhibition of two small machines, one operated by the foot and the other by hand. "For microscopical illustration [a dynamo] can be used with great advantage, especially in photography."]
*Journ. N. York Micr. Soc.*, I. (1885) p. 156.

**Fasoldt's (C.) Detaching Nose-piece.**
[See this Journal, IV. (1884) p. 959.]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 149–50 (1 fig.).

GRANT, F.—**Microscopical.**
[Whether daylight or lamplight is the better for illumination "can be settled only by experience."—Measuring amplifying power of the Microscope and angle of aperture of objectives.—Advantages and disadvantages of large apertures.—Explanation of numerical aperture.]
*Engl. Mech.*, XLII. (1885) pp. 57–8.

**Gray's (S.) Water Microscopes.**
[Claim by "the ghost of Stephen Gray" that Hippisley's Pocket Field Microscope *infra* is an inferior form of Gray's Water Microscope.]
*Engl. Mech.*, XLI. (1885) p. 520.

**Gundlach's Improved Microscope Objectives.** [*Supra*, p. 863.]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 130–1.

HART, C. P.—**Making a Microscope into a Microtome.** [*Supra*, p. 861.]
*Science*, VI. (1885) p. 228.

HASTINGS, C. S.—**On the Colour Correction of double Objectives.**
*Engl. Mech.*, XLI. (1885) pp. 559–60; XLII. (1885) pp. 8–9; from *Amer. Journ. Sci.*, XXIII. (1882).

HÉNOCQUE.—**Appareils destinés à l'examen du sang.** (Apparatus for the examination of blood.) [*Post.*]
*Journ. Soc. Scientifiques*, I. (1885) p. 24. (*Soc. de Biologie*, 11th Jan.)

HEURCK, H. VAN.—**Eclairage artificiel: Eclairage électrique par incandescence.** (Artificial illumination: Incandescent electrical illumination.) [*Supra*, p. 864.]
*Synopsis des Diatomées de Belgique.* Texte. 1885, pp. 219–22 (3 figs.).
Cf. *Journ. Soc. Arts*, XXXIII. (1885) p. 1005.

HIPPISLEY, J.—**A pocket field Microscope.**
["Magnifying 100 diameters, useful in the search for infusoria, &c., and which may be constructed, lens and all, in a few minutes.
Bend a slip of thin metal 5 in. or 6 in. long and 1/2 in. wide into the form of the letter V, make two circular holes 1/10 in., one in each arm, opposite each other, so that when the arms are sprung together by pressure the holes shall meet exactly. Place a drop of water in one hole, taking care not to wet more than its interior circumference. The water will assume the form of a perfect double convex lens, of focal length varying from 1/8 to 1/10 in. according to the quantity of water introduced. Such lens, though by evaporation its focal length is gradually increased, maintains its efficiency for a time quite sufficient for the examination of a drop of water or other substance in the opposite hole. The end of one arm of the V is bent inward so as to form a "stop," which when they are pressed towards each other to effect the focal adjustment, prevents a contact which would destroy the lenticular form. The definition of these water-lenses is excellent, and their magnifying power is from 80 to 100 diameters, according to the quantity of water in the lenticular drop."]
*Engl. Mech.*, XLI. (1885) p. 502.

„ „ **Microscopic.**
[It is very easy to make glass globules for microscopic use of ordinary glass. The difficulty is in using them as Microscopes. Besides the instrumental difficulty of focal adjustment for such small lenses, the light of so small a pencil of rays is quite inadequate, except with "violent" illumination. "But lenses by melting glass may be made to much better purpose of more useful focal lengths — not globular— but double-convex lenses, in the following manner, which, I believe, is new, or was so when I first made them, say 30 or 40 years ago. Take a bit of fine binding wire, iron (not brass or copper), make, by twisting it round a taper wire for mandrel, a nicely circular loop; flatten it so that the loop is all in one true plane. The loop may vary in diameter from any desired smallness up to 1/4 in. (which is nearly the largest size my glass-melting apparatus will conveniently manage). Place a square piece of glass—thicker or thinner, according as it is desired to have a lens of more or less convexity, but large enough to completely cover the loop. Then, holding it in a suitable blowpipe flame (which should be a vertical, not a horizontal one), the glass assumes in melting a doubly-convex lenticular form. A form, moreover, in which the spherical aberration of a globule tends to be corrected, and a larger proportion of the field is flatter than it is with an ordinary double-convex lens." "Such lenses are made in a few minutes, and perform most admirably when a suitable instrumental apparatus is used."]
*Engl. Mech.*, XLI. (1885) pp. 540–1.

HITCHCOCK, R.—**Optical arrangements for Photo-micrography and remarks on Magnification.** [*Post.*] *Amer. Mon. Micr. Journ.*, VI. (1885) pp. 168–70.

[HITCHCOCK, R.]—**The Postal Club.**
[Comments on its position.] *Amer. Mon. Micr. Journ.*, VI. (1885) pp. 134–5.

„ „ —**Testing Objectives.**
[Recommendation of the Abbe test-plate.]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 177–8.

**International Inventions Exhibition. XII. Philosophical Instruments and Apparatus.**
[Includes Microscopes and Apparatus.]
*Engl. Mech.*, XLI. (1885) pp. 444–5.

JAMES, F. L.—**American v. Foreign Microscopes.**
*The Microscope*, V. (1885) pp. 164–5, from the *National Druggist*.

KLEIN, C.—**[Horizontales Erhitzungsmikroskop.]** (Horizontal heating Microscope.) [*Post.*] *Nachr. K. Gesell. Wiss. Göttingen*, 1884, pp. 133–4.

LACAZE-DUTHIERS, H. DE.—**Note accompagnant la présentation d'Appareils d'éclairage électrique pour les travaux des naturalistes, chimistes, micrographes, &c., construits par M. G. Trouvé.** (Electrical illuminating apparatus for naturalists, chemists, microscopists, &c., constructed by G. Trouvé.)

[1. Glass jar with a silvered glass bottom and a silvered parabolic reflector over the mouth, having in the centre an incandescent lamp illuminating the interior of the jar. 2. Modified apparatus for fermentations. 3. Modified Hélot and Trouvé electric photophore.]

*Comptes Rendus*, CI. (1885) pp. 405–7 (1 fig.).

LEWIS, R. T.—**Electricity in the Microscope.** [*Supra*, p. 875.]

*Engl. Mech.*, XLII. (1885) p. 19.

MALCOLM.—**On Binocular Glasses adjustable to eyes having unequal focal lengths.** [*Post.*]

*Proc. Phys. Soc. Lond.*, VII. (1885) pp. 80–1.

M'CONNEL, J. C.—**Notes on the use of Nicol's Prism.**

[1. On the error in the measurement of a rotation of the plane of polarization caused by the axis, about which the Nicol turns, not being parallel to the incident light. 2. On a new method of obtaining the zero-reading of a Nicol circle.]

*Proc. Phys. Soc. Lond.*, VII. (1885) pp. 22–39 (7 figs.).

NELSON, E. M.—**Microscopical.** [*Supra*, p. 864.]

*Engl. Mech.*, XLI. (1885) p. 523.

**Nicol Prism, repairing.**

[Nicol prisms which have become scratched and dull may be restored by cementing a thin cover-glass over the ends with clarified gum-damar. The prisms should first be carefully cleaned with a very soft brush and soap, to which may be added a little precipitated chalk. They should then be rinsed with distilled water and carefully dried, pains being taken to remove every particle of dust and dirt from within the scratches. The cover-glass, which should be thin and perfectly clean, should then be applied in the usual way, exactly as in making a balsam mount. When carefully done, not a vestige of the scratches can afterwards be detected.]

*The Microscope*, V. (1885) pp. 188–9.

"ORDERIC VITAL."—**New Optical Glass.**

[Feil's "extra dense flint, No. 1738." Also remarks by A. Caplatzi.]

*Engl. Mech.*, XLI. (1885) p. 519; XLII. (1885) p. 15.

**Perfect Laboratory Microscope.**

[Four questions for "Professors and others who have had large experience in microscopical work" to answer, as to the model of Microscope generally preferred by educational institutions.]

*Micr. Bulletin* (Queen's), II. (1885) p. 25.

**Queen's (J. W. & Co.) Resistance Coil.**

[Designed especially for use with micro-electric lamps.]

*Micr. Bulletin* (Queen's), II. (1885) p. 30 (1 fig.).

"RECTOR, F.R.A.S."—**The Optical Lantern.**

[Queries as to improvements. (Four wick lamps burning best kerosene oil give as much light as can possibly be obtained from that medium.) Also facetious reply by A. Caplatzi, mainly as to the excessive heat of such lamps.]

*Engl. Mech.*, XLII. (1885) pp. 62 and 84–5.

"ROB. CRUS."—**The Micro-objective.**

[On mounting the lenses of eye-pieces and objectives.]

*Engl. Mech.*, XLI. (1885) pp. 563-4 (2 figs.).

See also p. 526.

ROCHER, B. DU.—**De la Mégaloscopie.** (On Megaloscopy.) [*Post.*]

*Comptes Rendus*, CI. (1885) pp. 329–30.

**Royal Society of South Australia, Postal Microscopical Section of.**

["A box of microscopical objects has been received from Victoria and duly circulated among the members of this section, and a box of South Australian objects has been made up in this colony and forwarded to Victoria and New South Wales."]

*Trans. and Proc. and Rep. R. Soc. S. Australia*, VII. (for 1883–4), 1885, p. 130.

STOKES, G. G.—**On Light as a means of Investigation.** Burnett Lectures. Second Course. 114 pp., 8vo, London, 1885.

**The "Times" on the Microscope.** [*Supra*, p. 883.]
*Times*, 1885, August 26th. Cf. also February 16th.

VERRALL, G. H.—**Micro-photography for illustrating the neuration of transparent winged insects.**
[Note of successful experiments.] *Proc. Entomol. Soc. Lond.*, 1885, p. iv.

**Walmsley's (W. H.) Photo-micrograph of Rinnbach's arranged Diatoms.** [Cf. *ante*, p. 530.]
*The Microscope*, V. (1885) p. 181.

WARD, R. H.—**The Binocular.** [*Post.*]
*Micr. Bulletin* (Queen's), II. (1885) pp. 28–9 (1 fig.) from *The Microscope in Botany* (Behrens).

### β. Collecting, Mounting and Examining Objects, &c.

**Method for Observing Protoplasmic Continuity.***—M. L. Olivier recalls that three years ago he pointed out that photography applied to the study of minute objects revealed details of structure which made no impression on the retina, and that in support of this he instanced a photograph which showed on the walls of the cells markings and perforations invisible under the Microscope. He now further illustrates the matter by reference to the canals which traverse the cell-walls of plants.

The existence of these canals escapes the ordinary processes of investigation, but can be shown by the employment of photography.

Thin transverse sections are made of living tissues whose growth is complete. A direct photograph is taken of the sections, with an amplification of 300 to 700. On these negatives, examined with a lens, the cell-membranes seem to be in a very surprising state of complication: perforated in various ways, with canals, some transverse, others longitudinal, that establish a communication between the contents of the cells. It seems impossible to explain by a phenomenon of diffraction this appearance of canals on the photographic plates.

After having made out this structure on the negatives, the author endeavoured to see them by direct vision and examined the preparations under an amplification of 700–900, in a dark chamber into which the Microscope was introduced, in such a way that the eye received no other impression than that of the light coming from the instrument. Under these conditions he succeeded in distinctly seeing the interruptions of the cell-walls in many plants.

Direct observation is, however, in most cases quite insufficient, and the author obtained a better result by staining, either the cell-membranes of his preparations, or the protoplasmic elements after fixing, turgescence or contraction by means of appropriate reagents. In the first case the septa presented here and there colourless lacunæ, at least in certain species of plants. In the second case the walls of the cells were white against the coloured ground; the canals which traverse the septa are then visible, since they are coloured like

* Comptes Rendus, c. (1885) pp. 1168-71.

the protoplasm itself. M. Olivier also attempted to cause a fluid, capable of colouring the protoplasm, to penetrate under gentle pressure into the organs; transverse sections were then made. The injection rarely succeeded; but when it took place in a fairly regular manner, this process led to a result identical with the preceding.

**Eau de Javelle as a Medium for Clarifying and Dissolving Plasma.***—Dr. F. Noll finds that eau de Javelle (an alkaline hypochlorite solution) destroys and then dissolves the whole of the plasma of the cells in preparations which have been preserved in alcohol. A similar, but more or less imperfect solution of the plasma-contents occurs in tissues which have been treated with glycerin, Müller's fluid, picric or chromic acid. It is not necessary that alcohol should be present during the operation of the reagent; if a drop of the water is placed on a section made through young cells rich in plasma, this is soon dissolved, with development of small bubbles of gas. If the action takes place in the open air, a soft pellicle quickly forms on the drop, consisting of calcium carbonate, which can be readily dissolved in acetic acid. The formation of this pellicle can be prevented by placing a cover-glass over the drop, under which the process can be studied step by step. In a very short time, usually 3–4 minutes, the plasma is converted into a clear fluid. When the section is sufficiently clear, it is washed in water, so as to remove the bubbles of gas. The superfluous granules of calcium carbonate are removed by acetic acid, and the section is then ready to be placed in glycerin. The water acts on cuticular membranes in the same way as Schultze's macerating fluid, but only slightly and after some time (1 hour or more). Calcified membranes should be first treated with acetic acid to dissolve the mineral constituents, washed, and treated with the water in the usual way. Starch-granules swell in the water, so as to become invisible.

**Cocaine for Mounting Small Animals.**†—Prof. J. Richard describes a new way of fixing Hydroids, Bryozoa, &c., in an expanded condition, which is as follows. A number of the animals are placed in a watch-glass with 5 c.cm. of water when they are fully expanded. A 1/2 per cent. solution of chlorhydrate of cocaine is added drop by drop till it forms a fifth part of the entire fluid. Half a c.cm. of the drug is then added, and the animals become so completely fixed that it is necessary to touch them very roughly with a needle in order to induce them to contract; ten minutes after, they are quite dead, and can be mounted in the ordinary way. This reagent is superior to all others, because it requires no delicate manipulation; it is not certain yet whether its effect upon marine animals is equally strong in all cases.

**Preparing Tissues to show Cell-division.**‡—Dr. C. Rabl objects to Flemming's chrom-osmic-acetic acid mixture, on the ground that the preparations soon become darkened; and to the 1/2 or 1/3 per cent. solution gold chloride, that in summer reduction takes place and the

* Bot. Centralbl., xxi. (1885) pp. 377–80.
† Zool. Anzeig., viii. (1885) pp. 332–3.
‡ Morphol. Jahrb., x. (1884) pp. 214–330 (6 pls.). See this Journal, *ante*, p. 217.

cell-substance is coloured violet. The best results are obtained from solutions of chromo-formic acid and platinum chloride. Formula for chromo-formic acid:—1/2 per cent. solution chromic acid, 200 grm.; concentrated formic acid, 4–5 drops. The mixture is always to be freshly prepared for use. Small pieces of fresh specimens are to be used. After 12 to 24 hours, wash in water and then transfer to 60 or 70 per cent. alcohol, and after 24 or 36 hours more to absolute alcohol. A 1/3 per cent. solution platinum chloride has the same effect as gold chloride, and this without being reduced by light or heat. Specimens should remain in this solution 24 hours, they are then washed and treated as before. The one method supplements the other, as chromo-formic acid causes certain fibres to swell, while platinum chloride has a somewhat shrivelling effect.

**Method for showing the Distribution and Termination of Nerves in the Human Lungs.***—Dr. E. F. Beckwith, aware of the futility of hoping to obtain good results from any known manner of preparation and staining of the nerves of the lungs, sought a new method, and the following modification of a process lately promulgated in Germany for staining brain-tissues was found to answer.

Harden fresh lung for about ten days in the following solution:—Bichromate of potash 2·5 per cent., to which is added sulphate of copper C. P. to the amount of 0·5 per cent. The tissue is then frozen and suitable sections made, which are treated with gold chloride 0·5 per cent., 2–10 minutes in the dark. Washed with distilled water. Sodium hydrate 1–5, until cleared up. Potassium carbonate 10 per cent., 30–60 minutes. Dried with absorbent paper. Potassium iodide 10 per cent., 15 minutes, when gold will be nicely reduced.

The nerves and ganglia in sections thus prepared are of a deep red or violet colour, occasionally shading off into a blueish green, the other tissue being red. The differentiation in colour is sharp, so that nerve-tissue may be recognized by its colour alone whenever seen.

The above method differs very little from the German process, with the exception of the potassium carbonate, which the author believes essential to success, as the unmodified process failed to give good results, when used on lung tissue. A great advantage of the method consists in the fact that the reduction of gold always takes place in a uniformly even manner; and with little practice, perfect staining can be accomplished with every section. Unfortunately, as in other gold preparations, the specimens spoil in a short time unless preserved in the dark in 40 per cent. alcohol, and when examined should be temporarily mounted in glycerin.

**Preparing Tail of Puppy.**†—Mr. A. C. Cole's method of preparation is to first harden the tail in methylated spirit for a week, then soak in water, then place in a considerable quantity of a 1/6 per cent. solution of chromic acid, to every ounce of which five drops of nitric acid are added. This mixture should be frequently changed.

* The Microscope, v. (1885) pp. 148–52 (3 figs.).

† Cole's Studies in Micr. Sci., iii. (1885) Sec. 4, p. 24.

When the bone is softened, the tail is to be soaked in water to remove the acid and reharden in spirit.

Transverse sections are cut from the tail and stained in the ordinary borax-carmine solution; when sufficiently stained they are transferred to methylated spirit, and then placed in a mixture of five parts spirit and one part hydrochloric acid; from this they must be removed as soon as they attain a brilliant scarlet tint, and be again placed in spirit until no trace of acid remains. The sections are then to be stained in sulph-indigotate of soda—two drops of a saturated aqueous solution of which are added to one ounce of spirit—and in this the sections should remain for from four to six hours. They are then to be finally and carefully washed in spirit, cleared in oil of cloves, and mounted in Canada balsam.

**Demonstrating Spindle-shaped Bodies in the Yolk of Frog's Ova.***—Dr. O. Hertwig states the best method is to place the ovary for two or three minutes in a mixture of 0·3 per cent. osmic acid and 0·1 per cent. acetic acid, and then in order to prevent over-blackening transfer to iodized serum or bichromate. Osmic acid causes ova to coagulate homogeneously, so that they are transparent. Very dilute acetic acid on the other hand clearly shows up the contours of germinal vesicle and nucleoli. Excessive blackening by osmic acid may be removed by peroxide of hydrogen. Thus treated, ova retain all their details after six months. Only teasing out is required.

**Microscopical Technique of the Eye.†**—Dr. R. Warlomont describes the method of preparing specimens of eyes for microscopical examination which is used at the Moorfields Ophthalmic Hospital. The whole eye is placed in Müller's fluid for 3–4 weeks, and then cut with a sharp knife into two symmetrical parts, which are washed in water to remove the yellow colour. The decoloration is hastened by placing them for several minutes in a 1 per cent. solution of chloral. They are then placed for a day in ordinary alcohol, and transferred to absolute alcohol for 24 hours. They are next placed for 24 hours in celloidin dissolved in equal parts of sulphuric ether and absolute alcohol, and laid in a paper box, which is filled with the celloidin solution. When this has become changed into a gelatinous elastic mass, it is placed in ordinary alcohol (70–80), in which it acquires the necessary hardness, and in which it can be preserved indefinitely. The sections are cut with Katsch's microtome beneath alcohol, stained with Ehrlich's logwood or other solution, washed in water and alcohol, clarified in oil of bergamot, and mounted in balsam.

**Preparing Eyes of Gasteropods.‡**—Concentrated solution of perchloride of mercury is found by Dr. C. Hilger to keep the rods in good condition for hardening in Müller's fluid. Picric acid or alcohol may be used. The best stain is hæmatoxylin. First overstain, then decolo-

* Morphol. Jahrb., x. (1884) pp. 337–43 (1 pl.).
† Bull. Soc. Belg. Micr., xi. (1885) pp. 201–8.
‡ Morphol. Jahrb., x. (1884) pp. 351–71 (2 pls.).

rize with weak alum solution for a period of several hours to some days. Nuclei and cell boundaries are well shown. Cut in paraffin. For macerating, a 2 or 3 per cent. solution of chromate of potash, or it may be concentrated and diluted with a weak oxalic acid solution or Müller's fluid.

Fresh material is ready in a few hours; hardened material in a few weeks. It is recommended to dissociate the macerated and stained specimen when in section, and to separate its elements by tapping on the cover-glass.

**Method of Softening Chitin.***—Dr. Looss describes a new method of dissolving the chitinous skeletons of Arthropoda, &c. The reagents used are hypochloride of potassium and sodium; the latter can be purchased in chemists' shops under the name of Eau de Laberraque. The percentage of the solution has not been definitely settled. The chitinous skeletons of insects are rendered completely transparent, and the nerves and muscles uninjured by the use of the reagent diluted 4–6 times with water.

**Demonstrating Nerve-end Organs in the Antennæ of Myriopods.†**—In order to demonstrate the origin and the articulation of the olfactory bulb in the antennæ of Chilognatha, Dr. B. Sazepin first washes the antennæ in alcohol, and then, in order to remove the pigment from the chitinous tissues, immerses in chloroform to which one drop of strong nitric acid has been added. After being placed in absolute alcohol they are treated with 1/2 per cent. solution of osmic acid. The nervous tissue becomes brown in about 20 hours. The processes previous to cutting are to place the antennæ in absolute alcohol and next in picric acid for a day. After washing frequently in 75 per cent. spirit, transfer to absolute alcohol and stain with Grenacher's alum-carmine. Wash for a whole day in water; for another in 75 per cent. spirit; then absolute alcohol, chloroform, paraffin, and cut.

**Sources of Error in the Examination of Fresh Tissues.‡**—Dr. Heller draws attention to two sources of error in the examination of fresh tissues, each of which can, however, be obviated by adopting proper precautions.

1st. The red blood-corpuscles are in a great many cases destroyed by the cold temperature when the sections are cut with a freezing microtome. This can, however, be prevented by placing the pieces of tissue, before cutting, for a short time in a weak solution of bichromate of potash.

2nd. When a large number of sections have to be examined, a development of micro-organisms may occur before there is time to carry out the examination. This, too, can be prevented by placing the sections in salt solution (3/4 per cent.) to which 1 per cent. chloral hydrate has been added. An addition of 1/2 per cent. chloral

* Zool. Anzeig., viii. (1885) pp. 333-4.
† Mém. Acad. Imp. Sci. St. Petersbourg, xxxii. (1884), 20 pp. and 3 pls.
‡ Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 47–8.

prevents the development of the Schizomycetes, but not of the moulds. A solution stronger than 2 per cent. acts unfavourably on many tissues.

**Mounting Media for Nematodes.***—The following is recommended by Dr. M. Braun as a medium in which unstained preparations of small nematodes may be mounted:—Gelatin 20, glycerin 100, water 120, carbolic acid 2. The preparations are treated beneath the cover-glass (after previous treatment with Müller's fluid and distilled water) with weak alcohol (first 25 per cent. and then 40 per cent.). This is removed by placing at the edge of the cover-glass glycerin diluted with an equal part of water; by the evaporation of the water pure glycerin remains. The cover-glass is then lifted up, and the gelatin, rendered fluid by warming, applied. A sealing varnish is not necessary.

**Preparing Myzostoma.†**—As preserved specimens did not give favourable results, their development was chiefly studied by Mr. J. Beard on the living animal. If plenty of naturally impregnated *Comatula* with adult *Myzostoma glabrum* can be obtained, the arms are cut off by the calyx and placed in a vessel filled with sea water. On the following day the *Comatula* are removed, and at the bottom of the glass the ova or larva of *Myzostoma* will be found. They can be kept alive from 4–5 days. But as only a few ova can be obtained, and the *Comatula* die in a few days, ova artificially impregnated are used. A number of adult *Myzostoma* are removed from their host and placed in a watch-glass containing 2–3 teaspoonfuls of freshly filtered sea water. They are then torn with needles and left for two or three hours. The pieces of *Myzostoma* are then fished out; the ova which remain at the bottom of the vessel are supplied with fresh sea water every other day and also with air by means of Andres' apparatus. Most larvæ die in about six days. For the later stages of development the *Comatula* are placed in a vessel containing a mixture of sea water with 10 per cent. of alcohol. By this they are slowly killed. On shaking the vessel *Myzostoma glabrum* and *cirriferum* fall to the bottom. Alcohol is then gradually added until it reaches 90 per cent. In this they are preserved.

**Sensitive Tests for Wood-fibre and Cellulose.‡**—Dr. A. Ihl finds that besides the well-known reagent phloroglucin, other phenols stain lignin in a characteristic way. An alcoholic solution of orcin acidulated with hydrochloric acid stains woody fibre a beautiful dark red. Cellulose remains unchanged. Resorcin with alcohol and hydrochloric acid gives a blue violet stain. Resorcin with alcohol and sulphuric acid (1 part $C_2H_6O$ to 1/3 part $H_2SO_4$) gives a dark blue violet stain. To cellulose a reddish hue. α-naphthol, alcohol, and hydrochloric acid produce a greenish hue: α-naphthol, alcohol (1 part), sulphuric acid (1 part), impart a dark-green colour to wood, to cellulose a red-violet

* Braun, M., 'Die thierischen Parasiten des Menschen nebst einer Anleitung zur praktischen Beschäftigung mit der Helminthologie, für Studirende und Aerzte.'

† Zeitschr. f. Wiss. Mikr., ii. (1885) p. 231.

‡ Chem. Ztg., 1885, p. 266.

colour. Pyrogallic acid, alcohol, and hydrochloric acid give, with heat, a blue-green stain. Carbolic acid, alcohol, and hydrochloric acid a yellowish green.

**Modification of Semper's Method of making Dry Preparations.*** —Prof. O. P. Hay, finding that preparations made according to Semper's method often present a dingy, weatherbeaten aspect, recommends that the method should be completed by saturating the preparation with a solid that fills up the pores and binds the parts together. The solid which he employs is a mixture of Canada balsam, paraffin, and vaseline, but it is probable that a soft paraffin will in most cases do quite well. It is necessary that the mixture shall melt at about 46° C.

**Freeing Objects from Air.**†—D. S. W. recommends the following plan for mounting objects containing a considerable quantity of air :—

"Take, for example, a collection of *Isthmia*, or some other diatom. The valves enclose so much air as to cause them to float upon water, and it must be extracted, for until they sink it is impossible to wash them. Drive from water all the air you can by a good boiling for about five minutes, allow the water to cool so as to be in condition to absorb air, and without delay drop in the diatoms. The water will extract the air from them and they will go to the bottom. Then add to the water a little dissolved chloride of soda, and with an occasional shake up, you will find the material pretty well cleaned and bleached in one hour. Wash thoroughly in several changes of water.

Take a drachm of redistilled alcohol and add thereto two drops of dissolved gum arabic. With a sharpened stick place a small quantity on the centre of a cleaned slide. It will spread out and the alcohol will quickly evaporate, leaving a very thin film of the gum. On this gummed spot place a drop of your cleaned diatoms, and see that they are thoroughly dried by time or heat. Of course, they are now filled with air, and are firmly enough attached to the slide, and can be covered in a cell if a dry mount is desired.

To mount in balsam, however, the air must be again extracted, and at this stage the boiled water prescription cannot be administered. Have Canada balsam made quite tough by age or heat, and then dissolved in benzole. Put around the objects which have been dried on the slide a few fragments of cover-glass, and on them, as legs to a stool, place a clean cover-glass. A drop of the pure benzole will quickly run under the cover-glass, and very promptly take the place of the air in the diatoms; and a drop of the balsam at one edge of the cover, and a corner of blotting-paper at the other, will quickly substitute the balsam for the benzole. Time or gentle heat will harden the cement, and the specimen is safe."

**Cleaning and Preparing Diatom Material—Mounting Diatoms.**— Herr E. Debes, in an article of 17 pages,‡ describes the necessary

* Amer. Natural., xix. (1885) p. 526.
† Amer. Mon. Micr. Journ., v. (1884) p. 18.
‡ Hedwigia, xxiv. (1885) pp. 49–66.

processes both in the case of recent and fossil forms. In a later article of 16 pages * Herr Debes describes the various mounting media, and gives directions for mounting diatoms. The articles cannot be usefully abstracted.

**Gowen's Microtome.**†—Mr. F. H. Gowen, considering that the use of paraffin for imbedding is attended with difficulties on account of its becoming loose in the microtome, has made a microtome in which the difficulties are overcome.

A hole is turned about half-way through the table of a microtome, and into this a tube is screwed, forming the well. The hole through the remainder of the table, forming the mouth of the well, is turned with sufficient "gather," or taper, to take up the shrinkage of the paraffin. On the upper side of the piston a dovetailed groove is turned. The column of paraffin receives no support from the tube, but is securely held by the piston at one end and by the contracted mouth of the well-hole at the other. (Diameter at the top, 0·9 in., tapering from diameter of 0·92 in. Length of taper, 0·15 in.)

**Jacobs's Freezing Microtome.**‡—Dr. F. O. Jacobs has devised the freezing-microtome shown in figs. 215 and 216. It consists of a copper rod A, 2 in. or more in diameter, and 6 in. high, inclosed by

Fig. 215.

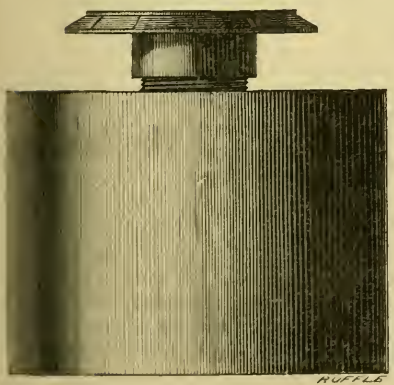
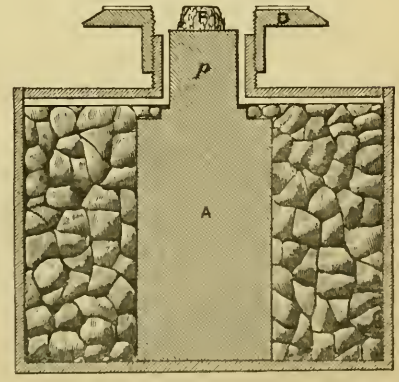


Fig. 216.




an inner zinc and an outer brass tank. Above is the table D, working on a fine screw. Through the centre of the table passes a narrower portion of the copper rod *p*.

When the inner tank is filled with a mixture of salt, ice, and water, the temperature of the copper rod is so reduced as to freeze any object F placed on its upper end. The size of the rod is such that its temperature will remain very steady for from four to six hours, without any further care on the part of the operator.

* Hedwigia, xxiv. (1885) pp. 151–66.
† Amer. Mon. Micr. Journ., vi. (1885) p. 156.
‡ Amer. Natural., xix. (1885) pp. 734–6 (2 figs.).

By this arrangement objects can be easily frozen, and without any slop.

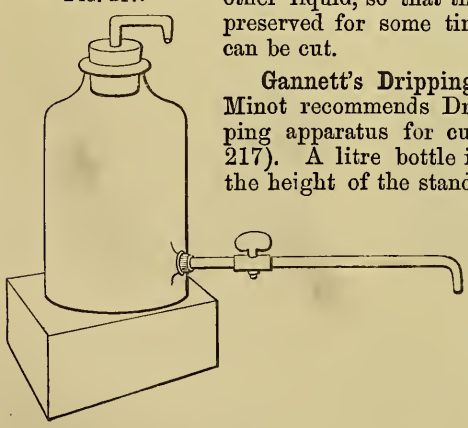
The imbedding medium is composed of:—gum arabic, 5 parts; gum tragacanth, 1 part; gelatin, 1 part. The mixture is dissolved in enough warm water to give it the consistency of thin jelly when cold. A little glycerin (1:6) is added to the water.

**Eternod's Microtome with Triple Pincers.***—The instrument of Dr. A. Eternod consists of a brass cylinder terminating above in a polished nickel-plated platform, on which the razor is directed. The cylinder is composed of two drums screwed one over the other so that the lower drum being fixed, if the upper drum is turned round its axis it is gradually raised. The edges of the upper drum are divided into 100 parts. Each entire revolution of the drum raises or lowers the platform 1 mm.; if it is moved through only one division, the platform is displaced to the extent of 1/100 mm.

The object is fixed in the axis of the microtome by a triple pincer consisting of three pieces of brass set on the base-cylinder, which can be separated or approximated by means of a screw beneath the instrument. If the screw is turned from right to left, the three pieces are separated and the specimen can be interposed, imbedded in cork, elder-pith, &c. If the screw is now turned from left to right, the pieces are approximated, and the specimen can be firmly fixed. It is easy with this microtome to cut sections 1/200–1/400 mm. thick.

Dr. A. Eternod, in writing † to claim to be the originator of the microtome, points out several advantages not noticed in the above description. It can be filled with alcohol or other liquid, so that the object to be cut can be preserved for some time. Objects 4 cm. long can be cut.

Fig. 217.



**Gannett's Dripping Apparatus.**‡—Dr. C. S. Minot recommends Dr. W. W. Gannett's dripping apparatus for cutting under alcohol (fig. 217). A litre bottle is convenient in size, and the height of the stand should be such as to bring the end of the dripping-tube about 1 in. above the blade of the knife, on which the alcohol is allowed to fall continuously. To regulate the flow an 1/8 in. globe-valve is found to be the most convenient.

**Staining for Microscopical Purposes.**§—In further continuation of his excellent articles, Dr. H. Gierke deals with (1) the treatment

* Journ. de Microgr., ix. (1885) pp. 171–4.
† Ibid., pp. 264–7.
‡ Amer. Natural., xix. (1885) p. 916 (1 fig.).
§ Zeitschr. f. Wiss. Mikr., i. (1884) pp. 497–557, and ii. (1885) pp. 13–36.

of specimens with various metal salts, such as chloride of palladium, oxide of iron, &c. (2) Staining methods in which carmine is combined with other reagents, e. g. picric acid, indigo-carmine, and metal salts. (3) Methods in which logwood is used in combination with various other reagents. (4) The combination of anilin dyes with each other and with metal salts. (5) The combination of the gold and silver methods. Not the least important and interesting part of the articles is the historical description of the development of the employment of anilin dyes in staining technique, commencing with mauvein and fuchsin in 1856. The author well observes that those who are engaged in histological research with the aid of staining materials should be thoroughly acquainted with the chemistry of the dyes with which they work, and a description is given of the source, manufacture and properties of the anilin dyes as well as alizarin, logwood, indigo, carmine, and others.

In his concluding article,* Dr. H. Gierke has drawn up elaborate tables respecting the anilin pigments. The first table gives the ordinary nomenclature, chemical formulæ, remarks on the solubility, reactions, and preparation of the various anilin stains. The second table, arranged according to colour, gives the solubility in water or alcohol and the behaviour with acid and alkalis.

The rest of the paper is chiefly occupied with a discussion as to whether, when a preparation becomes coloured, the colour is due to imbibition of pigment, or is the result of chemical changes effected in the tissue by the pigment. The author maintains that though histological staining depends for the most part on the physical processes of diffusion and imbibition, the occurrence of chemical combination in staining cannot be denied. On the contrary, such combinations are of frequent occurrence and, as micro-chemical reactions, are of the greatest importance. The histological stain, so far as it imparts a permanent dye, depends on the physical process of surface attraction. Chemical processes should be suspected when a pigment is discharged or changes to a different shade. We may, therefore, speak of chemical processes when one and the same pigment stains different tissue elements of a preparation in different ways. Double staining by the simultaneous or consecutive use of several dyes only in part depends on chemical processes. In greater measure they are effected by the unequally developed attraction-force of various tissues. It is also shown by the fact that one pigment is able to remove another from certain tissue elements, but not altogether from the same preparation. If a section of any organ, rich in various tissues, be laid in a mixture of several pigments, each histological element is stained by that for which it possesses the greatest attraction. If a certain part have for two or more dyes an exactly similar attraction, it then takes up both or all, and a mixed colour is the result. Examples of staining by chemical processes are, among others, the various reactions on amyloid substance. When Curshmann employed methyl-green for staining amyloid-degenerated nerves, all the normal parts were coloured green, the hyaline cylinder light blue, and the amyloid substances

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 164-221.

violet. The latter, therefore, entered into chemical union with the pigment, the new body only showing a colour differing from that of the dye. Thus, too, the rose-orange staining of red blood-corpuscles by eosin may be regarded as the result of a chemical reaction.

The author concludes by expressing the opinion that the staining problem of the future will be solved by the aid of chemical reaction.

**Staining Methods.***—Dr. J. H. List discusses some double stains which he has used for a long time with excellent effect, especially on gland and epithelium.

1. Bismarck-brown and methyl-green stain is prepared according to Weigert's method, i. e. 5 grm. of pigment to 100 c.c. aq. destil. The sections are left in the brown solution for from two to fifteen minutes. They are then washed and removed to the green stain, where they remain until they have assumed a dark-green colour. They are again washed and placed in absolute alcohol. Experience is the only guide as to when they should be taken out of alcohol, but as soon as a sap-green hue appears the sections may be withdrawn and placed in bergamot, xylol, &c., to clarify. The advantage of this method is that Bismarck-brown gives with methyl-green a beautifully distinct sap-green colour, while for goblet-cells and mucous membrane it is especially valuable, because the intracellular network is coloured brownish green or dark brown, and stands out with a sharpness as in no other staining combination.

2. Bismarck-brown and anilin-green may be used in an exactly similar manner.

3. Eosin and methyl-green were first used by Calberla, who dissolved a mixture of 1 part eosin and 60 parts methyl-green in 30 per cent. warm alcohol. The author uses the stains separately. The sections are first placed in an alcoholic solution of eosin made by mixing 5 c.c. of a watery solution of eosin (0·5 grm. to 100 c.c. aq. dest.) with about 15 c.c. absolute alcohol. Two to five minutes suffice to stain deeply. Wash again and transfer to absolute alcohol, from which it is usual to remove the sections when the eosin is perceptible. They are then placed in the clarifying medium. This method of staining may be recommended for epithelium, mucous membrane, and cartilage.

4. Eosin and anilin-green. Schiefferdecker was the first to employ this method of double staining. The following modification may be employed with excellent results for cartilage and glands. An alcoholic solution of eosin is prepared as in No. 3. After remaining in this solution for fifteen minutes or so, the sections are washed in alcohol, and are then transferred to an alcoholic solution of anilin-green. After remaining in this for fifteen minutes, they are removed to absolute alcohol, where they remain until the eosin stain begins to show itself.

5. Hæmatoxylin-glycerin and eosin. Renaut's method† of double staining, somewhat modified, produces splendid preparations. Three or four drops of Renaut's hæmatoxylin-glycerin are mixed with 1/4

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 145–50.

† Comptes Rendus, lxxxviii. (1879) p. 1039. See this Journal, ii. (1879) p. 763.

litre of aq. dest. In this the sections are left for 24 hours. Then wash and transfer to an alcoholic solution of eosin (as in No. 4) for several minutes. Wash in alcohol, and clarify. This method produces a beautiful nuclear stain, the nuclei are coloured deep violet, the rest of the tissue a beautiful rose red.

6. Hæmatoxylin-glycerin and rosanilin nitrate. The sections are placed in the dilute hæmatoxylin-glycerin (No. 5) for 24 hours; then for ten minutes in a solution of rosanilin nitrate; after washing in water, dehydrate and clarify.

7. Methyl-green and rosanilin nitrate. The sections are left in the No. 1 solution of methyl-green for ten minutes, then after washing are placed in solution of rosanilin nitrate for fifteen minutes; wash again, dehydrate, clarify.

The first three methods may be modified by using very dilute solutions and staining for 24 hours. For hardening, the author always employed absolute alcohol; and Müller's fluid or chromic acid for material to be imbedded in celloidin.

**Staining Nerves in Muscle.*** — To obtain good images of the ramification of nerves in muscle, Dr. K. Mays gives the following process. For small muscles, lay freshly prepared portions in a recently made mixture of 1/2 per cent. alkaline solution of gold chloride, 1 grm.; 2 per cent. osmic acid, 1 grm.; water, 20 grm., until the arborescent nerve ramifications can be perceived; then in the following mixture: glycerin, 40 grm.; water, 20 grm.; 25 per cent. hydrochloric acid solution, 1·0 grm., for about a day. This prevents them from becoming too dark.

Thicker muscles are placed for 12 hours in a 2 per cent. solution of acetic acid, then into a freshly made mixture of 1/2 per cent. alkaline solution of gold chloride, 1 grm.; 2 per cent. osmic acid, 1 grm.; 2 per cent. acetic acid, 50 grm. In this they remain for two or three hours and are then placed in the glycerin mixture. The muscle becomes transparent and amber-coloured, the nerve black-brown. By this method the nerve-end-plate is stained, but not the hypolemmal parts of the nerve.

**Anilin-green.†** — Dr. J. H. List controverts Schiefferdecker's statement that anilin-green requires exposure to light before it is fully capable of staining cell-structures. He finds that solutions of methyl-green and anilin-green (0·5 grm.–100 c.c. distilled water) always colour, even when freshly prepared, the reticulum of goblet and other cells. He also recommends Bismarck-brown and rosanilin nitrate, either in union or alone for the same object.

In reply to List, Dr. P. Schiefferdecker‡ maintains that the former has confused the reticulum which is perfectly apparent even in unstained specimens, with the reticulum only demonstrable by anilin-green solution which has undergone certain changes from lapse of time and exposure to light. The latter reticulum is much thicker than that which is described by List, but otherwise there does not seem to be much difference between them.

* Zeitschr. f. Biol., xx. (1884) pp. 449–528 (5 pls.).
† Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 222–3. ‡ Ibid., pp. 223–4.

**Perchloride of Mercury in the study of the Central Nervous System.***—Golgi's methods for staining nerve-elements black are based on the action of nitrate of silver and perchloride of mercury following the use of bichromate of potash. The mercurial salt, however, does not give a real black colour, but renders the elements opaque and causes them to appear black under the Microscope. For small pieces the method is to immerse in a 2 per cent. solution of bichromate or in Müller's fluid for a month. They are then transferred to a 0·5 per cent. solution of perchloride, which is daily renewed until all colour traces of bichromate have disappeared.

Dr. C. Mondino applies the foregoing method to whole brains by injecting through a carotid (the other and the vertebrals being tied) Müller's fluid by the pressure-bottle process. The excess fluid passes out by the jugular veins, and when the stream has become very slow or stopped, the brain may be transferred to Müller's fluid, where it should remain for a couple of months, though a longer period is not harmful. The carotid injection process is not absolutely necessary, as the brain after removal from the body may be placed in Müller's fluid at once. In this case the membranes must be stripped off. Directly after removal from the fluid, the brain must be placed in a 1/2 per cent. aqueous solution of perchloride and this must be continually changed so long as the solution is stained by the bichromate. It is proper to leave the brain in the perchloride solution for at least two or three weeks after all trace of bichromate has disappeared.

Sections are best made by Gudden's microtome. It is unnecessary to soak these brains in paraffin; owing to their consistence, imbedding alone is found to be sufficient. Out of a whole brain not more than twenty sections will be lost.

While by other methods thin sections are a *sine quâ non* for observation, in this, thick slices are almost necessary, the chief advantage of which is obviously that any fibre can be followed throughout its course in the brain. When a section has been made it is placed at once on a slide and then washed with water to remove any bits of paraffin. It is then dried with blotting-paper. Next a little pure creosote is placed on the centre of the section, which is thereby rendered quite transparent in a few hours. After draining away the excess of creosote, the specimen is covered with dammar. No cover-glass is used.

The author claims the following advantages for this method. It is the only one which shows the course of nerve-fibres throughout the brain. It is extremely simple. In all other methods, the specimens must be thin, require to be stained after section, and to go through many processes; all this renders them liable to injury. It is inexpensive, as the reagents used are very cheap when compared with those required for other methods.

Macroscopically, in other methods there is diminution of volume, disappearance of difference between white and grey matter, while brains prepared in perchloride show the difference between the white

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 157–63.

and grey substances even more markedly than in the fresh state. Moreover, if we wish to have them dry they are merely placed in glycerin for a few days, and on removal the excess of glycerin is allowed to drain off.

**Decalcification and Staining of Osseous Tissue.***—After alluding to methods for obtaining specimens by grinding and by section of bone decalcified by acids, Dr. G. Pommer advocates the advantage to be derived from using bone softened by osteo-malachic or rachitic changes. He states that Müller's fluid possesses properties hitherto unnoticed by previous writers; and that by an extensive series of experiments on bones softened by disease, he has been enabled by the use of certain anilin dyes to distinguish with precision between those parts of bone out of which the salts have been removed artificially, and those parts from which the salts are naturally wanting.

This important property of Müller's fluid apparently depends on the fact that its acid salts decalcify less completely than pure acids.

Decalcification by acids produces many deceptive appearances from shrinkage, &c., and these are altogether obviated by the use of Müller's fluid, which while allowing the bone to be easily cut, does not produce any of these deficiencies or dangers. These advantages are in no way lost from long immersion or frequent change of fluid.

The author's method of staining with anilin dyes depends on the fact that those parts which have at one time contained lime salts become coloured, while those which have never been impregnated remain unaffected.

The dyes, six in number, are the blue and red methyl-violets, dahlia, Parma violet, safranin, and methyl-green. The strength of the solution is for the violets ·02 per 1000; for dahlia ·04 per cent.; for safranin ·1 and ·16 per cent.; and for methyl-green ·3 per cent. The sections are allowed to remain in solution from 12 to 18 hours. The first five give a dark stain, the last only a pale green.

**Staining the Nucleus of the Germinal Vesicle in Arthropoda.†**—Though the methyl-green and acetic acid solution recommended by Mayzel and Strasburger usually produces a good nuclear stain, Dr. v. Wielowiefski states that the nucleus of the germinal vesicle in Arthropoda, and as he suspects in all animals, is absolutely, or almost, unstainable even though the cell be completely isolated in order that the staining fluid may have certain access to the nucleus. Only a few cell nuclei, e.g. the nuclei of nerve-cells and of Gregarinæ, show this peculiarity.

**Double Injections for Dissecting Purposes.‡**—Professor H. F. Osborn's method for double injections § was to fill the whole vascular system with a thin coloured injection-mass. When this has passed through the capillaries and well filled the veins, there is forced into the artery a differently coloured plaster mass which pushes the

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 151–6.
† Biol. Centralbl., iv. (1884) pp. 360–70.
‡ Amer. Natural., xix. (1885) pp. 526–7.
§ See this Journal, iv. (1881) p. 325.

previously injected thin mass before it until the plaster has reached the capillaries, where its onward movement is arrested. Prof. O. P. Hay uses the following method, based on the same principle.

A canula is fitted into the aorta of a cat, and a gelatin mass coloured with carmine injected until it is seen to flow from the right side of the heart; then the tube conveying the red mass being detached, a tube conveying a blue gelatin mass is slipped over the same canula, and the pressure again applied. Into this blue mass had been mixed thoroughly a quantity of starch, preferably from wheat. This starch-bearing mass pushes the carmine mass before it until the starch-grains enter the capillaries and effectually plug them up. The arteries are thus left blue and the veins red, and so well is the work accomplished that a lens of considerable power must be used to discover any admixture of the colours in the smallest vessels of thin membranes.

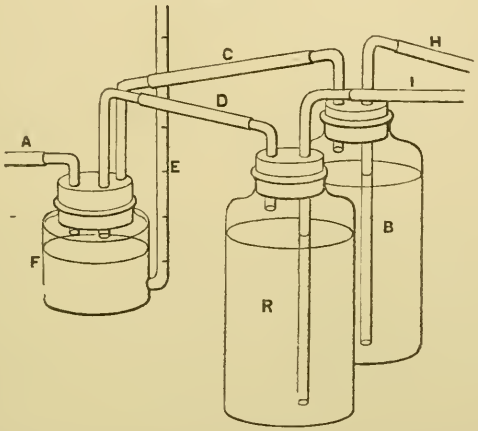
**Double Injections for Histological Purposes.***—Prof. O. P. Hay refers to the usual method of producing a double injection of the blood-vessels preparatory to making sections for the Microscope, by injecting first a gelatin mass of one colour into the artery until the increasing pressure gives notice that the mass is entering the capillaries, and immediately after to inject a differently coloured mass into the vein. The injection being thus accomplished, one of two things, it seems to him, is likely to happen; either the vessels will not be well filled, or the mass intended for one set of vessels will be driven through into the other.

To avoid these accidents he has practised the method of filling both sets of vessels at the same moment and under exactly the same pressure. This pressure is kept low at the beginning, so that all the arteries and veins shall be thoroughly filled before either mass begins to enter the capillaries. Then as the pressure is increased the differently coloured masses meet each other in the capillaries; and if the pressure on each is equal, the vessels may be filled as full as compatible with safety, without danger of either colour being driven from one set of vessels into the other. The desired pressure is secured by allowing a stream of water from a hydrant or cistern to flow into a tight vessel. As the water flows in, the air is forced out through a rubber tube A (fig. 218) into the wide-mouthed bottle F, whose tightly fitting cork gives passage to two other glass tubes. These extend below just through the cork, and above connect respectively with the rubber tubes C and D. Into the side of F near the bottom is fitted another tube E, reaching to a height of ten inches or more, open above, and graduated into inches. If preferred, this tube may also pass through the cork, and extend down well into the mercury with which F is partly filled. B is a bottle of suitable size in which is contained a blue injection-mass for filling the veins, and R a similar bottle containing a red mass for the arteries. The interiors of these bottles are connected with the bottle F by the tubes D and C. Each of the bottles B and R has a tube which, starting from near the bottom, passes through the cork, and is, a little above this, bent at

* Amer. Natural., xix. (1885) pp. 527–9 (1 fig.).

right angles. With these are connected the rubber tubes H and I. When water is allowed to flow into the reservoir mentioned above, the air is forced out through A into F, and thence along the tubes D and C into B and R. As soon as the pressure in these bottles becomes sufficiently great, the liquids which they contain will be driven out

Fig. 218.




through the tubes H and L. If there should be any obstacle to the escape of these fluid masses, the pressure in all the vessels will rise and be registered by the height of the mercury in E.

If now it is desired to inject, for instance, the kidney of a pig, a canula made of a glass tube must be fitted securely into the renal artery, and a similar one into the renal vein. The canulæ must be of such a size that the rubber tubes H and I will fit them well. Heat the gelatin-masses in the bottles B and R to the proper temperature, and keep them so heated until the injection has been finished. Special care must be taken with the tubes H and I, to prevent the gelatin passing through them from becoming frozen. Having clamped the tube H, have an assistant turn on a small stream of water until the gelatin begins to flow slowly from I. If the diameter of the canula is not too small it may be held with the free end directed upward and filled with gelatin allowed to drop from the mouth of I. Then slip I over the canula. Unclamp the tube H, and when the gelatin from B has begun to flow, slip it over the canula inserted in the vein. Then increase the pressure gradually until it has reached as high a point as experience has taught to be safe for the organ operated on.

By this apparatus double injections may easily be made of any organs whose veins are not provided with valves. Triple injections of the liver may be made by first injecting the hepatic artery with a green mass until the whole liver assumes a green tint, and afterwards injecting the portal vein and the hepatic vein with red and blue as above directed.

**Double-sided Slide.**—Dr. C. V. Zenger suggests that for viewing both sides of an object the slide should be pierced through in the centre, and the aperture surrounded on the upper and under side by countersunk rings for the cover-glasses to rest on, level with the surfaces of the slide.

It is to be feared that this plan, though theoretically very perfect, would be too difficult of execution to be practical, though Dr. Zenger writes that "the feat of turning out the slides in their centre without breaking numbers of them is not so difficult as it may seem, if they are well centered and cemented to a cork plate fastened centrally to avoid lateral irregular pressure." He adds, "Such a slide will do extremely good service to the microscopist as well as to the biologist, and amply repays the amount of labour spent on its construction."*

Dr. W. Krause has also suggested what appears to be a similar arrangement.†

**Uses of Collodion.**‡—Mr. E. L. Mark gives an historical account of the development of the use of collodion in histological technique.

The concentration of the collodion was rendered capable of variation by Merkel, through the use of celloidin dissolved in absolute alcohol and ether in equal parts. Schiefferdecker has shown that by dehydrating sections with 95 per cent. alcohol, and clarifying in oil of origanum or bergamot, they can be mounted in balsam. In combination with oil of cloves collodion can be used as a fixture for sections in series, which can be stained after they have been arranged and fixed on the slide.§ Gage || applies the collodion and oil of cloves separately, first coating a number of slides with collodion, which is poured on to one end of the slide and allowed to flow quickly over it and back into the bottle, and then adding a wash of oil of cloves. In order to remove any cloudiness that may arise in the collodion-film a little oil of cloves is added to the balsam. The use of collodion to prevent the crumbling of brittle sections originated with Mr. N. N. Mason,¶ who applied it by means of a fine brush, taking up a small drop and placing it in the centre of the object, so as to allow it to flow out on all sides. After being allowed to harden for a minute, the section may be cut and placed on the slide with the film of collodion underneath.

The following formulæ are given for the preparation of celloidin injection-masses.

A. *Asphalt celloidin.* 1. Pulverized asphalt placed in a well-closed bottle of ether and allowed to remain 24 hours, with occasional shaking.

2. The brown-coloured ether is turned off, and small pieces of celloidin dissolved in it until the solution flows like a thick oil.

* See also this Journal, *ante*, p. 377.
† Internat. Monatsschr. f. Anat. u. Histol., i. (1884) p. 353.
‡ Amer. Natural., xix. (1885) pp. 626–8.
§ Arch. f. Mikr. Anat., xxii. (1883) p. 689.
|| Med. Student, Nov. 1883, p. 14.
¶ Amer. Natural., 1880, p. 825.

B. *Vesuvin celloidin.* 1. Make a saturated solution of vesuvin in absolute alcohol.

2. Dissolve in this pieces of celloidin until the desired consistency is reached.

C. *Opaque celloidin.* 1. Dissolve celloidin in absolute alcohol and ether in equal parts.

2. Add vermilion or prussian blue.

**Mounting in Cells with Canada Balsam.***—Mr. H. Sharp describes a method which obviates many of the difficulties usually experienced.

A cell of paper or card of the requisite thickness is cemented on the slide with gum, and a small piece cut away on opposite sides of the ring.

The object (which has never been allowed to dry, but has been transferred from the medium in which it was arranged, into strong spirit and thence into oil of cajeput, into benzine and finally into turpentine) is next placed in the centre of the cell with a single drop of turpentine on it to keep it moist, and the cover-glass is put on the gummed surface of the cell. When the gum has set and the cover is quite firm a little benzine is taken up with a pipette and applied to one of the openings cut in the card cell, when the benzine instantly runs in and fills up the cell, and in a few minutes the card is thoroughly soaked with it without any effect on the gum. The benzine is then all drawn away with blotting-paper, and balsam applied to one of the openings. When the slide is gently warmed, this soon fills the cell and shows freely at both openings. When the balsam is sufficiently hardened the slide is put on the turntable and trimmed up, leaving a ring of balsam. The final finishing touch is done by holding the slide, cover side down, and giving it a circular sweep over a flame so that the latter just touches the balsam ring all round for an instant, leaving it as even and smooth as glass.

A great advantage of the method is claimed to be that when once the cover is in its place and the gum has set there is not the least danger of the cover shifting or the object being displaced when finishing and cleaning the slide.

**Monobromide of Naphthalin and Tribromide of Arsenic.**—Dr. C. V. Zenger finds that a concentrated solution of tribromide of arsenic in monobromide of naphthalin has a mean refractive index of 1·72, nearly approaching the index of the tribromide itself (1·78).†

The author says that the "aspect of Diatomaceæ mounted in this substance is simply surprising both as regards the crispness of the images and the amount of light received from the more minute details of the valves."

**Mayer's Carbolic Acid Shellac.‡**—Finding that clove oil and creosote produce fine granulations when used in the ordinary shellac method, Dr. P. Mayer has adopted a new method of dissolving the

* Journ. and Proc. Roy. Soc. N.S. Wales, xvi. (1883) pp. 286–8.

† See also this Journal, *ante*, p. 377.

‡ Amer. Natural., xix. (1885) p. 733.

shellac, by which an excellent fixative is obtained that never shows any traces of granulation. The fixative is applied by a fine brush to the *cold* slide.

Mayer prepares the solution in the following manner:—

1. Dissolve one part of bleached shellac in five parts of absolute alcohol.

2. Filter the solution and evaporate the alcohol on a water-bath. A yellowish residue quite stiff when cold is thus obtained. If any cloudiness arises during evaporation, the solution must be filtered again.

3. Dissolve the shellac residue in pure carbolic acid on a water-bath. A concentrated solution of carbolic acid is obtained by exposing the crystals to the air until they dissolve, or by adding a small amount of water (about 5 per cent.).

The quantity of acid should be sufficient to give a thickish liquid when cold.

This fixative is painted on to the cold slide with a brush, at the time of using. The sections are then put in place, and the slide left in the oven of a water-bath for some minutes (10–15 minutes is found sufficient). The carbolic acid is thus evaporated, leaving a perfectly transparent stratum of shellac on the slide. The sections are next freed from paraffin in the ordinary way and mounted in balsam.

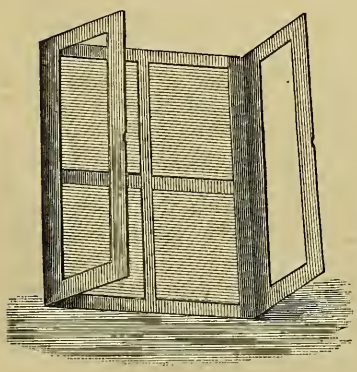
This method is considered to be the best and simplest for fixing *stained* sections.

The shellac can be dissolved directly in carbolic acid, but then the fluid must stand a long time in order to become clear, as it cannot be filtered. For this reason it is preferable to dissolve first in alcohol.

[According to a note just received, Mayer now prepares the shellac as follows:—

The shellac is pulverized and heated with crystals of colourless carbolic acid until it dissolves. In filtering, the funnel should be heated over a flame. It will filter slowly but quite well. If it is too thick, crystals of carbolic acid may be added until the desired consistency is reached.]

Fig. 219.



**Slide-Boxes.** — Messrs. Beck have supplied us with one of the most convenient slide-boxes that we have yet met with, and very economical in price (8*s.* 9*d.*). It consists of a cloth-covered pasteboard box 15 in. × 8½ in. × 3½ in. which contains twelve trays of the form shown in fig. 219, holding twenty-four slides each (or 288 in all). The bottom of the tray is divided into four parts by two cross-pieces, and the slides are prevented from shifting by shutting down the two

hinged frames (also of cardboard) which cover the ends of the slides and keep them in place.

**Chapman's Mould for Cells.***—This mould is a convenient implement for making cells out of such plastic material as shellac, sealing-wax, or paraffin. It consists of a cylindrical core, and a removable collar concentric with it—both of brass. A rounded or bevelled shoulder inside the collar shapes the top of the cell, and a small shoulder on the core moulds a countersink suitable for the reception of the cover-glass. As a single mould is intended for one size and one depth of cell, several are necessary to an outfit.

**Selection and Preparation of Objects for Photographing.†**—Dr. G. M. Sternberg has found that success in making photo-micrographs depends quite as much upon the selection of suitable objects and upon their proper preparation with reference to photography, as upon the optical apparatus used and the technical skill of the operator as a microscopist and photographer, and he accordingly indicates the kind of objects most suitable for making photo-micrographs, and the methods of preparation which have given him the best results.

*Micrococci* require a high power for their detection. When properly stained, they may be photographed with a good 1/10 in. objective; but a higher power is better. The author has obtained his best results by the use of the 1/18 in. homogeneous-immersion objective of Zeiss.

It is well to adopt a standard amplification for each class of objects, so that they may be readily compared as to dimensions by a simple inspection of the photo-micrographs made at different times and places. The standard adopted by the writer for bacterial organisms is 1000 diameters. A less amplification than this will not show the smallest *micrococci* in a satisfactory manner, and a greater is not necessary for a majority of the Bacteria. The method of mounting bacterial organisms in general, for the purpose of photographing them, is essentially to spread out a drop of the fluid containing them upon a very thin and perfectly clean glass cover. This is allowed to dry, and the bacteria are thus attached to the cover in a very thin and tolerably uniform layer.

The aim of the operator in preparing unicellular organisms or vegetable and animal tissues for photography should always be to secure a single layer of cells; for when the cells are piled upon each other, those in the background are necessarily out of focus, and interfere with the beauty of the picture.

*Amœbæ.*—Especial attention is called by the author to the photo-micrograph of an *Amœba* from life, as it illustrates the fact that transparent objects are the best suited for photography inasmuch as they alone show interior details of structure in a satisfactory manner.

Transparent objects which have a different refractive index from that of the medium in which they are placed, do not usually require to be stained; for the increased photographic contrast which is obtained

* Journ. N. York Micr. Soc., i. (1885) p. 188.

† 'Photo-micrographs and how to make them,' 1883, pp. 91–117.

by staining destroys the natural appearance, and the picture no longer conveys the idea that the object is transparent. It is consequently brought nearer to the level of a woodcut and to a certain extent loses its value as a photo-micrograph.

*Unicellular Algæ.*—These should be mounted for photography in very shallow cells, made by turning a circle of white-zinc cement upon a slide. Their colour and natural appearance will be preserved in an aqueous medium, such as weak carbolic-acid water or camphor water. Unfortunately, photography cannot reproduce the rich ruby colour of *Protococcus nivalis*, or the bright green of *Protococcus viridis*. The deeply coloured protoplasm of the former arrests light entirely, and we have in a positive print only a uniformly black mass with circular outline, surrounded by another line representing the cell-wall, to delineate the beautiful little ruby sphere with its more or less granular contents. The green colour of *P. viridis* is better adapted for photography.

*Infusoria.*—Many of the Infusoria may be successfully photographed, but it will be necessary to exercise great care in the preparation of slides for this purpose. Generally but a single individual should be in the field of view, and this should be a perfect specimen; for it is difficult to obtain fields containing several individuals all in the same plane, and in order to show cilia, flagella, and interior details of structure, high powers and very careful focusing will be required.

Occasionally a living Infusorian may be quiet long enough to have its photograph taken; but usually the Infusoria are in rapid motion, and it will be necessary to arrest this motion by means of some chemical agent fatal to their vitality. A weak solution of iodine does this very effectually, and at the same time stains the protoplasm a brownish colour. A ciliated Infusorian killed by adding a drop of this solution (iodine 1 gr., potassic iodide 2 grs., water 100 grs.) to a drop of the fluid in which it is swimming, remains for a time as if suddenly frozen, with its cilia rigid, and projecting like rays, from the surface of the body. This is a favourable time for photographing the creature, as, later, it is liable to undergo changes which destroy the internal structure.

Another method is to place a drop of fluid containing the Infusoria in the centre of a clean glass slide, and to invert this over the mouth of a bottle containing a 1 per cent solution of osmic acid. A very brief time is sufficient to destroy the life of the Infusoria, which may then be selected under a low power and transferred to a drop of clean water. They must be mounted in the thinnest possible stratum of fluid, otherwise they are likely to change position while the exposure is being made.

As a general rule, transparent objects, like *Amœbæ* and the Infusoria generally, should be mounted in an aqueous medium for photography, as this gives better photographic contrast than does a medium having a higher index of refraction, such as glycerin.

*Spores of Fungi.*—The spores of many of the fungi are suitable microscopic objects to photograph, and a photographic method could

not fail to be of value to one especially interested in the study of the fungi.

The deep brown colour of some of these spores, however, causes them to arrest the actinic rays so completely that the photograph does not show plainly the internal septa which are characteristic features of certain species (Coniomycetes).

The spherical or oval spores of moulds and mildews (*Penicillium*, *Aspergillus*, *Botrytis*, &c.,) are better adapted for photography than are the more deeply coloured septate spores referred to. They may be dusted upon the surface of a slide and photographed, dry, without the use of a cover-glass, or they may be mounted in an aqueous medium, or in glycerin, in a very shallow cell. The latter method gives the best results.

To get rid of air-bubbles, which will give great trouble if the attempt is made to introduce the spores at once into water or glycerin, it is best first to wet them thoroughly with alcohol, and before this has entirely evaporated, to place them in the medium which has been selected.

A good plan is to place a drop of alcohol in the centre of a glass slide, and to bring in contact with it a patch of mould in full fruit. The spores will be detached upon contact with the alcohol, and will sink to the bottom of the drop. By a little agitation of the slide they will be distributed in a tolerably uniform layer upon the surface of the glass. When they are nearly dry, in consequence of the evaporation of the alcohol, this is replaced by a drop of distilled water, or of glycerin, and the thin glass cover is applied. The superfluous fluid is removed with blotting-paper (Swedish filtering-paper is the best), and a circle of zinc cement may be turned around the edge of the glass to prevent evaporation while the exposure is being made, or if the intention is to preserve the preparation. A circle of cement is not used to support the margin of the glass cover, as the aim should be to have as thin a stratum of fluid as possible, in order to prevent the spores from floating about. It may be that mounting in glycerin-jelly would be a good plan for the spores having some colour, and this method would have the advantage of retaining them in position.

*Scales.*—The scales of Lepidoptera—butterflies and moths—are suitable objects for photography. They may be mounted dry, and extemporaneous preparations are quickly made by applying the wing or body of a lepidopterous insect to the surface of a clean glass slide.

*Blood-corpuscles.*—The blood-corpuscles of man and the lower animals are among the objects most suitable for photography. Comparatively high powers will be required; and, for purposes of comparison as to dimensions, it is well to adopt a standard of amplification, say 1000 diameters. The author's best results have been obtained with the 1/12 and 1/18 homogeneous-immersion objectives of Zeiss.

The corpuscles are spread upon a thin glass cover in as uniform a layer as possible, and are allowed to dry *in situ*. They do not require staining, and are mounted, dry, over a circle of cement. The simplest method of spreading them is to place a small drop of blood

on one edge of a glass cover resting upon a smooth surface, and to draw the end of a glass slide, held obliquely, across the face of the cover. No pressure must be used, or the delicate corpuscles will be crushed and distorted.

In selecting a field for photography, the aim should be to obtain one in which the circular form of the red corpuscles is preserved, in which they do not overlie each other, and in which one or more white corpuscles are to be seen. Unfortunately, an ideal field is hard to find, and the patience of the operator will often be sorely tried in the effort to find one.

The white corpuscles being larger than the red, and spherical in form, are very commonly drawn to the edge of the stain in the operation of spreading. Care must be taken that the blood-stain is quite dry and the circle of cement upon which the cover is to be mounted quite hard, before it is placed in position on the slide; for moisture, or chloroform from the cement, would injure the preparation.

A series of photo-micrographs of blood-corpuscles, made with a standard amplification, would not only be interesting and instructive, but might also be useful for reference, to those who are called upon to examine blood-stains for the purpose of giving expert medico-legal testimony.

The photographic method would also be useful for recording differences in the form and appearance of blood-corpuscles due to disease, if any constant peculiarities of this kind were associated with particular diseases. But the Microscope does not reveal any such peculiarities of a sufficiently definite character to justify the expectation, at one time extensively entertained, that its use, in the examination of the vital fluid, might prove of value in deciding questions of diagnosis. Differences in the relative proportion of the white and red corpuscles are, however, shown in a rough way, and the depth of colour of the red corpuscles is indicated, to a certain extent, by the photographic contrast with the ground; or, better still, with white corpuscles in the same field. The presence of foreign elements—parasitic organisms—is shown very satisfactorily in photographs; and if a sufficient power is used, their absence is rendered apparent when there are none.

The method is therefore especially useful for recording facts of this kind, as the observer is able to substantiate the truth of his statements, positive or negative, by unimpeachable evidence, and at the same time to show that his skill as a microscopist is sufficient to give confidence in his ability to manipulate the higher powers with which such observations are necessarily made.

For example, the photo-micrograph of yellow-fever blood given by the author, in which the amplification is nearly 1500, and in which the white and red corpuscles are well defined, may be taken as evidence that there were no parasites in the blood of the patient from whom this specimen was obtained; and a sufficient number of similar photo-micrographs of blood from different patients, and drawn at different stages of the disease in question, would prove the absence of any foreign elements, demonstrable with the power used, from the

blood of yellow fever. This has been demonstrated by the author in the manner indicated for the disease in question.

*Pollen-grains.*—Not all of these objects which it would be most desirable to photograph are suitable objects to be photographed by transmitted light, for the reason that the bright yellow colour and comparatively large size of some render them practically opaque. Doubtless this difficulty in the case of pollen-grains, the deeply coloured spores of fungi, &c., can be overcome by special methods of preparation,—the use of decolorizing agents, mounting in media of high refractive index, &c. The limits of the author's volume do not, however, permit him to go very extensively into details with reference to the preparation of objects, even if the technique were completely worked out, which is far from being the case. The general statement may be made, however, that objects which, in water, are not sufficiently transparent for photography, should be mounted in media having a higher refractive index, of which the most useful are glycerin and Canada balsam.

Some pollen-grains swell up and the membranous envelope is ruptured when they are immersed in water. For this reason, as well as for that already given, glycerin is commonly a more suitable fluid in which to mount them. When first placed in glycerin, the cell-wall becomes collapsed from exosmosis of the watery contents; but after a time the natural form is recovered by endosmosis and the fluid within and without is of the same density.

To prevent the trouble arising from the presence of air-bubbles, which are apt to adhere tenaciously to the pollen-grains, it is best to immerse them first in alcohol, as recommended for the spores of fungi. A drop of alcohol is placed in the centre of a glass slide, and the ripe anthers, held in slender forceps, are brought into contact with it; the pollen is detached, and falls to the bottom of the drop. A little agitation of the slide causes it to be distributed in a stratum consisting of a single layer of cells. When the alcohol is nearly evaporated, a drop of glycerin is put in its place, the thin cover is applied, and the superfluous fluid removed with bibulous paper.

*Plant Hairs.*—Some ingenuity will have to be exercised in preparing objects of this kind for photography. Hairs that are closely applied to the surface of the leaf may be photographed *in situ* by mounting the epidermis, or by reflected light. Others will require to be detached, and may be shaved off with a razor, and mounted in a very shallow cell in water or in glycerin. It is always desirable to obtain a field in which the objects do not overlie or cross each other; and with long plant hairs, like cotton, this is not an easy matter unless they are carefully arranged one by one. A good plan both for long plant hairs and animal hairs is to place several side by side on a dry glass slide, fixing the ends to the edges of the slide with sealing-wax. When they are adjusted in position the central portion is wet with alcohol, then with water, and finally with glycerin, if it is to be used. A thin glass cover is then applied.

*Animal Hairs.*—A series of photo-micrographs of animal and vegetable hairs would be extremely interesting and instructive.

Reagents will often be required to show the structure of animal hairs, which is not so simple as that of those from the vegetable kingdom. The thickness of these hairs makes it desirable that photo-micrographs should be made with low-power objectives, as these have the greatest penetrating power. At the same time, good definition is required to show the outlines of the imbricated cells in wool, for example. Wool, ready dyed, of any shade required, is to be had by picking out a little end of coloured worsted.

*Sections of Vegetable Tissues.*—Photo-micrographs are especially well adapted as illustrations of vegetable histology; and the ease with which sections of vegetable tissues are made and mounted for the purpose, as well as the beauty of the result, cannot fail to make this one of the most popular applications of the art.

Sections—transverse, oblique, or longitudinal—are quickly made with a sharp razor from the petioles of leaves; from succulent stems, like the new growth of asparagus, geranium, &c.; from bulbous roots and tubers; from endogenous plants, such as canna, maize, &c.; and from recent sprouts on exogenous trees and shrubs. No section-cutter is required for this purpose; and every one engaged in work of this kind should make himself an expert in free-hand section-cutting, as many of the best photographs are made from extemporaneous preparations.

The proportion of mounted preparations in animal and vegetable histology to be found in every collection which are *not* suited for photographing, will surprise one who attempts to save himself the trouble of mounting his own specimens for the purpose.

The first requisite is a very *thin* section; the second, a very *clean* specimen, free from dirt or air-bubbles. To secure cleanliness, wash the leaf or stem or tuber perfectly clean before commencing to make sections, and place the sections in filtered water when they are made. Use a very sharp instrument, and cover the face of the stem, or whatever it may be, with water or alcohol; the razor also should be wet before making each cut.

"Be extravagant in the number of sections cut, and select only the best. The selected sections will often require soaking for a considerable time in alcohol, to get rid of the air-bubbles. They are to be mounted in water, solution of acetate of potash, glycerin, or Canada balsam. A little experience will enable the operator to judge whether a section, examined under the Microscope in water, requires a medium of higher refractive index in order to render it more transparent. Cells in which the cellulose envelope is comparatively thin, as in the pith of exogenous stems, the epidermis of thin-leaved plants, &c., will show better in water. Thin longitudinal shavings of the wood of the Coniferæ—pine, cedar, &c.—may be mounted in glycerin, after being soaked in alcohol to remove air from the cells. Of course water and glycerin may be mixed in any proportion which seems desirable, to secure a refractive index between the two; and it may be that the addition of chloride of cadmium, or chloral hydrate, to glycerin, for the purpose of obtaining a fluid of still higher refractive index, would in certain cases give still better results."

"There is ample room for experiment and improvement of the technique, and the author can commend this fascinating art to those who have patience and are fond of overcoming difficulties, as one well worthy of occupying their leisure time. Moreover, the knowledge of histology gained in searching for suitable objects to photograph will be of a practical kind, like the knowledge of anatomy gained in the dissecting-room, and the time expended in this way will not be lost."

*Diatoms* are especially well adapted for photo-micrography. When a considerable number are arranged upon a single slide, it is impossible to make satisfactory photographs of all at one exposure, as the focal adjustment and time of exposure which would be best for one is not the best for others. In this case the aim should be to get the best average result.

The photographic method is well adapted for the illustration of a work upon the Diatomaceæ; but as a matter of economy it would be necessary to arrange several species upon a single plate. The best results would be obtained by making a separate negative for each diatom. These might be made with an amplification considerably above that admissible in the published work, and afterwards reduced to the proper size. For this purpose, silver prints of uniform tone should be made, and the diatoms should be cut out and pasted on a large white sheet of cardboard. A reduced negative should then be made from this, from which the gelatine plate used in heliotype printing could be prepared.

Another method would be for an expert to mount selected diatoms for each plate, with special reference to uniformity as to amplification and exposure required.

When a number of negatives are used to make up a single plate, these should have as nearly as possible the same tone-printing quality, and they will require to be skilfully cut for the purpose.

Diatoms should be mounted in balsam for photography, and the amateur will do well to obtain a slide of arranged diatoms by a skilled preparer.

*Insects.*—Small insects which are not too deeply coloured, mounted in balsam, are very good objects to photograph with low powers. The wings, tracheal tubes, feet, antennæ, &c., may also be photographed with higher powers. The suggestion is made that photo-micrographs of the larger insects might be made by reflected light with a lens of comparatively long focus but good defining power, and that the enlargement might be made from the first negative, in which the image should be even less than the natural size of the object.

**Dolley's Technology of Bacteria Investigation.***—This work is divided into three parts: (*a*) General Directions, (*b*) Special Methods of Investigation, and (*c*) Formulary. Under the first we have the

* Dolley, C. S., 'The Technology of Bacteria Investigation; explicit directions for the study of Bacteria, their culture, staining, mounting, &c., according to the methods employed by the most eminent investigators.' xii. and 263 pp., 12mo, Boston, 1885.

study of microscopical preparations, both living and stained, by means of photography, by culture experiments, inoculation, and biological analysis. Following each topic is the literature pertaining to it. The second part treats of the special methods used by different investigators in studying anthrax, cholera, glanders, hog cholera, hydrophobia, leprosy, malaria, septicæmia, syphilis, tuberculosis, typhoid fever, diphtheria, erysipelas, yellow fever, &c., each being followed by the literature of the subject. The third part contains forty-six formulæ for the preparation of stains, reagents, culture media, &c.

The descriptions are short and sometimes quite inadequate; there are no illustrations, which in many instances would be as valuable as descriptions; the work is evidently compiled from literature alone without that fulness of detail which the author could only give from personal knowledge of the manipulations; there is no index.*

Discrimination of Butter and its Substitutes.†—Dr. T. Taylor, microscopist of the Department of Agriculture (U.S.A.), records some discoveries he has recently made while experimenting with butters and the various forms of butterine and oleomargarine. He first boiled a number of samples of pure butter for the purpose of crystallizing their fatty acids. After a lapse of twenty-four hours, during which time they were laid away in a cool place to crystallize, on placing small portions of each under the Microscope, using cotton-seed oil as a mounting medium, he discovered that the crystals of pure butter were sometimes globular and sometimes ellipsoidal in shape, and on turning the polarizer so as to cross the analyser there appeared on each a well-defined cross, having equal arms, like that known as the St. Andrew's cross, and that on rotation of the polarizer the cross rotated in like manner. He found also that the crystals of butterine and of oleomargarine, beef and swine fats, are of stellar forms, and differ from each other. These do not exhibit the cross spoken of in the case of true butter, and do not follow the rotation of the polarizer. In this way butters may be distinguished from oleomargarine made of beef or swine fats.

Dr. Taylor states that only in fresh butter has he been able to detect the cross in perfect form, and that in butter that has been kept for some time, or butter of inferior quality, when boiled and viewed under the polarizer, the crystals present a rosette form, generally four-lobed, and these rotate on the turning of the polarizer as do those in fresh butter—conditions not observed in any other fatty bodies, animal or vegetable.

In connection with Dr. Taylor's non-microscopic test,‡ Mr. J. B.

* Bot. Gazette, x. (1885) p. 315.

† Amer. Mon. Micr. Journ., vi. (1885) p. 115. Cf. also this Journal, *ante*, p. 356.

‡ See this Journal, *ante*, p. 357. "The test is a very simple one. If a few drops of sulphuric acid be combined with a small quantity of pure butter, the butter will assume first an opaque whitish-yellow colour, and after the lapse of about ten minutes it will change to a brick red. Oleomargarine made of beef fat when treated in the same manner, changes at first to a clear amber, and after a lapse of about twenty minutes to a deep crimson."

Betts describes * his examination of samples of butter, in all of which some other fat was present.

**Microscopical Observations on the Constituents of Clouds.†**—Herr R. Assmann during a stay of three weeks on the Brocken in November 1884, made some microscopical observations on the constituent elements of clouds, which has furnished for the first time a number of what he considers to be exhaustive and reliable facts on the subject.

On 3rd November at sunrise the Brocken was completely enveloped in cloud, the weather having been very warm, and the mountain clear for several days previously. The higher cloud-line sank however rapidly, and at 7.30 Herr Assmann's body was completely enveloped in thick clouds while his head was above them. The surface of this sea of cloud was kept tolerably even by a gentle south wind, portions rising to the height of some metres were driven slowly by the wind. A quarter of an hour later the boundary of the cloud had sunk low enough to leave the highest summit of the Brocken uncovered. This state of things continued throughout the day and the cloud-line remained 5 metres below the summit.

The Microscope was placed on a rock, a carefully cleaned glass slide used, and observations with direct illumination made with a power of 200. After some time a cloud rose and covered the summit for a space of two metres. Three or four small drops fell on the glass, but evaporated immediately. Others soon appeared, and these it was possible to observe for some time, as the glass had gradually assumed the temperature of the air. Careful measurements, which were considerably facilitated by the use of oblique illumination, gave the following results:—

The smallest drops of water observed had a diameter of 0·014 mm. when spread out on the glass slide. This was the usual size as long as the observations were made near the upper cloud-line; none were found larger than 0·018 mm. Ten metres lower down the smallest drops were much more rarely found, the predominating size being 0·02 mm.; the clouds were here thick and the sunlight remarkably diminished. Another observation made 20 metres lower down showed a complete disappearance of the smallest drops. Besides those of 0·02 mm. in diameter, many others were observed of 0·03 mm. After a further descent of 50 metres the lower cloud-line was reached, and here the drops found were of the largest diameter observed, being 0·035 mm. In ascending to the former points of observation which had been previously visited, Herr Assmann found generally somewhat larger drops than in descending: at the highest point, however, the smallest drops again predominated. The upper cloud-line did not alter one metre in height during the two hours that the observations lasted. The ratio between the height and the diameter of the small drops was calculated by the author at 1:12 to 1:8.

* Micr. Bulletin (Queen's), ii. (1885) pp. 23–4.

† Meteorolog. Zeitschr., ii. (1885) p. 41. See Naturforscher, xviii. (1885) pp. 129–30.

Herr Assmann took the opportunity, with a power of 400, to test Aitken's theory as to the condensation of the vapour in the air to solid particles. The smallest drops evaporated slowly in from 10 to 15 seconds under the Microscope, without leaving the slightest trace of any residue. A particle of the size of 0·005 mm. could not have escaped observation under the favourable conditions of light and during the many hundred separate observations.

At 2 o'clock the wind veered from W. to N.W. and became cooler, the air being 1° colder, the relative dampness greater, and the clouds higher and thicker. Under the Microscope large drops of a diameter of 0·04 mm. were almost exclusively to be observed, and they lay so close that the entire field of view was covered with water. At 3 o'clock a fine rain fell.

In a subsequent ascent of the Brocken on 31st December, undertaken for the purpose of studying the formation of hoar-frost, Herr Assmann fixed his Microscope by allowing it to freeze to a lump of ice, attached a fine woollen hair to the glass slide, and soon saw very small drops of water fall on the glass, when the summit was quite hidden by clouds. These drops were all liquid in spite of the temperature being at − 10° C. and they evaporated comparatively quickly. The smallest forms predominated. Not a single crystal of ice or snowflake was visible among the drops of water. Small drops that did not evaporate in 5–10 seconds froze to ice of the same size. These were entirely transparent and devoid of air.

**Micro-chemical Test for Brucin and Strychnin.***—Dr. O. Lindt has examined the seeds of *Strychnos nux-vomica* and *Strychnos ignatii* micro-chemically for the above alkaloids. Nitric acid and Erdmann's reagent cannot be employed for detecting brucin, as the former gives the xanthroproteic acid reaction, and the latter the sugar-albumin reaction. If, however, the section to be examined is first treated with light petroleum to remove the fat, and a mixture of selenic and nitric acids is afterwards added, the cell-walls assume a bright red colour which gradually changes to orange, and then to yellow, whilst the parts containing no brucin remain uncoloured. In order to detect strychnin, the fat, grape-sugar, and brucin are removed by maceration with light petroleum and with absolute alcohol, and then a solution of cerium sulphate in sulphuric acid is added; this produces a violet-blue coloration in the cell-walls, and afterwards a red coloration inside the cells.

**Micro-chemical Examination of Minerals.**†—If in a section a mineral has been found which cannot be recognized by its optical properties, morphological aspect, cleavage, &c., Dr. A. Wichmann recommends that the cover-glass should be removed, and the whole slide together with the section smeared over with a thin fluid solution of Canada balsam in ether by means of a soft brush. If it is not put on too thickly, it is sufficiently dry in a few hours for further treatment. The mineral to be examined is laid bare with a strong needle, or the

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 237–40.
† Ibid., pp. 417–9.

point of a knife, and a drop of the acid, which is to be applied, placed on it. In the application of hydrochloric acid Wichmann allows it to dry, redissolves in another drop, and brings the solution by means of a capillary pipette or platinum spatula to a part of the slide away from the region of the section. If one is dealing with fluo-silicic acid, the drop is removed with a platinum spatula as soon as it has half dried. In this case it is judicious to hasten the decomposition by previously adding a drop of watery fluoric acid.

For dealing with isolated particles of a mineral in a powder, it is best to cover a carefully cleaned slide with the balsam in ether, and before it has dried sprinkle a small quantity of the powder on it, so that the particles adhere to it. The balsam is allowed to dry, and one then searches for the granules of the mineral under the Microscope, and covers over all the others with more balsam solution. The granules thus isolated can be treated in the usual way.

**Isolating Minerals in Sections for Micro-chemical Examination.***—Dr. A. Streng uses cover-glasses which are prepared by dipping them into melted wax, and, when this is cold, making an opening (1/2–1 mm.) with a pin in the middle of the wax. The spot so laid bare is covered with a drop of concentrated hydrofluoric acid, until it is perforated, and the remaining wax is then removed. To examine a given mineral chemically, one side of the perforated cover-glass is covered round the opening with a thin layer of heated Canada balsam, and this side is, when the balsam has set, laid on the section in such a way that the opening is over the mineral to be tested. By means of a heated wire the balsam is melted. The opening thus filled with balsam is made free by a brush dipped in alcohol, and test solutions can be applied to the mineral. By warming the slide, the cover-glass can be lifted off, and the various reactions studied on it.

**The Microscope in Geology.**†—Mr. G. H. Williams, in an article on this subject, recurs to what we have before commented on, viz. the comparatively limited appreciation among Englishmen of the microscopic study of rock-sections. He refers to what he terms the "surprising fact that the appreciation of it among English-speaking people has been so slow, that not one reliable text-book on the subject of petrography exists in the language of the man who gave the first impulse to its modern development," forgetting, however, Mr. Rutley's 'Study of Rocks.'

He also points out that "heretofore microscopical petrography has been essentially a branch of mineralogy, but its future certainly lies in the far wider sphere of geology. The mere laboratory study of isolated rock specimens, which has served so good a purpose in the perfecting of delicate and accurate methods, no longer possesses any significance, now that these are so thoroughly developed. What in Germany has been secured by years of patient labour may now be learned in a comparatively short time. Geologists have only to know and realize its application to their field of work in order to eagerly

* Ber. Oberhess. Gesell. f. Natur. u. Heilk., xxii. (1883) p. 260.
† Science, v. (1885) pp. 190–1.

avail themselves of such an important aid. The use of the Microscope alone will in future produce but little that is new; but its possibilities in geology, when intelligently employed in connection with the most detailed and careful field-work—the necessity of which has been increased, not diminished, by its introduction—cannot be easily overrated.

What palæontology has done for the fossiliferous deposits, this, and even more, the Microscope must do for the crystalline rocks. The less altered forms of igneous masses have thus far been almost exclusively studied; and, although they still have much to teach us, it is not by their investigation that the Microscope is destined to yield its greatest assistance to geology. The changes, structural and chemical, which go on in rocks after they are first formed, leave behind them more or less distinct traces which it is the special province of the Microscope to follow out and interpret. . . . It is by dealing with such problems as Lossen, Renard, and Lehmann in Europe, and Wadsworth in this country [U.S.A.] have especially pointed out that the Microscope in geology can in future render its best service. The manner in which this can be accomplished is by the patient following, step by step, of unchanged rocks into their most completely altered equivalents, and carefully comparing the condition of each constituent at every point. In this manner the succession of changes which they undergo may be as completely worked out as though we could see the process actually going on before our eyes. . . . What is especially to be desired are detailed studies of many small areas where the same rock, whether eruptive or sedimentary, can be traced from its original form to its more altered state and a comparison of the results obtained in each. This Lossen has recently attempted for the southern Hartz, and has thereby indicated what is perhaps the most promising field for microscopic work in geology."

**Application of the Microscope to Practical Mineralogical Questions.***—In examining an argentiferous mineral which was found in Wales, and known there as "blue stone," it became desirable to determine whether the mineral was a definite double sulphide of lead and zinc, or whether it was a fine mechanical mixture of the two well-known minerals galena and blende. Prof. Tichborne found that on gradually powdering the mineral and examining it from time to time under the Microscope, a point was at length reached when half the particles became transparent and transmitted light, whilst no amount of powdering would render the other particles transparent. To try such an experiment it was necessary to view with very strong transmitted light (a 1/2 in. object-glass) and to cut off all reflected light. From this experiment he came to the conclusion that the mineral was an intimate mixture of fine crystals of blende and galena, the blende being the transparent particles and the galena the opaque. Although both these minerals possess a certain degree of metallic lustre, galena is one of the most perfectly opaque substances known, whilst blende in very thin layers is perfectly transparent.

* Ann. and Mag. Nat. Hist., xvi. (1885) p. 145.

**Microscopical Examination of Volcanic Ash from Krakatoa.***—Mr. J. Joly in preparing this dust for the Microscope found that mere shaking up with water, and pouring off before complete settlement, served only to remove the lighter fragments of pumice, and that complete separation was only readily effected by the following method:—

Into a glass tube 1 m. long and about 4 cm. in diameter, closed at one end and filled with water to the brim, the partially cleansed dust is introduced and allowed to settle. A strip of glass is now pressed on the open end, and the whole rapidly inverted into a shallow dish containing water. The denser particles descending most rapidly through the column of water in the tube, reach the dish first. When the more slowly moving particles are observed to have nearly attained the dish, a movement of the tube to one side effects the desired separation.

The author found that the constituents of the ash presented under the Microscope a spectacle of the most extreme interest and beauty, especially with polarized light.

**Examination of Potable Waters.†** — The method recommended by Herr J. W. Gunning for the chemical examination of water consists in adding to a litre of the water enough ferric chloride to correspond with about 5 mgrms. of iron. The ferric chloride should be as nearly neutral as possible. Under these conditions, ammonia, nitrites and nitrates are left in solution, whilst other nitrogenous substances are carried down with the precipitate of ferric hydroxide. By heating this with soda-lime the nitrogen of these compounds is obtained as ammonia. By this treatment cloudy water is completely clarified and yellow moor-water decolorized. The process has been applied with success on a large scale in Holland for the purification of drinking-water, especially during diarrhœa and cholera epidemics.

In the bacteriological examination of water, the author prefers to develope a pure culture in a liquid medium rather than in the solid medium recommended by Koch. The water to be tested is mixed with a clear sterilized yeast decoction. By sterilizing this again, certain bacteria are either killed or rendered inactive, while the others from their superior vitality survive and develope. By a process of progressive sterilization, beginning at low temperatures and gradually ascending, pure cultures are obtained.

**Removal of Micro-organisms from Water.‡**—Dr. P. F. Frankland has investigated the efficiency, as regards the removal of micro-organisms, of methods of water-purification depending upon (*a*) filtration; (*b*) agitation with solid particles; (*c*) subsidence, and (*d*) chemical precipitation (Clark's process). The method of investigation consisted in determining the number of organisms present in a given volume of the water before and after treatment, the determinations being made by Koch's process of gelatin-culture on glass plates.

* Scientif. Proc. R. Dublin Soc., iv. (1885) pp. 291-9 (2 pls.).

† Chem. Centr., 1884, pp. 151-2. See Journ. Chem. Soc.—Abstr., xlviii. (1885) p. 841.

‡ Proc. Roy. Soc., xxxviii. (1885) pp. 379-93.

The filtering materials were greensand, silver sand, powdered glass, brickdust, coke, animal charcoal, and spongy iron. These materials were all used in the same state of division, being made to pass through a sieve of 40 meshes to the inch. Columns 6 in. in height were used.

It was found that only greensand, coke, animal charcoal, and spongy iron wholly removed the micro-organisms from water filtering through them, and this power was in every case lost after the filters had been in operation for one month. With the exception of the animal charcoal, however, all these substances, even after being in action for one month, continued to remove a very considerable proportion of the organisms present in the unfiltered water, and in this respect coke and spongy iron occupy the first place.

The results obtained by agitating water with various solid materials show that a very great reduction in the number of suspended organisms may be accomplished by this mode of treatment, and the complete removal of all organisms by agitation with coke is especially worthy of notice.

Again, the results obtained with Clark's process show that we possess in this simple and useful mode of treating water a means of greatly reducing the number of suspended organisms.

Thus, although the production in large quantities of sterilized potable water is a matter of great difficulty, involving the continual renewal of filtering materials, there are numerous and simple methods of treatment which secure a large reduction in the number of organisms present in water.

Ady, J. E.—**The Microscopic Study of Rocks. VII., VIII. Petrographical Demonstrations.**

*Illus. Sci. Monthly*, III. (1885) pp. 227–9 (1 fig.), 259–62 (1 fig.).

**Bacillus tuberculosis, modified method of staining.**

[The method which, according to the 'Deutsche Militär - Aertzliche Zeitung,' is taught the medical officers of the army. Also Baumgarten's method.]

*The Microscope*, V. (1885) pp. 189–90. from *Western Medical Review.*

Beckwith, E. F.—**Some observations on the Distribution and Termination of Nerves in the Human Lungs.**

[Methods. *Supra*, p. 894.]

*The Microscope*, V. (1885) pp. 148–52 (3 figs.).

*Bizzozero*, G.—**Manuel de Microscopie clinique, Microscopie légale, Chimie clinique, Technique, Bactérioscopie.** (Manual of clinical microscopy, legal microscopy, clinical chemistry, technique, bacteriology.)

2nd French edition, translated by C. Firket. xviii. and 568 pp., 7 pls. and 103 figs., 8vo, Bruxelles, 1885.

**Chapman's Mould for Microscopical Cells.** [*Supra*, p. 911.]

*Journ. N. York Micr. Soc.*, I. (1885) p. 188.

Cole's (A. C.) **Studies in Microscopical Science.** (Parts VII. and VIII., pp. 25–8, 29–32.)

Sect. I. The Structure of Antheridia in *Polytrichum*. Plate VII. Antheridia and Sporogonium of a Moss.—Non-sexual organs of reproduction in Vascular Cryptogams. Plate VIII. V. S. of Sorus of *Scolopendrium*. × 75.

Sect. II. Respiratory Organs. Plate VII. Gill of Anodon. V. T. Sec. with

glochidia *in situ*. × 75. Plate VIII. Structure of Gills of Lamellibranchs (after Holman Peck).

Sec. III. Phthisis. Pulmonary Consumption. Brown induration of the Lung. Plate VII. Phthisis. × 185. Plate VIII. Lung (Brown Induration). × 36.

Sect. IV. The Frog. Plate VII. Mouth of Tadpole. × 70. Plate VIII. Tracheæ of Silkworm (*Bombyx mori*). × 46.

Cox, C. F.—**Hard-rubber Cells.**

[Made from hard-rubber tubes about 1 ft. long, and of the exact sizes necessary, when made into rings, to take 1/2 in., 5/8 in. and 3/4 in. cover-glass. By means of a turning lathe the tubes may be easily and evenly cut into cells of any desired depth.]

*Journ. N. York Micr. Soc.*, I. (1885) p. 188.

Davis, J. J.—**A Simple Cover-compressor.**

["Divide a small cork transversely and cut a notch in one end of one of the pieces. Pass an ordinary stationer's rubber elastic ring over the end of the slide; put the piece of cork under it, the ring resting in the notch; then draw it along until the under side of the ring will rest under the point to which the pressure is to be applied, then lower the cork on the cover. If more pressure is desired a second ring may be placed over the first. Pieces of cork of different lengths give more or less pressure, and those of different diameters apply it over more or less space. The slides can be laid away side by side."]

*The Microscope*, V. (1885) p. 36.

Day, E. G.—**Hints on Microscopical Mounting.**

[Wax cells (readily made by using a pair of dividers). White zinc cement excellent for shallow cells. Fungus growths prevented by carbolic acid. Cleaning cover-glasses with nitric acid.]

*Journ. N. York Micr. Soc.*, I. (1885) pp. 190–1.

Debes, E.—**Die Herstellung von Diatomaceen Dauerpräparaten.** (Making permanent preparations of diatoms.) [*Supra*, p. 898.]

*Hedwigia*, XXIV. (1885) pp. 151–66, 171–2.

Dolley, C. S.—**The Technology of Bacteria Investigation:** explicit directions for the study of Bacteria, their culture, staining, mounting, &c., according to the methods employed by the most eminent investigators. [*Supra*, p. 917.]

xii. and 263 pp., 12mo, Boston, 1885.

Draper, E. T.—**Graphic Microscopy.** XX. Small Brittle Star-fish. XXI. Group of Foraminifera.

*Sci.-Gossip*, 1885, pp. 169–70 (1 pl.), 193–4 (1 pl.).

Eternod, A.—**Le Microtome à triple pince.** (The microtome with triple pincers.) [*Supra*, p. 900.]

*Journ. de Microgr.*, IX. (1885) pp. 264–7.

Ewell, M. D.—**Measurement of Blood-corpuscles.** [*Post.*]

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 150–1.

*The Microscope*, V. (1885) pp. 183–6, from *Chicago Legal News*.

*Firket, C.*—See Bizzozero, G.

Frankland, P. F.—**The Removal of Micro-organisms from water.** [*Supra*, p. 923.]

*Proc. Roy. Soc*, XXXVIII. (1885) pp. 379–93.

Gage, S. H.—**The Limitation and Value of Histological Investigation.**

[Abstract of address to the section of Histology and Microscopy of the Amer. Assoc. Adv. Sci.]

*Science*, VI. (1885) pp. 226–7, 228.

Gierke, H.—**Färberei zu mikroskopischen Zwecken.** (Staining for microscopical purposes.) (*Concld.*) [*Supra*, p. 901.]

*Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 164–221.

*Gierke, H.*—**Staining Tissues in Microscopy. III., IV.**

[Transl. by Prof. W. H. Seaman from 'Zeitschr. f. Wiss. Mikr.']

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 151–3, 152–6.

Gowen, F. H.—**Improved Microtome.** [*Supra*, p. 899.]

*Amer. Mon. Micr. Journ.*, IV. (1885) pp. 15–6.

HAACKE, W.—**Ueber die Conservation der Medusen.** (On the preservation of Medusæ.) [*Post.*]
*Zool. Anzeig.*, VIII. (1885) pp. 515–6.

HAUSHOFER, K.—**Beiträge zur Mikroskopisch-Chemischen Analyse.** (Contributions to Microscopical-Chemical Analysis.)
[*Post.* A small filtering apparatus is also described and figured.]
*SB. K. Bayer. Akad. Wiss. München*, 1885, pp. 206–26 (1 fig.).

[HITCHCOCK, R.]—**Prof. H. L. Smith's New Mounting Medium.**
[Defence of Prof. Smith for not having published the formula. "We are not at present authorized by Prof. Smith to make any statement concerning this matter, but from what we know, and have learned from conversation with Prof. Smith some time ago, we are assured that there are excellent reasons why the composition is still withheld from the public."]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 157.

" " **Microscopical Exhibitions.**
[Reply to a correspondent who insists that the "general public does not want to be instructed as much as it wants to be amused." "Before we reach a conclusion so uncomplimentary to the intelligence of the public as that of our correspondent, we should at least try the experiment of making interesting to the mind objects not specially attractive to the eye. The experiment has yet to be systematically tried. The criticism to be made upon our exhibitions generally is that they are mere displays of fine objects, and those who look at them are not able to learn what they are. Even the wing-case of the diamond-beetle gains in interest by a few words of explanation, especially if the scales of a butterfly's wing are shown beside it and their relation to it briefly stated."]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 158–9, 160.

HOYLE, W. E.—**Preserving Eggs of Cephalopoda, and Preparing Blastoderms.** [*Post.*]
*Nature*, XXXII. (1885) p. 506 (Report to British Association).

JAMES, F. L.—**Arrangement of Work-table.**
[Brief suggestions for the places of instruments, &c., "so that no time is lost in putting the hand directly upon the desired instrument or object."]
*The Microscope*, V. (1885) pp. 190–1, from *National Druggist.*

" " **Elementary Microscopical Technology.**
[Bell's Cement. Seiler's Cement. Casein Cement. Marine Glue. Chrome Cement.]
*Micr. Bulletin* (Queen's), II. (1885) pp. 25–6, from *National Druggist.*

JULIEN, A. A.—**The Sealed Flasks of Crystal.**
[Fluid-cavities in quartz. Directions for preparing the material and for examination under the Microscope. Detection of the chemical nature of the contained liquids and gases—*post.* Immersion warm stage—*post*—&c.]
*Journ. N. York Micr. Soc.*, I. (1885) pp. 129–44.

KÜKENTHAL, W.—**Die mikroskopische Technik im zoologischen Praktikum.** (Microscopical technique in practical zoology.)
37 pp. and 3 figs., 12mo, Jena, 1885.

LANGTON, W.—**Thoma's Microtome.** Its practical and theoretical advantages.
*Trans. and Ann. Rep. Manchester Micr. Soc.*, 1884–5, pp. 29–31.

LATHAM, V. A.—**The Anatomy of the Cockroach.**
[Directions for bleaching and mounting wing, gizzard, eyes, &c.]
*Sci.-Gossip*, 1885, pp. 210–1.

LENDENFELD, R. v.—**The method of Section-cutting, with some improvements.** [*Post.*]
*Proc. Linn. Soc. N. S. Wales*, X. (1885) pp. 23–4.

LEUCKHART, R.—**Mittheilung.**
[In praise of the preservative methods in use at the Naples Zoological Station; the skill of Salvatore in preserving with all their natural appearances such delicate creatures as Siphonophora having conferred a great boon upon working zoologists by rendering it possible to study these creatures in a museum as well as when living in the sea.]
*Zool. Anzeig.*, VIII. (1885) p. 333.

List, J. H.—**Zur Färbetechnik.** (On staining methods.) [*Supra*, p. 902.]
*Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 145-50.

„ „ **Zur Anwendung des Anilingrüns.** (On the use of anilin green.) With remarks by P. Schiefferdecker. [*Supra*, p. 903.]
*Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 222-4.

Minot, C. S.—**Some histological methods.**
[Müller's fluid.—Beale's carmine.—Eosin in alcohol.—Imbedding in celloidin, *post*.—Dripping apparatus for cutting under alcohol, *supra*, p. 900. —Benzole.—Balsam.—Alcohol.—Oil.—Paraffin.—Picric acid carmine.]
*Amer. Natural.*, XIX. (1885) pp. 828-30 (1 fig.), 916-7 (1 fig.).

Möller, J.—**Die Mikroskopie der Cerealien.** (The microscopy of cereals.) [*Post.*]
*Pharmaceut. Centralhalle f. Deutschland*, 1884, Nos. 44-8.

Nachtrieb, H. F.—**A new Water-bath.** [*Post.*]
*Amer. Natural.*, XIX. (1885) pp. 917-9 (3 figs.).

Osborn, H. F.—**A simple method of injecting the arteries and veins in small animals.** [*Post.*]
*Amer. Natural.*, XIX. (1885) pp. 920-1 (1 fig.).

**Queen's (J. W. & Co.) Prepared Diatoms in fluid ready for mounting.**
["Recognizing the fact that the mounting of diatom-slides from the dry material is not always satisfactory (to put it mildly), we are now prepared to offer something better, consisting of eight gatherings thoroughly cleaned and put up in equal parts of alcohol and distilled water (in homœopathic vials). They are of the right density or proportion for mounting, and as they have *never been dried* since cleaning they will not exhibit that annoying tendency to cling together in masses when dried on the slide or cover."]
*Micr. Bulletin* (Queen's), II. (1885) p. 29.

Pommer, G.—**Ueber Methoden, welche zum Studium der Ablagerungsverhältnisse der Knochensalze und zum Nachweise kalkloser Knochenpartieen brauchbar sind.**
[*Supra*, p. 905.] *Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 151-6.

Ryder, J. A.—**A cheap Bell-glass for the Laboratory table.** [*Post.*]
*Amer. Natural.*, XIX. (1885) p. 920.

*Sachs, J.*—**Preparing leaves to show starch-grains.** [*Post.*]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 178.

Savastano, L.—**Tecnica microscopica vegetale. Trattamento delle gemme fiorali di agrumi con l'acido picrico.**
[Microscopical technique of plants. Treatment of the flower-buds of Aurantiaceæ with picric acid.]
*Rivista Ital. Sci. Naturali*, I. (1885) p. vii.

Schäfer, E. A.—**The Essentials of Histology,** descriptive and practical, for the use of students.
[Each of the forty-two lessons commences with a short statement of methods for the microscopic examination of the tissue described in the lesson.]
x. and 245 pp., 281 figs., 8vo, London, 1885.

Schiefferdecker, P.—See List, J. H.

*Seaman, W. H.*—See Gierke, H.

Selenka, E.—**Zur Paraffin-Einbettung.** (On Imbedding in Paraffin.) [*Post.*]
*Zool. Anzeig.*, VIII. (1885) pp. 419-20 (2 figs.).

Slack, H. J.—**Pleasant Hours with the Microscope.**
[Aphides—*Phylloxera*.]
*Knowledge*, VIII. (1885) pp. 129-30 (3 figs.), 174-6 (4 figs.).

Smith, H. L.—**Mounting Media of high Refractive Index.** [*Post.*]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 161-3 (1 fig.).

Taylor, G. H.—**Cleaning Marine Muds.**
[Detailed directions.] *Amer. Mon. Micr. Journ.*, VI. (1885) pp. 147-9.

Taylor, T.—**Butter and Fats.** [*Post.*]
*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 163-4 (1 fig.).
Cf. also p. 174—exhibits at New Orleans Exposition showing the results of experiments on butter, fats, and fibres of various kinds treated with reagents.

**Technical Notes, various.—**

Siliceous Cement, for protecting corks from the fumes of acid, &c.—Mix equal parts colloid silica and thick gum-water, with sufficient gilders' whiting to make it of the consistency of treacle.—Labelling slides.

Carbolic Acid Preservative, for animal and vegetable tissues.—Carbolic acid, 1 drachm; alcohol, 2 drachms; distilled water, 12 oz.: dissolve the carbolic acid with the alcohol, then add it to the water and boil for ten minutes.

Acetate of Aluminium.—To 1 part acetate add 4 parts distilled water. This is very good for preserving vegetable colours, as in desmids and other algæ.

Glycerin and Acetic Acid is useful for mounting minute insects, &c.; glycerin, 1 oz.; acetic acid, ½ oz.

Dammar Cement.—Dissolve gum dammar in benzole, and add one-third gold-size; it dries very quickly, and is preferably used as a first coat for fixing the cover-glass when glycerin is used for mounting.

Gum, for attaching labels, covering papers, and objects mounted dry. Dissolve 2 oz. of gum arabic in 2 oz. of water, and add 2 drachms of soaked gelatin, 30 drops of glycerin, and a lump of camphor.

*The Microscope*, V. (1885) pp. 179 and 182.

Tichborne.—**Experiments to illustrate the application of the Microscope to practical Mineralogical questions.** [*Supra*, p. 922.]

*Ann. and Mag. Nat. Hist.*, XVI. (1885) p. 145.

Tyas, W. H.—**Small Freezing Microtome.**

[Golding-Bird's, Vol. IV. (1884) p. 523, with the addition of a clamp which can be fixed to a table and a woollen cover to slip over during the freezing process.]

*Trans. and Ann. Rep. Manchester Micr. Soc.*, 1884–5, p. 33.

Van Brunt, C.—**Prof. H. L. Smith's new Mounting Medium.**

*Journ. N. York Micr. Soc.*, I. (1885) pp. 158–9.

Vorce, C. M.—**The Microscopical Discrimination of Blood.**

[Details the practical requisites for accurate measurements of blood-corpuscles, and the examination of blood-stains, and gives the processes followed and the results obtained in an investigation of a murder case.]

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 127–9.

„ „ **The Working Session.** A word to the working microscopists.

*The Microscope*, V. (1885) pp. 152–3.

Ward, E.—**Dry Mounting.**

[Prefers metal cells and brown cement. For black ground, matt black, which dries dull, is unsurpassed. Object should if possible be cut to the size of the cell and kept in position by the cell-wall without gum. Directions for gumming small objects. Sealing up, *post*.]

*Trans. and Ann. Rep. Manchester Micr. Soc.*, 1884–5, pp. 33–6.

**Watson and Son's Slides of British Fresh-water Algæ.**

[Twenty-four slides illustrating the most important genera for the use of students.]

*Grevillea*, XIV. (1885) p. 22.

[Whitman, C. O.]—**Microtome Knives.** [*Post*.]

*Amer. Natural.*, XIX. (1885) pp. 830–2 (1 fig.).

Williams, G. H.—**The Microscope in Geology.** [*Supra*, p. 921.]

*Science*, V. (1885) pp. 190–1.

Wright, R. R.—**Suggestions as to the Preparation and Use of Series of Sections in Zootomical Instruction.** [*Post*.]

*Amer. Natural.*, XIX. (1885) pp. 919–20.

Ziegler, E.—**Technik der histologischen Untersuchung pathologisch-anatomischer Präparate.** (Technique of the histological investigation of pathological-anatomical preparations.) Appendix to the 'Lehrbuch der allg. u. spec. patholog. Anatomie u. Pathogenese.' 36 pp., 8vo, Jena, 1885.

## PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held on the 26th November, 1884.

The following objects, &c., were exhibited:—

Mr. C. D. Ahrens:

New Erecting Microscope. Ant Lion.

Mr. Badcock:

*Lophopus crystallinus.*

Mr. Charles Baker:

Prof. Abbe's Condenser modified for Students' Microscopes. New Slide-cases. Dr. George Grübler's Stains and Reagents. Zeiss's Microscopes.

Messrs. R. and J. Beck:

Corneal corpuscles. Bacteria developing from spores. *Pleurosigma angulatum* on silvered 3 × 1 slip. Sorby's Diehroiscope. New Mineral Stage.

Prof. Bell:

Cuticle (dorsal) of *Peripatus capensis.*

Mr. Bolton:

Permanent mounts of *Cordylophora lacustris. Thuricola operculata*? *Hydra vulgaris. Pedalion mira.*

Mr. Cheshire:

*Bacillus alvei* (Cheshire) sporulating.

Spermathecal valve from Queen Bee.

Mr. Cole:

New species of *Bacillus* as yet unknown and unnamed.

Mr. Crisp:

Young *Gobius* in the egg. *Amphipleura pellucida* coated with silver.

Mr. Curties:

Osborne's Diatomescope.

Mr. Enock:

1st leg of Honey Bee (worker) *A. mellifica*, showing semicircular comb used for cleaning the antennæ. Web of house spider, *Amaurobius similis*, showing the curled threads attached to the plain ones and the flocculus of adhesive silk.

Mr. Hardy:

Section of eye of drone-fly. Pond Life in new Flat Bottle.

Mr. Joshua:

*Anadyomene flabellata* Lam., from Bermuda.

Cystocarpous fruit of *Polysiphonia* and *Bonnemaisonia.*

*Codium tomentosum*, section of plant showing spores.

Desmidieæ, various species from Minnesota.

Desmids collected at Capel Curig 15th Sept., 1884, containing *Euastrum abrense* Elf., *Hyalotheca undulata* Nordstedt, *Micrasterias radiosa* Ralfs, &c.

Mr. M'Intire:

Larva of *Tiresias Serra* from which the "Hairs of Dermestes" are obtained.

Dr. Maddox:

Three pierced culture cells.

Specimens of coloured lichenized nutritive paper exposed for Bacteria, &c., and unexposed.

Two Photographs of apparatus used at the Observatory of Montsouris, Paris, in Bacteriology.

Rough diagram of Dr. Miquel's Udo-bactériemètre for rain analysis.

Dr. Van Heurck:

Photomicrographs of *A. Lindheimeri* × 3000.

*A. pellucida* × 2850 and 7000, showing "beaded" or alveolar structure. The photomicrographs produced with Powell and Lealand's 1/8 in. of 1·47 N.A., and their vertical illuminator, the preparation being one of the silvered slides of Dr. A. Y. Moore intended specially for use with the vertical illuminator.

Mr. J. Mayall, jun.:

A modification of Wenham's single plate mechanical stage, by which the plate is suppressed and the slide lies on the rotating stage bed.

Mr. Michael:

*Plumularia setacea* with extended tentacles as in nature (slightly stained.)

Mr. E. M. Nelson:

*Amphipleura pellucida* in Prof. H. L. Smith's medium, ref. ind. 2·4 × 2400 with Powell and Lealand's 1/12 1·43 N.A., illuminated with oblique light with Powell and Lealand's truncated condenser 1·4 N.A.

"Comma" bacillus (Dr. Koch) × 2500 with Powell and Lealand's 1/25 1·38 N.A.

Messrs. Powell and Lealand:

Section of *Triceratium favus* prepared by Dr. J. H. L. Flögel × 800 with 1/16 oil-immersion.

Mr. B. W. Priest:

*Haliphysema.*

Mr. T. B. Rosseter:

*Stephanoceros eichhornii* and other Infusoria.

Mr. G. J. Smith:

Limestone with shells, from Headon Beds, Christchurch Bay, Hants. Quartz Diatase from Freiburg, with polarized light.

Mr. James Smith:

*Pleurosigma elongatum* × 1200 with 1/16 immersion.

Messrs. Swift and Son:

Photograph of Blow-fly's Tongue taken with their new 1 in. objective.

Mr. Ridley:

'Challenger' Deep-sea Sponges — Specimens of *Esperia* and *Tedania* showing canal-system and histological elements.

Mr. Amos Topping:

Transverse section of head of Lamprey (stained).

Mr. H. J. Waddington:
Magnesium urate (radiating crystals).
Mercurious chloride (Calomel).
Dr. Wallich:
Diatoms from Nottingham (Virginia) shown with new condenser.

---

The second Conversazione of the Session was held on the 22nd April, 1885.

The following objects, &c., were exhibited:—
Mr. Badcock:
*Melicerta ringens* on *Hydrodictyon utriculatum*, *Lophopus crystallinus*, *Stephanoceros eichhornii*, *Floscularia cornuta*, &c., from a London Park.
Mr. Chas. Baker:
Microscopes, Apparatus, and Objectives by Zeiss. Various forms of Prof. Abbe's Illuminator for English and other Students' Microscopes. New German Object-cases.
Mr. Bolton:
*Atax upsilophora*, *Chirocephalus diaphanus* (Nauplius stage) *Asplanchna Ebbesbornii*, and diatoms with attached fibres.
Mr. E. W. Burgess:
*Janischia? antiqua* Grun.
Longitudinal section of Ebony showing crystals.
Mr. Cheshire:
Gland (oil?) from vertex of head of Hive Bee.—Probably this gland by its secretion enables the bee to render its wax plastic at the time of comb-building.
Gland (Salivary) from the head of Hive Bee.—This gland converts the cane sugar of nectar into grape sugar.
Gland (Salivary?) from pro-thorax of Hive Bee.—This gland probably has to do with supplying a developing queen with food.
Mr. Crisp:
Nobert's Ruling Machine.
Mr. Dowdeswell:
The Microbe of Fowl Cholera, in blood of Pigeon.
Mr. E. T. Draper:
Original Drawings of Microscopic Objects.
Mr. F Enock:
Legs of various Bees, showing the pollen-collecting apparatus; also plain, spiral, plumed, razor-shaped, and pinnate hairs.
Drawing of some of the British Mymarides.
Mr. F. Fitch:
Dissection of Earwig showing gastric teeth *in situ*.
Mr. Hardy:
*Melicerta ringens*, *Conochilus volvox*, &c.
Mr. J. Hood:
*Floscularia cornuta*, *Limnias ceratophylli*, *Melicerta ringens*, &c.

Mr. McIntire:
Section of Eye of Drone-fly showing minute structure.
Mr. G. E. Mainland:
Larva of *Corethra culiciformis?*
Dr. A. C. Malley:
Photo-micrographs of Lung containing *Bacillus anthracis.*
Scales of *P. argus.*
Mr. Michael:
*Licmophora flabellata*, in natural position as growing; double stained.
Mr. E. M. Nelson:
Comma-bacillus (Powell's 4/10 in. objective, 0·65 N.A.) and dark-ground illumination × 570.
Col. O'Hara:
Small Intestine of Sea Devil (*Lophius piscatorius*) injected. Liver-section and ova of same.
Mr. T. Powell:
Podura Scales, *Pleurosigma angulatum*, and *Amphipleura pellucida*, with 1/12 in. oil-immersion (1·5 N.A.) and dry achromatic condenser.
Mr. Priest:
New Marine Sponge, *Chalina polychotoma* var. *mauritiana* Ctv.
Messrs. Ross:
New fine adjustment by Dr. H. Schröder.
Mr. G. J. Smith:
Augite, Syenite, Propylite, &c., with polarized light.
Mr. J. Smith:
Wings of Lepidoptera.
Prof. Stewart:
Posterior surface of Eye of Rabbit, choroid injected.
Mr. Suffolk:
Proboscis of Blow-fly showing false appearances in connection with the pseudo-tracheæ. Lips of Blow-fly showing teeth.
Mr. Swift:
Stephenson Binocular Microscope with 1/12 in. objective.
Mr. A. Topping
Series of transparent injected preparations.
Mr. J. B. Turner:
Desmids (*Micrasterias*, &c.) stained.
Dr. Wallich:
*Coscinodiscus Sol* (from surface of the Indian Ocean), showing permanent membranous expansion which is given off from the margin of each valve of the frustule (described and figured in Trans. Micr. Soc. Lond., N.S. viii. (1860) p. 38, pl. ii. fig. 1).

The Titles, Contents, and Index will be issued as a separate Part (No. 49a).

Ser. II.
Vol. V. Part 6.

DECEMBER, 1885.

To Non-Fellows,
Price 5s.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

## CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

## ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

## MICROSCOPY, &c.

---

*Edited by*

**FRANK CRISP, LL.B., B.A.,**

*One of the Secretaries of the Society*
*and a Vice-President and Treasurer of the Linnean Society of London;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S.,
*Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A., F.Z.S.,
*Professor of Comparative Anatomy in King's College.*

JOHN MAYALL, JUN., F.Z.S.,

FRANK E. BEDDARD, M.A., F.Z.S.,

B. B. WOODWARD, F.G.S.,
*Librarian, British Museum (Natural History),*

R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

J. ARTHUR THOMSON, M.A.,

FELLOWS OF THE SOCIETY.


WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED.] [STAMFORD STREET AND CHARING CROSS.

# CONTENTS.


TRANSACTIONS OF THE SOCIETY— PAGE

XVIII.—ON SOME NEW AND RARE DESMIDS. By W. Barwell Turner, F.R.M.S., F.C.S. (Plates XV. & XVI.) .. .. .. .. 933

XIX.—FURTHER EXPERIMENTS ON FEEDING INSECTS WITH THE CURVED OR "COMMA" BACILLUS. By R. L. Maddox, M.D., Hon. F.R.M.S. .. .. .. .. .. .. .. .. 941

XX.—ON THE CHOLERA "COMMA" BACILLUS. By G. F. Dowdeswell, M.A., F.R.M.S., F.L.S., &c. .. .. .. .. .. 953

XXI.—IMPROVED FORM OF STEPHENSON'S BINOCULAR PRISMS. By C. D. Ahrens. (Figs. 220 and 221) .. .. .. .. .. 959

XXII.—REMARKS ON PROF. ABBE'S 'NOTE ON THE PROPER DEFINITION OF THE AMPLIFYING POWER OF A LENS OR LENS-SYSTEM.' By E. Giltay, Ph.D., Teacher of Botany at the State Agricultural School at Wageningen (Netherlands). (Figs. 222 and 223) .. .. .. .. .. .. 960

XXIII.—ON THE LIMITS OF RESOLUTION IN THE MICROSCOPE. By Frank Crisp, LL.B., B.A., V.P. and Treas. Linn. Soc., Sec. R.M.S. (Figs. 224–8) .. .. .. .. .. .. 968


## SUMMARY OF CURRENT RESEARCHES.

### ZOOLOGY.

#### A. GENERAL, including Embryology and Histology of the Vertebrata.


LAULANIÉ, F.—*Development of Sexuality* .. .. .. .. .. .. .. .. .. 974

FLEMMING, W.—*Formation of Spindles in Mammalian Ova during the Degeneration of the Graafian Follicle* .. .. .. .. .. .. .. .. .. .. 975

KÖLLIKER, A.—*Significance of Cell-nuclei in the Processes of Heredity* .. .. .. 975

SELENKA, E.—*Development of the Opossum* .. .. .. .. .. .. .. .. .. 976

BELLONCI, J.—*Karyokinesis in Segmentation of Axolotl Ova* .. .. .. .. .. 976

KÖLLIKER, A.—*Epidermic Cells of Tadpoles* .. .. .. .. .. .. .. .. .. 977

SWAEN, A.—*Early Developmental Stages of Torpedo* .. .. .. .. .. .. .. 977

RYDER, J. A.—*Position of the Yolk-Blastopore as determined by the Size of the Vitellus* .. .. .. .. .. .. .. .. .. .. .. .. 978

" " *Development of Viviparous Osseous Fishes* .. .. .. .. .. .. 978

BIONDI, D.—*Origin of the Spermatozoids in the Seminiferous Canals* .. .. .. 979

LIST, J. H.—*Wandering Cells in Epithelium* .. .. .. .. .. .. .. .. 980


#### B. INVERTEBRATA.


BARFURTH, D.—*Comparative Histochemical Observations on Glycogen* .. .. .. 981

M'INTOSH, W. C.—*Phosphorescence of Marine Animals* .. .. .. .. .. .. 981

VARIGNY, H. DE—"*Latent Period*" *of unstriped Muscle in Invertebrates* .. .. 982

HASWELL, W. A.—*Symbiosis of Worms and Sea-Anemones* .. .. .. .. .. 982

THOMPSON, D'ARCY—*Thompson's Bibliography of Protozoa, Sponges, Cœlenterata, Worms, and Molluscoida* .. .. .. .. .. .. .. .. .. .. .. 983


##### Mollusca.


VIALLETON, L.—*Fecundation in Cephalopoda* .. .. .. .. .. .. .. .. 983

HOYLE, W. E.—*Loligopsis and Allied Genera* .. .. .. .. .. .. .. .. 984

KRUKENBERG, C. F. W.—*Distribution of Chitin* .. .. .. .. .. .. .. .. 984

HOYLE, W. E.—*New Cephalopoda* .. .. .. .. .. .. .. .. .. .. 984

LACAZE-DUTHIERS H. DE—*Anatomy of Dentalium* .. .. .. .. .. .. .. 984

BOUTAN, M. L.—*Anatomy of Fissurella* .. .. .. .. .. .. .. .. .. 985

VAYSSIÈRE, A.—*Respiration of Truncatella* .. .. .. .. .. .. .. .. 986

WILLCOX, J.—*Spawning of Fulgur perversus* .. .. .. .. .. .. .. .. 986

BLUNDSTONE—*Glycogen in "Vesicular Cells" of Molluscs* .. .. .. .. .. 986


##### Molluscoida.

###### a. Tunicata.


SABATIER, M. A.—*Eggs of Ascidians* .. .. .. .. .. .. .. .. .. .. 987

PAGE

## Arthropoda.

### α. Insecta.

SLATER, J. W.—*Influence of Magnetism upon Insect Development* .. .. .. .. 988
LENDENFELD, R. v.—*Flight of Insects* .. .. .. .. .. .. .. .. .. .. .. 988
DAHL, J.—*Foot-glands of Insects* .. .. .. .. .. .. .. .. .. .. .. 989
CHATIN, M. J.—*Morphology of the Mouth-organs of Hymenoptera* .. .. .. .. 989
LUBBOCK, J., & G. J. ROMANES—*Homing Faculty of Hymenoptera* .. .. .. .. 990
LÖW, E.—*Insects as Fertilizers* .. .. .. .. .. .. .. .. .. .. .. 990
PACKARD, A. S.—*Unusual number of Legs in the Caterpillar of Lagoa* .. .. .. 990
HALLEZ, M. P.—*Orientation of the Embryo and Formation of the Cocoon of Periplaneta orientalis* .. .. .. .. .. .. .. .. .. .. .. .. .. 991
GRIFFITHS, A. B.—*Physiology of the Alimentary Canal of Blatta periplaneta* .. 991
ROSSITER, T. B.—*Uses and Construction of the Gizzard of Larvæ of Corethra plumicornis* .. .. .. .. .. .. .. .. .. .. .. .. .. 991
BEAUREGARD—*Structure of the Wings of Vesicating Insects* .. .. .. .. .. .. 992
RATTE, F.—*Larvæ and Larva-cases of some Australian Aphrophoridæ* .. .. .. 992

### δ. Arachnida.

LANKESTER, E. RAY, W. B. S. BENHAM, & Miss E. J. BECK—*Muscular and Endoskeletal Systems of Limulus and Scorpio* .. .. .. .. .. .. .. .. .. 992
SCHIMKEWITSCH, W.—*Sense-organ of Spiders* .. .. .. .. .. .. .. .. .. 993
BERTKAU, P.—*Seasonal Dimorphism in Spiders* .. .. .. .. .. .. .. .. .. 993
HASWELL, W. A.—*Australian Pycnogonida* .. .. .. .. .. .. .. .. .. .. 994

### ε. Crustacea.

FRENZEL, J.—*Alimentary Canal of Crustacea* .. .. .. .. .. .. .. .. .. 994
ISHIKAWA, C.—*Development of Atyephira compressa* .. .. .. .. .. .. .. .. 996
IMHOF, O. E.—*Sense-organs of Calanidæ* .. .. .. .. .. .. .. .. .. .. 997
CHILTON, C.—*Polymorphism in the Amphipoda* .. .. .. .. .. .. .. .. .. 997
HASWELL, W. A., & C. CHILTON—*Australian Crustacea* .. .. .. .. .. .. .. 998

## Vermes.

VIGUIER, C.—*Pelagic Annelids* .. .. .. .. .. .. .. .. .. .. .. .. 998
HARKER, A.—*Coloration of the Anterior Segments of the Maldanidæ* .. .. .. 999
BEDDARD, F. E.—*Nephridia of a new species of Earthworm* .. .. .. .. .. 999
SAINT-LOUP, REMY—*Organization of Pachydrilus enchytræoides* .. .. .. .. 1000
HASWELL, W. A.—*Parasite of the Rock Oyster* .. .. .. .. .. .. .. .. 1000
REIGHARD, J.—*Anatomy and Histology of Aulophorus vagus* .. .. .. .. .. 1001
LINSTOW, O. VON—*Angiostomum* .. .. .. .. .. .. .. .. .. .. .. 1001
BELL, F. J.—*Gordius verrucosus* .. .. .. .. .. .. .. .. .. .. .. 1002
THOMAS, J. D.—*Experimental Breeding of Tænia Echinococcus* .. .. .. .. .. 1002
" " *Frequent occurrence of Tænia Echinococcus in Domestic Dogs (Australia)* .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. 1002
POIRIER, J.—*Trematoda* .. .. .. .. .. .. .. .. .. .. .. .. .. 1002
FRITSCH, G.—*Anatomy of Bilharzia hæmatobia* .. .. .. .. .. .. .. .. 1003
SONSINO, P.—*Small Rod-like Cell contents of certain Cercariæ* .. .. .. .. 1003
IMHOF, O. E.—*Deep-water Tubellarians of Lakes* .. .. .. .. .. .. .. .. 1004
HUBRECHT, A. W.—*Development of Nemertines* .. .. .. .. .. .. .. .. 1004
DELAGE, Y.—*Nervous System of Acœlomate Planarians and new Sensory Organ of Convoluta Schultzii* .. .. .. .. .. .. .. .. .. .. .. .. 1004
LACAZE-DUTHIERS, H. DE—*Phœnicurus* .. .. .. .. .. .. .. .. .. .. 1005
ZACHARIAS, O.—*Relationship of Rotifers and Nematodes* .. .. .. .. .. .. 1006
PEREYASLAVTSEFF, Miss C.—*Development of Rotifers* .. .. .. .. .. .. .. 1006
MILNE, W.—*New Rotifer* .. .. .. .. .. .. .. .. .. .. .. .. .. 1007

## Echinodermata.

LAMPERT, K.—*Variation in Holothurians* .. .. .. .. .. .. .. .. .. .. 1007
HAACKE, W.—*Morphology of Echinoids* .. .. .. .. .. .. .. .. .. .. 1008
PROUHO, H.—*Larval Form of Dorocidaris papillata* .. .. .. .. .. .. .. 1008
AYERS, H.—*Structure and Functions of the Sphæridia of the Echinoidea* .. .. 1009
DÖDERLEIN, L.—*Japanese Echinoidea* .. .. .. .. .. .. .. .. .. .. 1009
PERRIER, E.—*Brisingidæ of the 'Talisman' Expedition* .. .. .. .. .. .. 1009
LORIOL, P. DE—*Asteroidea of Mauritius* .. .. .. .. .. .. .. .. .. 1009

## Cœlenterata.

FEWKES, J. W.—*Development of Agalma* .. .. .. .. .. .. .. .. .. .. 1009
CLAUS, C.—*Cyclical Development of Siphonophora* .. .. .. .. .. .. .. .. 1010
BIDOT—*Structure of Velella* .. .. .. .. .. .. .. .. .. .. .. .. 1010
BELL, F. J.—*New Minyas* .. .. .. .. .. .. .. .. .. .. .. .. .. 1010
LENDENFELD, R. v.—*Metamorphosis of Bolina Chuni* .. .. .. .. .. .. .. .. 1010
" " *Beroid of Port Jackson* .. .. .. .. .. .. .. .. 1011
" " *Australian Hydromedusæ* .. .. .. .. .. .. .. .. 1011

PAGE

### Porifera.

LENDENFELD, R. v.—*Histology and Nervous System of Calcareous Sponges* .. .. 1011
MARSHALL, W.—*Reproduction of Spongilla lacustris* .. .. .. .. .. .. .. 1011
LENDENFELD, R. v.—*The Phoriospongiæ* .. .. .. .. .. .. .. .. 1012
VOSMAER, G. C. J.—*Sponges of the 'Willem Barents' Expedition* .. .. .. .. 1013
LENDENFELD, R. v.—*New Sponges from South Australia* .. .. .. .. .. .. 1013
POTTS, E.—*Fresh-water Sponge from Mexico* .. .. .. .. .. .. .. .. 1014
LENDENFELD, R. v.—*Australian Sponges* .. .. .. .. .. .. .. .. 1014

### Protozoa.

ZACHARIAS, O.—*Experiments on Formation of Pseudopodia* .. .. .. .. .. 1014
MAUPAS, E.—*Coleps hirtus* .. .. .. .. .. .. .. .. .. .. 1015
BURCH, G. J.—*Supposed new Infusorian* .. .. .. .. .. .. .. .. 1015
METSCHNIKOW, E.—*Erythropsis agilis* .. .. .. .. .. .. .. .. .. 1016
FISCH, C.—*Flagellata and allied Organisms* .. .. .. .. .. .. .. .. 1016
BÜTSCHLI, O.—*Marine Rhizopoda* .. .. .. .. .. .. .. .. .. 1016
FOLIN, DE—*New Condition of Reticular Rhizopods* .. .. .. .. .. .. 1017
LENDENFELD, R. v.—*Amœba infesting Sheep* .. .. .. .. .. .. .. .. 1018
WALLICH, G. C.—*Critical Notes on Amœbæ* .. .. .. .. .. .. .. .. 1018
„ „ *Pseudocyclosis in Amœba* .. .. .. .. .. .. .. .. 1019

## BOTANY.

### A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

#### α. Anatomy.

LOEW, O.—*Various Degrees of Resistance in Protoplasm* .. .. .. .. .. .. 1019
GILTAY, E.—*Peculiar Structure of Protoplasm in the Paratracheal Parenchyma* .. 1020
HARTWICH, C.—*Tannin and Lignin in Galls* .. .. .. .. .. .. .. .. 1020
GILBERT, J. H.—*Conditions of the Development and of the Activity of Chlorophyll* .. 1020
FISCHER, A.—*Sieve-tubes in the Leaves of Dicotyledons* .. .. .. .. .. .. 1020
WILSON, A. S., & G. MURRAY—"*Sclerotioids*" *of Potato* .. .. .. .. .. .. 1022
SCHWENDENER, S.—*Laticiferous Vessels* .. .. .. .. .. .. .. .. .. 1022
KNY, L., & A. ZIMMERMANN—*Spiral Cells of Nepenthes* .. .. .. .. .. .. 1023
COSTANTIN, J., & L. MOROT—*Fibrovascular Bundles of Cycadeæ* .. .. .. .. 1023
PENHALLOW, D. P.—*Relation of Annual Rings of Exogens to Age* .. .. .. .. 1023
HECKEL, E., & J. CHAREYRE—*Anatomy of Pitcher-plants* .. .. .. .. .. .. 1024
KAMIENSKI, F.—*Vegetative Organs of Monotropa* .. .. .. .. .. .. .. .. 1025
FLEISCHER, E.—*Protection of Leaves from excessive Transpiration* .. .. .. .. 1025
BRIOZI, G.—*Heterophylly of Eucalyptus globulus* .. .. .. .. .. .. .. .. 1025
BEYERINCK, W.—*Cecidomyia-galls on Poa* .. .. .. .. .. .. .. .. .. 1026
BESSEY, C. E.—*Opening of the Flowers of Desmodium sessilifolium* .. .. .. .. 1026
„ „ *Inflorescence of Cuscuta glomerata* .. .. .. .. .. .. .. 1026
COULTER, J. M.—*Relation of Ovary and Perianth in the development of Dicotyledons* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 1026
MEEHAN, T.—*Elasticity in the Fruit of Cactaceæ* .. .. .. .. .. .. .. .. 1027
„ „ *Use of Spines in Cactuses* .. .. .. .. .. .. .. .. .. .. 1027

#### β. Physiology.

STRASBURGER, E.—*Theory of Descent* .. .. .. .. .. .. .. .. .. .. 1027
STURTEVANT, E. L.—*Hybridization and Cross-breeding of Plants* .. .. .. .. 1028
FOERSTE, A. E.—*Fertilization of the Wild Onion* .. .. .. .. .. .. .. 1028
BARNES, C. R.—*Fertilization in Campanula americana* .. .. .. .. .. .. 1028
DUCHARTRE, P.—*Influence of Want of Moisture on the Growth of the Chinese Yam* 1029
BURRILL, T. J.—*Mechanical Injury to Trees by Cold* .. .. .. .. .. .. .. 1029
JAMIESON, J.—*Essential Food of Plants* .. .. .. .. .. .. .. .. .. 1029
MARTIN, S.—*Digestion of Proteïds in Plants* .. .. .. .. .. .. .. .. .. 1030
HANSEN, A.—*Ferments and Enzyma* .. .. .. .. .. .. .. .. .. .. 1031
VESQUE, J.—*Ascent of Sap* .. .. .. .. .. .. .. .. .. .. .. 1031
RISCHAWI, L.—*Galvanotropism* .. .. .. .. .. .. .. .. .. .. 1032
HANSEN, A.—*Transpiration-currents* .. .. .. .. .. .. .. .. .. .. 1032
KNOP, W.—*Absorption by the Plant of Non-nutrient Substances* .. .. .. .. .. 1032

### B. CRYPTOGAMIA.

#### Cryptogamia Vascularia.

SOHRODT, J.—*Bursting of the Sporangium of Ferns and the Anther of Flowering Plants* .. .. .. .. .. .. .. .. .. .. .. .. .. .. 1032
LAOHMANN, P.—*Root-organs of Nephrolepis* .. .. .. .. .. .. .. .. .. 1033
BOWER, F. O.—*Apex of the Root in Osmunda and Todea* .. .. .. .. .. .. .. 1033
PRANTL, K.—*Structure and Classification of Ophioglossaceæ* .. .. .. .. .. 1034
BOWER, F. O.—*Morphology of Phylloglossum Drummondii* .. .. .. .. .. .. 1034

PAGE

**Muscineæ.**

LEITGEB, H.—*Exudation of Water from the Female Receptacle of Corsinia* .. .. 1035
PHILIBERT—*Peristome of Bryaceæ* .. .. .. .. .. .. .. .. .. .. .. 1035
VENTURI, G.—*Spores of Pottia* .. .. .. .. .. .. .. .. .. .. .. 1036
BARNES, C. R.—*Stomata of Marchantia* .. .. .. .. .. .. .. .. .. 1036
SCHLIEPHACKE, K.—*Pleuroweisia, a new genus of Moss* .. .. .. .. .. 1036
MÜLLER, C.—*Mosses of Terra-del-Fuego* .. .. .. .. .. .. .. .. 1036

**Algæ.**

HANSGIRG, A.—*Polymorphism of Algæ* .. .. .. .. .. .. .. .. .. 1037
HANSEN, A.—*Chlorophyll-green of Fucaceæ* .. .. .. .. .. .. .. .. 1038
BESSEY, C. E.—*Bisexuality of the Zygnemaceæ* .. .. .. .. .. .. .. 1038
SAPORTA, G. DE—*Problematic Organisms of the Ancient Sea* .. .. .. .. .. 1039
KJELLMAN, F. R.—*Algal-flora of the Arctic Ocean* .. .. .. .. .. .. 1039
FOSLIE, M.—*Laminariaceæ of Norway* .. .. .. .. .. .. .. .. .. 1039
REINHARDT, L.—*Morphology and Classification of Black Sea Algæ* .. .. .. .. 1039
KLEBS, G.—*Movement and Formation of Mucilage by the Desmidieæ* .. .. .. 1040
CASTRACANE, AB. F.—*Internal Spore-formation in Diatoms* .. .. .. .. .. 1041
KITTON, F.—*Mysterious Appearance of a Diatom* .. .. .. .. .. .. .. 1041
„ „ *Navicula Durrandii n. sp. F. K.* .. .. .. .. .. .. .. .. 1042
CLEVE, P. T.—*Fossil Marine Diatoms* .. .. .. .. .. .. .. .. .. 1042

**Lichenes.**

MÜLLER, J.—*Müller's 'Contributions to Lichenology'* .. .. .. .. .. .. .. 1042
FORSSELL, K. B. J.—*Anatomy and Development of Lecanora granatina* .. .. .. 1043

**Fungi.**

ERRERA, L.—*Hydrocarbon Reserve-products of Mushrooms* .. .. .. .. .. .. 1044
PATOUILLARD, N.—*Helicobasidium, a new Genus of Hymenomycetes* .. .. .. 1045
VUILLEMIN, P.—*Puccinia Thlaspidis* .. .. .. .. .. .. .. .. .. .. 1045
COHN, F—*Mould-fungi as Ferments* .. .. .. .. .. .. .. .. .. .. 1045
COCARDAS, E.—*Penicillium-Ferment in Pharmaceutical Extracts* .. .. .. .. 1046
WETTSTEIN, R. v.—*Rhodomyces, a new Human Parasite* .. .. .. .. .. .. 1046
GUILLEBEAU, A.—*Fungus-disease in Daphnia* .. .. .. .. .. .. .. .. 1046

**Protophyta.**

SCHNETZLER, J. B.—*Beggiatoa alba* .. .. .. .. .. .. .. .. .. .. 1046
THORE, J.—*Algæ of Thermal Waters* .. .. .. .. .. .. .. .. .. .. 1047
LÉPINE, R., & G. ROUX—*Cystitis and Nephritis produced by Micrococcus ureæ* .. 1047
DUCLAUX, E.—*Effect of Sunlight on Micrococcus* .. .. .. .. .. .. .. .. 1047
HÜPPE, F.—*Decomposition and Fermentation of Milk* .. .. .. .. .. .. .. 1048
KÜNSTLER, J.—*Systematic Position of the Bacteriaceæ* .. .. .. .. .. .. .. 1048
HAUSER, G.—*Pleomorphy of Pathogenic Bacteria* .. .. .. .. .. .. .. 1049
ARLOING, S.—*Influence of the Sun on the Growth and Activity of Bacillus anthracis* 1050
FINKLER & PRIOR, & POUCHET—*Cholera Bacillus* .. .. .. .. .. .. .. 1050
FERRAN, J.—*Morphology of the Comma Bacillus* .. .. .. .. .. .. .. .. 1051
NICATI, W., & RIETSCH—*Attenuation of the Choleraic Virus* .. .. .. .. .. 1051
KOUBASSOFF—*Passage of Pathogenic Microbes from the Mother to the Fœtus* .. .. 1051
„ *Passage of Microbes by means of Milk* .. .. .. .. .. .. .. .. 1052
TAYON—*Microbe of Typhoid Fever in Man* .. .. .. .. .. .. .. .. 1052
SALMON, D. E., & T. SMITH—*New Chromogenous Bacillus—B. luteus suis* .. .. 1052
SCHLEN, v.—*Bacilli of Malaria* .. .. .. .. .. .. .. .. .. .. .. 1052
COMES, C.—*Gummosis of Figs* .. .. .. .. .. .. .. .. .. .. .. 1053
CORVO, L. A.—*Bacillus of the Vine* .. .. .. .. .. .. .. .. .. .. 1053
ARTHUR, J. C.—*Pear Blight* .. .. .. .. .. .. .. .. .. .. .. .. 1053
COLEMAN, J. J., & M'KENDRICK—*Action of Ozonized Air upon Micro-organisms and Albumen in Solution* .. .. .. .. .. .. .. .. .. .. .. .. 1053

## MICROSCOPY.

### *a.* Instruments, Accessories, &c.

D'ARSONVAL'S *Water Microscope* (Figs. 229–231) .. .. .. .. .. .. .. .. 1054
AMYOT, T. E.—*Direct Vision Microscopes* .. .. .. .. .. .. .. .. .. 1056
MICROSCOPE *with Catgut Focusing Adjustment* (Fig. 232) .. .. .. .. .. .. 1057
INOSTRANZEFF'S *Double Microscope* .. .. .. .. .. .. .. .. .. .. 1058
MICROSCOPES *with Accessory Stages* (Fig. 233) .. .. .. .. .. .. .. .. 1058
RIDDELL'S *Binocular Compound Microscope* (Figs. 234 and 235) .. .. .. .. 1059
ROCHER, BOISSEAU DU—*Megaloscopy* .. .. .. .. .. .. .. .. .. .. 1061

PAGE

WATSON'S *Swinging Substage Microscope* (Fig. 236) .. .. .. .. .. .. .. 1062
„ *Camera or Lantern Microscope* (Fig. 237) .. .. .. .. .. .. .. 1064
LECKENBY'S *Microscope Pencil-case* .. .. .. .. .. .. .. .. .. 1065
MALCOLM—*Adjusting the Eye-pieces of Binoculars to eyes of unequal focal length* .. 1065
GRUNOW, J.—*Abbe Condenser* (Fig. 238) .. .. .. .. .. .. .. .. 1065
SMITH, H. L.—*Device for Testing Refractive Index* (Fig. 239) .. .. .. .. .. 1066
JOLY'S *Meldometer* (Figs. 240 and 241) .. .. .. .. .. .. .. .. 1068
STOKES-WATSON *Electric Spark Apparatus* (Fig. 242) .. .. .. .. .. .. .. 1069
HITCHCOCK, R.—*Optical Arrangements for Photo-micrography, and Remarks on Magnification* .. .. .. .. .. .. .. .. .. .. .. .. .. 1070
COX, J. D.—*Actinic and Visual Foci in Photo-micrography with High Powers* .. 1070
NELSON, E. M.—*Images in the Binocular Microscope* (Figs. 243–248) .. .. .. 1073
„ „ *Position of Objects with the Binocular* .. .. .. .. .. .. 1074
MICROSCOPES *at the Inventions Exhibition* .. .. .. .. .. .. .. .. 1076
SWIFT, MANSELL J.—*Photo-micrograph of Tongue of Blow-fly* .. .. .. .. .. 1077
CONNOR, ROCHEFORT—*Pen-and-Ink Drawings of Microscopic Objects* .. .. .. 1077
SUPPOSED *increase of the Aperture of an Objective by using highly refractive Media* 1077
BANKS, C. W.—*Electricity under the Microscope* .. .. .. .. .. .. .. .. 1078
BLACKING *Brass Diaphragms, &c.* .. .. .. .. .. .. .. .. .. .. 1079
HYDE, H. C.—*The Electric Light in Microscopy* .. .. .. .. .. .. .. .. 1080
SMITH, H. L.—*The Influence of Science Studies* .. .. .. .. .. .. .. .. 1081
W., E. D.—*Measurement of Power and Aperture of Microscopic Objectives* .. .. 1082
WARD, R. H.—*Choice of Objectives and Oculars* .. .. .. .. .. .. .. .. 1082

### β. Collecting, Mounting and Examining Objects, &c.

HOYLE, W. E.—*Preserving Eggs of Cephalopoda and preparing Blastoderms* .. .. 1083
LOCY, W. A.—*Treatment of the Eggs of the Spider* .. .. .. .. .. .. .. 1083
BALKWILL'S *Foraminifera Slides* (Figs. 249 and 250) .. .. .. .. .. .. 1084
SACHS, J.—*Preparing Leaves to show Starch-grains* .. .. .. .. .. .. .. 1084
BARNES, C. R.—*Studying Pollen-grains* .. .. .. .. .. .. .. .. .. 1085
SELENKA, E.—*Imbedding in Paraffin* (Fig. 251) .. .. .. .. .. .. .. .. 1086
ANDREWS & NACHTRIEB'S *Water-Bath* (Figs. 252–254) .. .. .. .. .. .. 1086
BARRETT'S *New Microtome* .. .. .. .. .. .. .. .. .. .. .. .. 1089
BAUSCH & LOMB *Optical Co.'s Laboratory and Student's Microtome* (Figs. 255–257) 1089
SEILER'S *Microtome Attachment* .. .. .. .. .. .. .. .. .. .. .. 1091
WHITMAN, C. O.—*Cambridge Rocking Microtome* .. .. .. .. .. .. .. .. 1091
WRIGHT, R. RAMSEY—*Suggestions as to the Preparation and Use of Series of Sections in Zootomical Instruction* .. .. .. .. .. .. .. .. .. .. 1091
LENDENFELD, R. v.—*Series of Sections. Thickness of Sections* .. .. .. .. .. 1092
FOL'S *Injection Table* (Fig. 258) .. .. .. .. .. .. .. .. .. .. .. 1092
OSBORN, H. F.—*Simple Method of Injecting the Arteries and Veins in small Animals* (Fig. 259) .. .. .. .. .. .. .. .. .. .. .. .. .. .. 1093
ARCANGELI, G.—*New Methods of Preparing Carmine Staining Fluids* .. .. .. 1094
KULTSCHIZKY, N.—*Staining Salivary Glands* .. .. .. .. .. .. .. .. 1095
HASWELL, W. A.—*Staining with Hæmatoxylin* .. .. .. .. .. .. .. .. 1095
„ „ *Imbedding in Paraffin* .. .. .. .. .. .. .. .. .. 1096
STRASBURGER, E.—*Eau de Javelle for Clearing* .. .. .. .. .. .. .. .. 1097
BRUNT, C. VAN—*Fixing Objects to the Cover-glass* .. .. .. .. .. .. .. 1097
SMITH'S *Mounting Media of High Refractive Index* (Fig. 260) .. .. .. .. .. 1097
SMITH'S *New Cement* .. .. .. .. .. .. .. .. .. .. .. .. .. 1099
MILES, J. L. W., T. W. LOFTHOUSE, & E. WARD—*Dry Mounting* .. .. .. .. 1100
JAMES, F. L.—*White Zinc Cement* .. .. .. .. .. .. .. .. .. .. .. 1101
„ „ *Leakage of Cells* .. .. .. .. .. .. .. .. .. .. .. 1102
STRASBURGER, E.—*Coloured Crayons for Marking Preparations—Finder* .. .. 1103
HAUSHOFER, K.—*Filtering Minute Quantities* (Fig. 261) .. .. .. .. .. .. 1103
RALPH, T. S.—*Examining Blood in Typhoid Fever* .. .. .. .. .. .. .. 1104
EWELL, M. D.—*Measurement of Blood-corpuscles* .. .. .. .. .. .. .. .. 1105
BESSEY, C. E.—*Styles of Indian Corn for Examining Movement of Protoplasm* .. 1106
HAUSHOFER'S *Microscopical Reactions* .. .. .. .. .. .. .. .. .. .. 1106
JAMES, F. L.—*Examining Diamonds and Cut Gems* .. .. .. .. .. .. .. .. 1108
GRABER, V.—*Preparing Eyes of Annelids* .. .. .. .. .. .. .. .. .. 1110
JAMES, F. L.—*Cement* .. .. .. .. .. .. .. .. .. .. .. .. .. 1110
RYDER, J. A.—*A Cheap Bell-glass for the Laboratory Table* .. .. .. .. .. 1111

PROCEEDINGS OF THE SOCIETY .. .. .. .. .. .. .. .. .. 1112

INDEX .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. 1115

# ROYAL MICROSCOPICAL SOCIETY.

## COUNCIL.

ELECTED 11th FEBRUARY, 1885.

**PRESIDENT.**

Rev. W. H. Dallinger, LL.D., F.R.S.

**VICE-PRESIDENTS.**

John Anthony, Esq., M.D., F.R.C.P.L.
G. F. Dowdeswell, Esq., M.A.
Prof. P. Martin Duncan, M.B., F.R.S.
Albert D. Michael, Esq., F.L.S.

**TREASURER.**

Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

**SECRETARIES.**

*Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.
Prof. F. Jeffrey Bell, M.A., F.Z.S.

**Twelve other MEMBERS of COUNCIL.**

Joseph Beck, Esq., F.R.A.S.
A. W. Bennett, Esq., M.A., B.Sc., F.L.S.
*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
James Glaisher, Esq., F.R.S., F.R.A.S.
*J. William Groves, Esq.
John Matthews, Esq., M.D.
John Mayall, Esq., Jun.
*John Millar, Esq., L.R.C.P., F.L.S.
Urban Pritchard, Esq., M.D.
Stuart O. Ridley, Esq., M.A., F.L.S.
*Prof. Charles Stewart, M.R.C.S., F.L.S.
William Thomas Suffolk, Esq.

**LIBRARIAN and ASSISTANT SECRETARY.**—Mr. James West.

* Members of the Publication Committee.

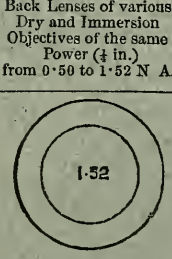
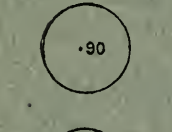
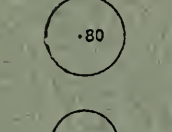
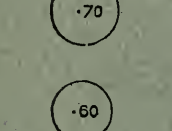
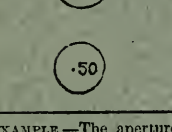
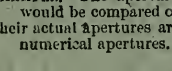
## MEETINGS FOR 1885, at 8 p.m.

| | | | |
|---|---|---|---|
| Wednesday, | January .. .. | 14 | |
| „ | February .. .. | 11 | |
| | *(Annual Meeting for Election of Officers and Council.)* | | |
| „ | March .. .. | 11 | |
| „ | April .. .. .. | 8 | |
| Wednesday, | May .. .. .. | 13 | |
| „ | June .. .. .. | 10 | |
| „ | October .. .. | 14 | |
| „ | November .. .. | 11 | |
| „ | December .. .. | 9 | |

## I. Numerical Aperture Table.

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n \sin u$, $n$ being the refractive index of the medium and $u$ the semi-angle of aperture. The value of $n \sin u$ for any particular case is the "*numerical aperture*" of the objective.

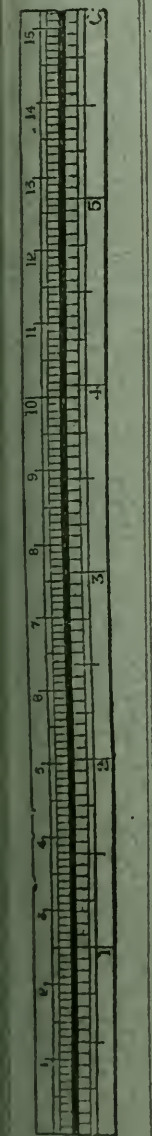
| Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (¼ in.) from 0·50 to 1·52 N A. | Numerical Aperture. ($n \sin u = a$.) | Angle of Aperture ($= 2u$). | | | Illuminating Power. ($a^2$.) | Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.) | Penetrating Power. $\left(\frac{1}{a}\right)$ |
|---|---|---|---|---|---|---|---|
| | | *Dry* Objectives. ($n = 1$.) | *Water-Immersion* Objectives. ($n = 1{\cdot}33$.) | *Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.) | | | |
|  | 1·52 | .. | .. | 180° 0′ | 2·310 | 146,528 | ·658 |
| | 1·50 | .. | .. | 161° 23′ | 2·250 | 144,600 | ·667 |
| 1·52 | 1·48 | .. | .. | 153° 39′ | 2·190 | 142,672 | ·676 |
| | 1·46 | .. | .. | 147° 42′ | 2·132 | 140,744 | ·685 |
| | 1·44 | .. | .. | 142° 40′ | 2·074 | 138,816 | ·694 |
| | 1·42 | .. | .. | 138° 12′ | 2·016 | 136,888 | ·704 |
| | 1·40 | .. | .. | 134° 10′ | 1·960 | 134,960 | ·714 |
| | 1·38 | .. | .. | 130° 26′ | 1·904 | 133,032 | ·725 |
| | 1·36 | .. | .. | 126° 57′ | 1·850 | 131,104 | ·735 |
| | 1·34 | .. | .. | 123° 40′ | 1·796 | 129,176 | ·746 |
|  | 1·33 | .. | 180° 0′ | 122° 6′ | 1·770 | 128,212 | ·752 |
| 1·33 | 1·32 | .. | 165° 56′ | 120° 33′ | 1·742 | 127,248 | ·758 |
| | 1·30 | .. | 155° 38′ | 117° 34′ | 1·690 | 125,320 | ·769 |
| | 1·28 | .. | 148° 28′ | 114° 44′ | 1·638 | 123,392 | ·781 |
| | 1·26 | .. | 142° 39′ | 111° 59′ | 1·588 | 121,464 | ·794 |
| | 1 24 | .. | 137° 36′ | 109° 20′ | 1·538 | 119,536 | ·806 |
| | 1·22 | .. | 133° 4′ | 106° 45′ | 1·488 | 117,608 | ·820 |
|  | 1·20 | .. | 128° 55′ | 104° 15′ | 1·440 | 115,680 | ·833 |
| 1·16 | 1·18 | .. | 125° 3′ | 101° 50′ | 1·392 | 113,752 | ·847 |
| | 1·16 | .. | 121° 26′ | 99° 29′ | 1·346 | 111,824 | ·862 |
| | 1·14 | .. | 118° 00′ | 97° 11′ | 1·300 | 109,896 | ·877 |
| | 1·12 | .. | 114° 44′ | 94° 56′ | 1·254 | 107,968 | ·893 |
| | 1·10 | .. | 111° 36′ | 92° 43′ | 1·210 | 106,040 | ·909 |
| | 1·08 | .. | 108° 36′ | 90° 33′ | 1·166 | 104,112 | ·926 |
|  | 1·06 | .. | 105° 42′ | 88° 26′ | 1·124 | 102,184 | ·943 |
| 1·0 | 1·04 | .. | 102° 53′ | 86° 21′ | 1·082 | 100,256 | ·962 |
| | 1·02 | .. | 100° 10′ | 84° 18′ | 1·040 | 98,328 | ·980 |
| | 1·00 | 180° 0′ | 97° 31′ | 82° 17′ | 1·000 | 96,400 | 1·000 |
| | 0·98 | 157° 2′ | 94° 56′ | 80° 17′ | ·960 | 94,472 | 1·020 |
| | 0·96 | 147° 29′ | 92° 24′ | 78° 20′ | ·922 | 92,544 | 1·042 |
|  | 0·94 | 140° 6′ | 89° 56′ | 76° 24′ | ·884 | 90,616 | 1·064 |
| ·90 | 0·92 | 133° 51′ | 87° 32′ | 74° 30′ | ·846 | 88,688 | 1·087 |
| | 0·90 | 128° 19′ | 85° 10′ | 72° 36′ | ·810 | 86,760 | 1·111 |
| | 0·88 | 123° 17′ | 82° 51′ | 70° 44′ | ·774 | 84,832 | 1·136 |
| | 0·86 | 118° 38′ | 80° 34′ | 68° 54′ | ·740 | 82,904 | 1·163 |
| | 0·84 | 114° 17′ | 78° 20′ | 67° 6′ | ·706 | 80,976 | 1·190 |
|  | 0·82 | 110° 10′ | 76° 8′ | 65° 18′ | ·672 | 79,048 | 1·220 |
| ·80 | 0·80 | 106° 16′ | 73° 58′ | 63° 31′ | ·640 | 77,120 | 1·250 |
| | 0·78 | 102° 31′ | 71° 49′ | 61° 45′ | ·608 | 75,192 | 1·282 |
| | 0·76 | 98° 56′ | 69° 42′ | 60° 0′ | ·578 | 73,264 | 1·316 |
| | 0·74 | 95° 28′ | 67° 36′ | 58° 16′ | ·548 | 71,336 | 1·351 |
| | 0·72 | 92° 6′ | 65° 32′ | 56° 32′ | ·518 | 69,408 | 1·389 |
|  | 0 70 | 88° 51′ | 63° 31′ | 54° 50′ | ·490 | 67,480 | 1·429 |
| ·70 | 0·68 | 85° 41′ | 61° 30′ | 53° 9′ | ·462 | 65,552 | 1·471 |
| | 0·66 | 82° 36′ | 59° 30′ | 51° 28′ | ·436 | 63,624 | 1·515 |
| | 0·64 | 79° 35′ | 57° 31′ | 49° 48′ | ·410 | 61,696 | 1·562 |
| | 0·62 | 76° 38′ | 55° 34′ | 48° 9′ | ·384 | 59,768 | 1·613 |
|  | 0·60 | 73° 44′ | 53° 38′ | 46° 30′ | ·360 | 57,840 | 1·667 |
| ·60 | 0·58 | 70° 54′ | 51° 42′ | 44° 51′ | ·336 | 55,912 | 1·724 |
| | 0·56 | 68° 6′ | 49° 48′ | 43° 14′ | ·314 | 53,984 | 1·786 |
| | 0·54 | 65° 22′ | 47° 54′ | 41° 37′ | ·292 | 52,056 | 1·852 |
|  | 0·52 | 62° 40′ | 46° 2′ | 40° 0′ | ·270 | 50,128 | 1·925 |
| ·50 | 0·50 | 60° 0′ | 44° 10′ | 38° 24′ | ·250 | 48,200 | 2·000 |

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 : ·98 : 1·26 : 1·38 or their numerical apertures.

## II. Conversion of British and Metric Measures.

### (1.) Lineal.

Scale showing the relation of Millimetres, &c., to Inches.




1000 μ =1 mm.
10 mm.=1 cm.
10 cm. =1 dm.
10 dm. =1 metre.

*Micromillimetres, &c., into Inches, &c.*

| μ | ins. | mm. | ins. | mm. | ins. |
|---|---|---|---|---|---|
| 1 | ·000039 | 1 | ·039370 | 51 | 2·007892 |
| 2 | ·000079 | 2 | ·078741 | 52 | 2·047262 |
| 3 | ·000118 | 3 | ·118111 | 53 | 2·086633 |
| 4 | ·000157 | 4 | ·157482 | 54 | 2·126003 |
| 5 | ·000197 | 5 | ·196852 | 55 | 2·165374 |
| 6 | ·000236 | 6 | ·236223 | 56 | 2·204744 |
| 7 | ·000276 | 7 | ·275593 | 57 | 2·244115 |
| 8 | ·000315 | 8 | ·314963 | 58 | 2·283485 |
| 9 | ·000354 | 9 | ·354334 | 59 | 2·322855 |
| 10 | ·000394 | 10 (1 cm.) | ·393704 | 60 (6 cm.) | 2·362226 |
| 11 | ·000433 | 11 | ·433075 | 61 | 2·401596 |
| 12 | ·000472 | 12 | ·472445 | 62 | 2·440967 |
| 13 | ·000512 | 13 | ·511816 | 63 | 2·480337 |
| 14 | ·000551 | 14 | 551186 | 64 | 2·519708 |
| 15 | ·000591 | 15 | ·590556 | 65 | 2·559078 |
| 16 | ·000630 | 16 | ·629927 | 66 | 2·598449 |
| 17 | ·000669 | 17 | ·669297 | 67 | 2·637819 |
| 18 | ·000709 | 18 | ·708668 | 68 | 2·677189 |
| 19 | ·000748 | 19 | ·748038 | 69 | 2·716560 |
| 20 | ·000787 | 20 (2 cm.) | ·787409 | 70 (7 cm.) | 2·755930 |
| 21 | ·000827 | 21 | ·826779 | 71 | 2·795301 |
| 22 | ·000866 | 22 | ·866150 | 72 | 2·834671 |
| 23 | ·000906 | 23 | ·905520 | 73 | 2·874042 |
| 24 | ·000945 | 24 | ·944890 | 74 | 2·913412 |
| 25 | ·000984 | 25 | ·984261 | 75 | 2·952782 |
| 26 | ·001024 | 26 | 1·023631 | 76 | 2·992153 |
| 27 | ·001063 | 27 | 1·063002 | 77 | 3·031523 |
| 28 | ·001102 | 28 | 1·102372 | 78 | 3·070894 |
| 29 | ·001142 | 29 | 1·141743 | 79 | 3·110264 |
| 30 | ·001181 | 30 (3 cm.) | 1·181113 | 80 (8 cm.) | 3·149635 |
| 31 | ·001220 | 31 | 1·220483 | 81 | 3·189005 |
| 32 | ·001260 | 32 | 1·259854 | 82 | 3·228375 |
| 33 | ·001299 | 33 | 1·299224 | 83 | 3·267746 |
| 34 | ·001339 | 34 | 1·338595 | 84 | 3·307116 |
| 35 | ·001378 | 35 | 1·377965 | 85 | 3·346487 |
| 36 | ·001417 | 36 | 1·417336 | 86 | 3·385857 |
| 37 | ·001457 | 37 | 1·456706 | 87 | 3·425228 |
| 38 | ·001496 | 38 | 1·496076 | 88 | 3·464598 |
| 39 | ·001535 | 39 | 1·535447 | 89 | 3·503968 |
| 40 | ·001575 | 40 (4 cm.) | 1·574817 | 90 (9 cm.) | 3·543339 |
| 41 | ·001614 | 41 | 1·614188 | 91 | 3·582709 |
| 42 | ·001654 | 42 | 1·653558 | 92 | 3·622080 |
| 43 | ·001693 | 43 | 1·692929 | 93 | 3·661450 |
| 44 | ·001732 | 44 | 1·732299 | 94 | 3·700820 |
| 45 | ·001772 | 45 | 1·771669 | 95 | 3·740191 |
| 46 | ·001811 | 46 | 1·811040 | 96 | 3·779561 |
| 47 | ·001850 | 47 | 1·850410 | 97 | 3·818932 |
| 48 | ·001890 | 48 | 1·889781 | 98 | 3·858302 |
| 49 | ·001929 | 49 | 1·929151 | 99 | 3·897673 |
| 50 | ·001969 | 50 (5 cm.) | 1·968522 | 100 (10 cm.=1 decim.) | |
| 60 | ·002362 | | | | |
| 70 | ·002756 | | | | |
| 80 | ·003150 | | | | |
| 90 | ·003543 | | | | |
| 100 | ·003937 | | | | |
| 200 | ·007874 | | | | |
| 300 | ·011811 | | | | |
| 400 | ·015748 | | | | |
| 500 | ·019685 | | | | |
| 600 | ·023622 | | | | |
| 700 | ·027559 | | | | |
| 800 | ·031496 | | | | |
| 900 | ·035433 | | | | |
| 1000 (=1 mm.) | | | | | |

| decim. | ins. |
|---|---|
| 1 | 3·937043 |
| 2 | 7·874086 |
| 3 | 11·811130 |
| 4 | 15·748173 |
| 5 | 19·685216 |
| 6 | 23·622259 |
| 7 | 27·559302 |
| 8 | 31·496346 |
| 9 | 35·433389 |
| 10 (1 metre) | 39·370432 |
| | = 3·280869 ft. |
| | = 1·093623 yds. |

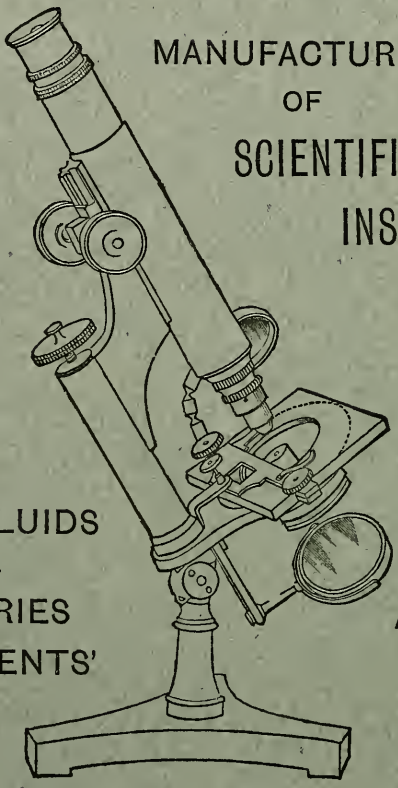
*Inches, &c., into Micromillimetres, &c.*

| ins. | μ |
|---|---|
| $\frac{1}{25000}$ | 1·015991 |
| $\frac{1}{20000}$ | 1·269989 |
| $\frac{1}{15000}$ | 1·693318 |
| $\frac{1}{10000}$ | 2·539977 |
| $\frac{1}{9000}$ | 2·822197 |
| $\frac{1}{8000}$ | 3·174972 |
| $\frac{1}{7000}$ | 3·628539 |
| $\frac{1}{6000}$ | 4·233295 |
| $\frac{1}{5000}$ | 5·079954 |
| $\frac{1}{4000}$ | 6·349943 |
| $\frac{1}{3000}$ | 8·466591 |
| $\frac{1}{2000}$ | 12·699886 |
| $\frac{1}{1000}$ | 25·399772 |
| | mm. |
| $\frac{1}{900}$ | ·028222 |
| $\frac{1}{800}$ | ·031750 |
| $\frac{1}{700}$ | ·036285 |
| $\frac{1}{600}$ | ·042333 |
| $\frac{1}{500}$ | ·050800 |
| $\frac{1}{450}$ | ·056444 |
| $\frac{1}{400}$ | ·063499 |
| $\frac{1}{350}$ | ·072571 |
| $\frac{1}{300}$ | ·084666 |
| $\frac{1}{250}$ | ·101599 |
| $\frac{1}{200}$ | ·126999 |
| $\frac{1}{150}$ | ·169332 |
| $\frac{1}{100}$ | ·253998 |
| $\frac{1}{50}$ | ·507995 |
| $\frac{1}{25}$ | 1·015991 |
| $\frac{1}{20}$ | 1·269989 |
| $\frac{1}{16}$ | 1·587486 |
| $\frac{1}{15}$ | 1·693318 |
| $\frac{1}{12}$ | 2·116648 |
| $\frac{1}{10}$ | 2·539977 |
| $\frac{1}{8}$ | 3·174972 |
| $\frac{1}{6}$ | 4·233295 |
| $\frac{3}{16}$ | 4·762457 |
| $\frac{1}{5}$ | 5·079954 |
| $\frac{1}{4}$ | 6·349943 |
| $\frac{5}{16}$ | 7·937429 |
| $\frac{1}{3}$ | 9·524915 |
| | cm. |
| $\frac{7}{16}$ | 1·111240 |
| $\frac{1}{2}$ | 1·269989 |
| $\frac{9}{16}$ | 1·428737 |
| $\frac{5}{8}$ | 1·587486 |
| $\frac{11}{16}$ | 1·746234 |
| $\frac{3}{4}$ | 1·904983 |
| $\frac{13}{16}$ | 2·063732 |
| $\frac{7}{8}$ | 2·222480 |
| $\frac{15}{16}$ | 2·381229 |
| 1 | 2·539977 |
| 2 | 5·079954 |
| 3 | 7·619932 |
| | decim. |
| 4 | 1·015991 |
| 5 | 1·269989 |
| 6 | 1·523986 |
| 7 | 1·777984 |
| 8 | 2·031982 |
| 9 | 2·285979 |
| 10 | 2·539977 |
| 11 | 2·793975 |
| 1 ft. | 3·047973 |
| | metres. |
| 1 yd.= | ·914392 |

# CHARLES COPPOCK,

LATE
PARTNER WITH
R. & J. BECK.

MANUFACTURER
OF
SCIENTIFIC
INSTRUMENTS.



PATHOLOGICAL
AND
PHYSIOLOGICAL
PREPARATIONS.

STAINING FLUIDS
AND ALL
ACCESSORIES
FOR STUDENTS'
USE.

Microscopes
for
Students and
Amateurs.

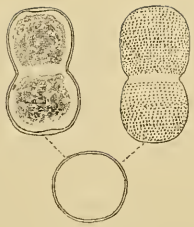
*ILLUSTRATED*
*CATALOGUE,*
*2s.*

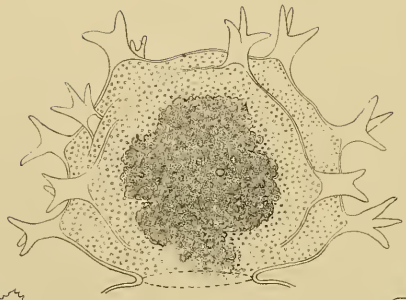
## 100, NEW BOND STREET,
## LONDON, W.

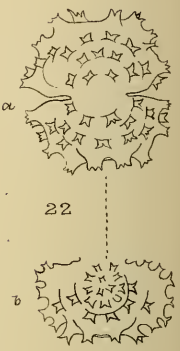
**N.B. SPECTACLES!!**

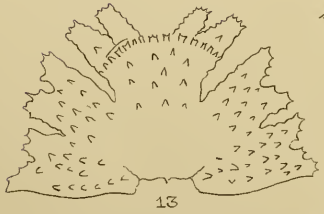
OCULISTS' PRESCRIPTIONS RECEIVE PERSONAL ATTENTION.

AGENT FOR W. H. BULLOCH, CHICAGO, ILLS., U.S.A.
R. H. SPENCER & CO., N.Y., U.S.A.
JAMES L. PEASE, MASS., U.S.A.
M. PRAZMOWSKI, PARIS.
M. A. INACHET, PARIS.

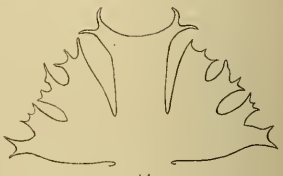


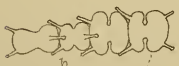



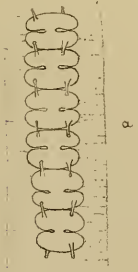



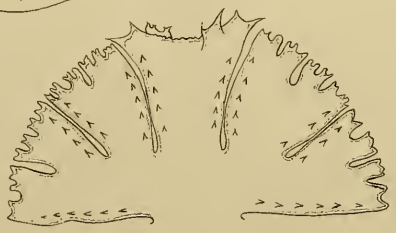





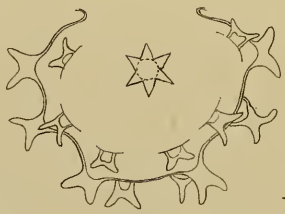


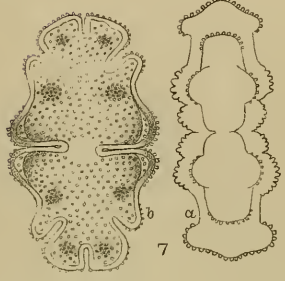



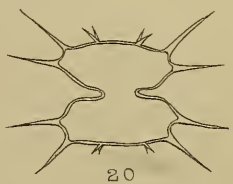





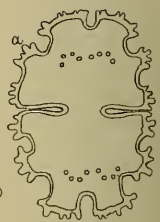






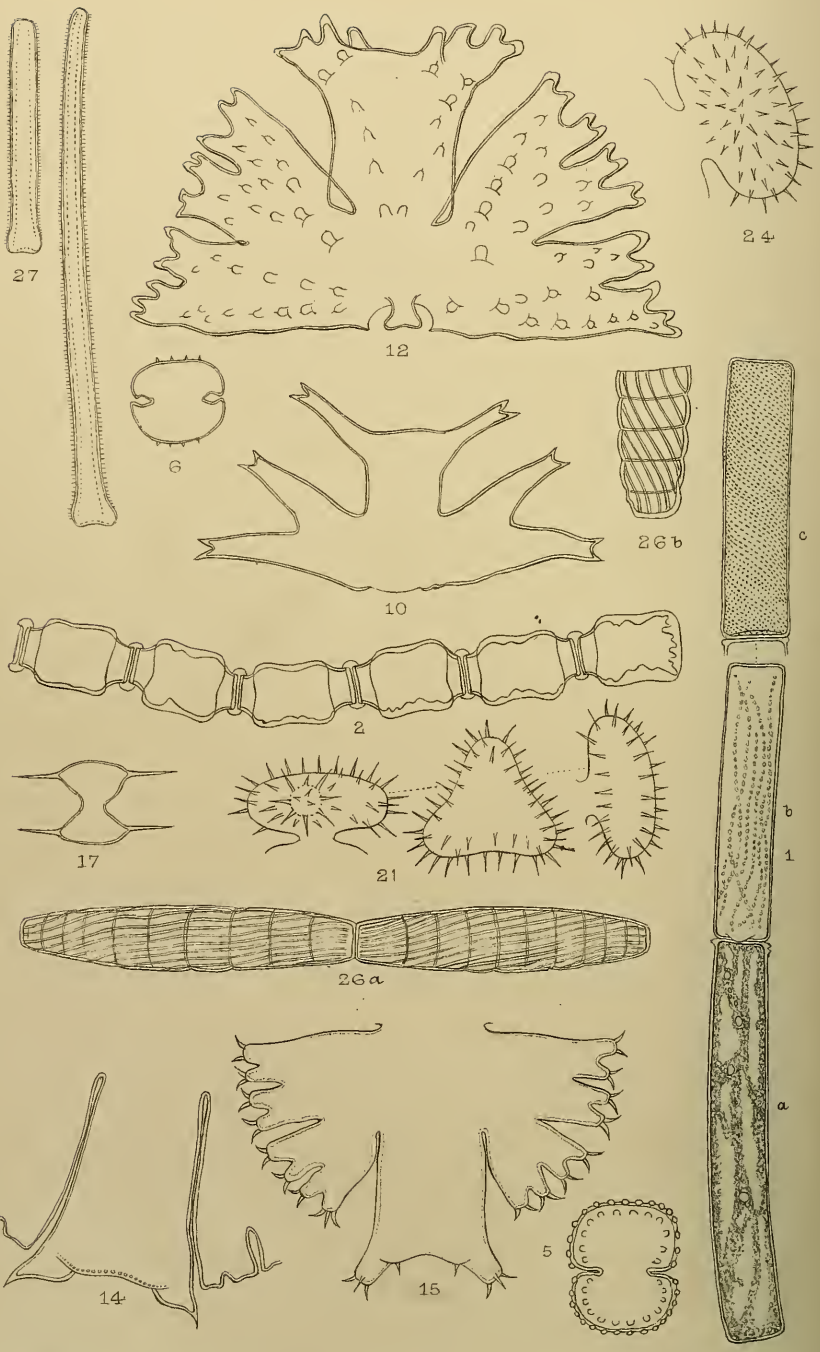





W. B. T. del. ad nat.

West, Newman & Co. lith.

New & rare Desmids.




W.B.T. del. ad nat.

West, Newman & Co lith.

New & rare Desmids.

JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1885.

## TRANSACTIONS OF THE SOCIETY.

### XVIII.—*On some new and rare Desmids.*

By W. Barwell Turner, F.R.M.S., F.C.S.

(*Read* 11*th November*, 1885.)

Plates XV. and XVI.

The forms which I am herein describing are all more or less beautiful, beauty being an especial attribute of this charming family of micro-algæ—so exquisite and curious are they that it is a marvel that a larger number of observers do not take up their study. The field is ample, and the life-histories of all but a very small number are as yet unknown, the latter remark applying to *very* common forms.

In the following observations I have not taken the genera in strict sequence, such sequence itself being a *quæstio vexata.*

#### Genicularia De Bary.

1. *G. Americana* nov. sp. Cells or joints comparatively short and stout, covered with tiny granules *spirally arranged* in close lines. Joints three and a half to six times as long as broad. Chlorophyll radiate, but inclined to spiral form; the moribund and effete cell-contents (*b*) showing this inclination to spirals more strongly; two or more amylum corpuscles in each joint. Zygospores not observed. Minnesota, U.S.A. Fig. 1*a*, *b*, *c*.

Cells, long. 71·5–143 $\mu$ = ·0028–56 in.; lat. 23–25·4 $\mu$ = ·0009–·001 in.

This form differs considerably from the only species of the genus hitherto described, *G. spirotænia* De Bary ('Conjugatæ,' 1858, t. iv. figs. 1–22), which is much longer and a little narrower in the

cells, and the little prominent granules are scattered, not arranged spirally on the cytioderm. De Bary's figures give:—

Cells, long. 222–383 $\mu$ = ·0089–·015 in.; lat. 20–25 $\mu$ = ·00079–98 in. [The measure given by Dr. Rabenhorst in Flora Europ. Alg. iii. p. 156 is not quite correct.]

### Leptozosma nov. gen.*

Filamentous, long, cateniform; not twisted or but slightly so. Joints united by a strongly marked suture; cells attenuate at the ends towards the suture. Near to *Bambusina* Kütz., but differing therefrom in the suture.

2. *Leptozosma catenula* nov. sp. Cells irregularly annular, inclining to quadrate, slightly hollowed or incurved at the sides, tapering rapidly towards the suture, which is thickened and projects considerably. Cell-wall very thick. Chlorophyll parietal or confluent. Malaga, New Jersey, U.S.A.

Cells, long. (central portion) 26–30 $\mu$ = ·001–·0012 in.; long. total 36–38 $\mu$ = ·0014–15 in.; lat. max. 26–28 $\mu$ = ·001–·0011 in. Fig. 2.

### Onychonema Wallich.

3. *O. Nordstedtiana* nov. sp. Cells forming filaments of fifty to sixty cells or more, connected by the curious subcapitate "claspers" peculiar to this genus. Without these processes the cells resemble smooth *Cosmaria*, as they do not possess the hooklets (at the ends of the segments) which pertain to *O. uncinatum* Wallich and *O. læve* Nordst. Chlorophyll confluent. India, U.S.A., and recently found by me at Strensall Common, near York.

Syn. *O. inermis* Turner in lit. c. ic.

Cells, long. (sin. proc.) 14 $\mu$ = ·00055 in.; lat. 18 $\mu$ = ·0007 in.; breadth of gelatinous sheath 36–40 $\mu$ = ·0014–·00157 in.; lat. isthmi 3–4 $\mu$ = ·00012–16 in. Figs. 3*a*, *b*.

This is a very cosmopolitan and distinct species. My friend Dr. O. Nordstedt, of Lund, at first deemed it to be a young form of his *O. læve*, but as that is so much larger, and, moreover, as this has been found where *O. læve* was not present, I certainly think it separate therefrom.

### Cosmarium Corda.

4. *C. Cordanum* Bréb., in Pritch. Infusoria, 1861 (= *Colpopelta viridis* Corda, Alm. de Carlsbad, 1835, p. 206, t. ii. f. 28). Diameter about half the length; gently and slightly constricted in

* Ex λεπτος, slender, ζωσμα, a band.

the middle; ends round or a little truncate; cell-coat lightly granular or punctate. End view circular. Germany, France, Nova Scotia. The specimens figured are from the latter.

Long. 47–50 $\mu$ = ·00185–197 in.; lat. 26–27 $\mu$ = ·001–·00106 in.; lat. isthmi 17–19 $\mu$ ·00067–75 in.

I cannot find any published dimensions of this rare species, which I give as above, and I think that the specimens may safely be hereto referred. Fig. 4.

5. *C. gemmatum* nov. sp. Of medium size, subquadrate; upper angles gently rounded, the lower ones rather more acute; smooth, except at margins, which are provided with 3 concentric series of large gemmules, the 2 inner series 12 and the marginal one 14 in number. Sinus linear, rapidly expanding outwards. Minnesota, U.S.A.

Long. 47·5 $\mu$ = ·00187 in.; lat. 39 $\mu$ = ·00154 in.; lat. isthmi 15 $\mu$ = ·00059 in. Fig. 5.

6. *C. rostratum* nov. sp. Small, rather broader than long (excl. spin.), upper margin rounded, slightly truncate at apex, and ornate with four small triangular spines; lower margins prolonged into convergent rostra, which meet, or nearly so. Cytioderm smooth. Sinus open, quadrangular in appearance, with blunt angles. Isthmus wide. Minnesota, U.S.A.

Long. (excl. spin.), 29 $\mu$ = ·00114 in.; lat. max. 34 $\mu$ = ·00134 in.; lat. isthmi 20 $\mu$ = ·00079 in. Fig. 6.

### Euastrum Ehr. (*mut. char.*).

7. *E. Floridanum* nov. sp. Of medium size, diameter = about half the length; punctate, partly granular; segments three-lobed, with sinuate sides; having but two principal frontal prominences, which are well marked; end protuberances not so strongly defined except in side view; end lobe tumid, the terminal incision a linear notch; sinus linear; segments closely adpressed. Numerous in the gathering. Maitland, Florida.

Long. 96 $\mu$ = ·00378 in.; lat. max. 54 $\mu$ = ·00213 in.; lat. isthmi 14 $\mu$ = ·00055 in. Figs. 7*a*, *b*.

This may *possibly* be a small form of *E. crassum* Bréb., but the difference in size and disposition of the prominences seems to separate it clearly.

8. *E. pseudelegans* nov. sp. General outline of frond inclining to oval shape; ends protruding, rounded; terminal incisions large; segments sinuate, with 5 central and 4 marginal markings. U.S.A.

Long. 40 $\mu$ = ·00157 in.; lat. max. 25·5 $\mu$ = ·001 in.; lat. isthmi 7 $\mu$ = ·00027 in. Fig. 8.

9. *E. coronatum* nov. sp. Of medium size, about one-third

longer than broad; lobes well defined, each with a coronet of large protuberant gemmules, some of which are rather spiniform; smooth or obscurely punctate; on the front of segments, at the base of polar lobes, two series of four granules arcuately arranged. The side view shows the "coronæ" well. Minneapolis, Minnesota, U.S.A. Figs. 9*a*, *b*.

Long. 70–78 $\mu$ = ·00276–307 in.; lat. max. 52–58 $\mu$ = ·00205–228 in.; lat. isthmi 13 $\mu$ = ·0005 in.

Micrasterias Agdh. (in part.) Mengh.

10. *M. furcata* Ralfs (non Agdh.) nov. var. *decurta*. A strange and apparently abnormal form. Only two semi-cells seen, of which one possessed a curious double lobelet. Water Town, New York, U.S.A.

Long. (semi-cell) 72 $\mu$ = ·00283 in.; lat. 166 $\mu$ = ·0065 in.; lat. isthmi 24 $\mu$ = ·00094 in. Fig. 10.

11. *M. Crux-Melitensis* (Ehr.) Ralfs nov. var. *superflua*. In this the superior side lobelets are trifid, end lobe with curved points. Several specimens seen, having one or both segments as figured. Near Bowness, Windermere.

Long. 116 $\mu$ = ·00457 in.; lat. 102 $\mu$ = ·004 in.; lat. isthmi 17 $\mu$ = ·00067 in. Fig. 11.

[Note.—I find that the American forms of this species are large, with broad end lobes. They measure long. 145–152 $\mu$ = ·0057–599 in.; lat. 118–130 $\mu$ = ·0046–51 in.; lat. isthmi 23–28 $\mu$ = ·0009–·0011 in. The Rev. F. Wolle, Amer. Desm. p. 111, t. xxxv. f. 3, gives an abnormal form as his example of the species, and says "diam. 100–125 $\mu$." The form Mr. Wolle gives is near that given by Ralfs, Br. Desm. t. ix. f. 3 *b*, which is not common, f. 3 *a* being the typical one. Ralfs, p. 74, notes the dimensions of English specimens as long. 123 $\mu$ = ·00485 in.; lat. 115 $\mu$ = ·00452.]

12. *M. mamillata* nov. sp. A very interesting and well-marked form. Segments papilionaceous, five-lobed; end lobe broad; its ends and those of the other lobes divided into palmate shapes, with the points broadly rounded; surface adorned with mamilliform processes radially arranged; provided with a process at isthmus, the purpose of which is apparently (?) to strengthen the segmental union. Only one specimen (semi-cell) seen. Seemingly related to *M. apiculata* Ehr. Harvey Lake, U.S.A. Fig. 12.

Long. (semi-cell) 114 $\mu$ = ·00449 in.; lat. base 198 $\mu$ = ·0078 in.; lat. isthmi 23 $\mu$ = ·0009 in.

13. *M. Americana* Ehr. nov. var. *spinosa*. A small "compressed" form. About one-eighth less in length and breadth than the type. Central portion of segments smooth; lobes ornamented

with short stout spines; the end lobe bearing near its extremity a species of annular rugoso-spinous coronet. Picton, Nova Scotia. Fig. 13.

Long. (semi-cell) 112 $\mu$ = ·00441 in.; lat. 68 $\mu$ = ·00268 in.; lat. isthmi 22 $\mu$ = ·00086 in.

14. *M. denticulata* Bréb. nov. var. *Minnesotensis.* A large and handsome variety; in general contour closely following the type, except the polar lobe, which has pointed extremities, and bears a central terminal inflation ornate with a single series of pearly dots or granules. Minnesota, U.S.A.

Long. 266 $\mu$ = ·0105 in.; lat. 252 $\mu$ = ·0099 in.; lat. end lobes apic. 68 $\mu$ = ·00268 in.; lat. isthmi 39 $\mu$ = ·00154 in. Fig. 14.

15. *M. brachyptera* Lundell nov. var. *bispinata.* This beautiful species was first observed by Lundell in Sweden (Desm. Suec. p. 12, t. i. f. 4, 1871), and was added to the British flora last year, by Mr. John Bisset from the Windermere district.* Of the form shown I obtained several from near Bowness, in August last. The marginal contour in this species is very erratic. The variety figured is not of such "spreading" form as the type, and has two, in lieu of three, spines at the apices of the lobules.

Long. sin. acul. 191 $\mu$ = ·0075 in.; lat. 131 $\mu$ = ·0041 in.; lat. max. lob. pol. 54 $\mu$ = ·00213 in.; lat. isthmi 37 $\mu$ = ·00146 in. Fig. 15.

16. *M. papillifera* Bréb. nov. var. *Novæ-Scoticæ.* In length and breadth about one-sixth larger than the type. General contour following type pretty closely, but the end lobe is very different, the two normal digitiform appendages being replaced by broad, pointed elevations; moreover, in the type the apices of the end lobe are rounded off, in this form they are sharply pointed. Picton, Nova Scotia.

Long. 152 $\mu$ = ·00599 in.; lat. 133 $\mu$ = ·0052 in. Fig. 16.

### Arthrodesmus Ehr.

17. *A. incus* (Bréb.) Hassall nov. var. *Americanus.* Frond swollen at base, and differing from the European type by having pyramidal segments, not oblong-quadrangular as in the familiar form. Harvey Lake, U.S.A. Fig. 17.

Long. (s. spin.) 30 $\mu$ = ·00118 in.; lat. 25 $\mu$ = ·00098 in.; long. spin. 16 $\mu$ = ·00063 in. The measure agrees closely with that of Dr. Rabenhorst in Fl. Eur. Alg. iii. p. 226, and it may possibly be a variety of Dr. R.'s "*b.* forma-semicellulis basi gibbosis, aculeis rectis vel convergentibus," Rabh. l. cit.

* See this Journal, iv. (1881) p. 192.

### Xanthidium Ehr.

18, 19. *X. armatum* Bréb. In a slide from the United States I have found two widely different forms of this fine species :—

*a.* Nov. var. *Wolleanum.* This form greatly exceeds the limit of size of European type, being nearly as broad as they are long. Rather finely punctate. The average measure of several specimens is long. (s. spin.) 168 $\mu$ = ·0066 in.; lat. (s. spin.) 104 $\mu$ = ·0041 in.; lat. isthmi 42 $\mu$ = ·00165 in. Fig. 18.

*β.* Nov. var. *Americanum.* This smaller form varies much in size. Scrobiculi well defined. On several specimens I could not (under careful illumination) perceive any puncta. Fig. 19. Measure, without spines, long. 70–123 $\mu$ = ·0027–·00484 in.; lat. 38–73 $\mu$ = ·00149–29 in.: lat. isthmi 31–37 $\mu$ = ·00122–146 in. The Rev. F. Wolle gives (Amer. Desm., p. 92) lat. 62–140 $\mu$. Ralfs gives lat. as 94 $\mu$, with long. 139 $\mu$; and Rabenhorst gives lat. as 95–115 $\mu$. The specimens figured were from New Jersey; and it is noteworthy that they approach in contour the European type, rather than the "angular" forms figured by Wolle, loc. cit.

20. *X. hastiferum* nov. sp. This form approaches one described by Dr. Nordstedt from Java, as "*X. antilopæum* f. *javanica*" (Alg. Mus. Lugd. Batav. p. 12, t. i. f. 21, 1880) but is smaller by about one-sixth, and the central spines are comparatively minute. Southern India. Fig. 20.

Long. sin. acul. 38·5 $\mu$ = ·00152 in.; lat. sin. acul. 40 $\mu$ = ·00157 in.; lat. isthmi 11 $\mu$ = ·00043 in.; long. acul. 21 $\mu$ = ·0008 in. I cannot but think that this and forms allied to it would be wrongly placed as varieties of *X. antilopæum*, as the contour of cell, inclination of spines, isthmus and sinus so widely differ.

### Staurastrum Meyen.

21. *S. gladiosum* nov. sp.—Species with reniform segments; spines strong, arrayed in series, a few smaller ones scattered; end view triangular, with gently concave sides; ends broadly rounded with six to eight large spines at each; sinus open, expanding rapidly. Malaga, New Jersey, U.S.A.

Long. 49 $\mu$ = ·0019 in.; lat. = long.; lat. isthmi 11–12 $\mu$ = ·00043–47 in. Fig. 21. This forms a unit in a series comprising *Saxonicum, Brébissonii, echinatum, aculeatum, pecten, tridentiferum*, &c. It is near to the *small* form of *S. Saxonicum* Bulnheim, but is just as broad as long, and the segments are not "densely aculeate," as in that species.

22. *S. spongiosum* Bréb. The form figured as "the more frequent" one in Amer. Desm. t. xlvii. f. 5, 6, by the Rev. F. Wolle is so different from the type that it would perhaps be better

to name it "var. *Americanum*." Mr. Wolle states that the sides are convex, but they are frequently concave in the type; and the typical form bears larger and fewer spines, and is not so regular in outline as the above. I find that the typical form is found in America, and give figures of specimens from Minnesota and Nova Scotia. Their dimensions are long. 52–62 $\mu$ = ·00205–·00244 in.; lat. 52 $\mu$ = ·00205 in.; lat. isthmi 17–18 $\mu$ = ·00067–7 in. Ralfs gives lat. isthmi as 30·5–34·5 $\mu$! Mr. Wolle, loc. cit. p. 148, remarks on the variability of this species, and gives the diameter as 45–50 $\mu$. Figs. 22*a*, *b*.

23. *S. dejectum* Bréb. var. *Sudeticum* Kirchner (Krypt. Flor. v. Schlesien, p. 169). This rare and curious form has only before been noted by Kirchner from Germany. So far as I am aware it has not been figured. Minnesota, U.S.A.

Long. 26 $\mu$ = ·00102 in.; lat. 40 $\mu$ = ·00158 in.; lat. isthmi 5 $\mu$ = ·0002 in. Fig. 23. I am indebted to Dr. Nordstedt for a copy of Dr. Kirchner's drawing.

24. *S. Pringsheimii* Reinsch nov. var. *duplo-major*. A very large and handsome form of this species. Rather over double the size of the type. Picton, Nova Scotia.

Long. 75–80 $\mu$ = ·00295–315 in.; lat. 56–62 $\mu$ = ·0022–244 in.; lat. isthmi 22 $\mu$ = ·00087 in. Fig. 24.

### Docidium Bréb.

25. *D. occidentale* nov. sp. Near to *D. gracile* Bailey, but only about half the size of that species. Segments straight, with tumid portions at regular intervals; apex trifid, each subdivision bearing a long stout spine; the tumid processes each having a double series of smaller spines, the superior pointing apically and the inferior directed to the base of segment. One semi-cell only seen. U.S.A.

Long. (spin. excl.) semi-cell 150 $\mu$ = ·0059 in.; lat. corp. max. 17 $\mu$ = ·00067 in.; lat. spin. incl. 20·4 $\mu$ = ·00079 in.; lat. apicis (spin. excl.) 19 $\mu$ = ·00075 in. Fig. 25.

The peculiarity in the setting of the spines and the simple (not bifid) ends render this species very distinct from its near allies *gracile* and *verticillatum* Bail., and *bidentatum* Nordst. It is a member of Bailey's sub-genus *Triploceras*.

### Penium Bréb.

26. *P. spirostriolatum* Barker. "Large, elongated, somewhat attenuated in the centre, and tapering slightly towards the rotundo-truncate ends; the cell-wall possessing a number of superficial, conspicuous, rather coarse striæ, running in a spiral direction;

these somewhat interrupted at a number of annular rib-like projections varying in number; these projections most numerous towards the upper third of each segment."—Barker, in Proc. Dub. Micr. Club, Q.J.M.S., 1869, p. 194. As I do not know of the publication of any measurements or authentic figure of this interesting and unique species, I may possibly be in error in referring these American forms to it; the figures therefore must speak for themselves, though, owing to the dense dark endochrome, drawing was difficult. Frond, fig. 26*a*; fragment, showing apex more clearly, fig. 26*b*.

Long. 227–260 $\mu$ = ·0089–·0102 in.; lat. max. 23–31 $\mu$ = ·0009–·00122 in. Specimens from near Minneapolis, Minnesota, U.S.A. Not previously reported from America.

### Gonatozygon De Bary.

27. *G. sex-spiniferum* nov. sp. Joints variable in length, ten to thirty times the breadth; base swollen, apex either rotundo-truncate or quite rounded; spines (or rather setæ) very short, and arranged longitudinally in six linear series. Forming long filaments. Minnesota, U.S.A.

Long. 88–191 $\mu$ = ·00346–·0075 in.; lat. 6–8·5 $\mu$ = ·000236–33 in. Fig. 27.

The figures which illustrate these remarks are all drawn by myself from nature, and to a uniform scale of × 500.

## XIX.—*Further Experiments on Feeding Insects with the Curved or "Comma" Bacillus.*

By R. L. Maddox, M.D., Hon. F.R.M.S.

(*Read 14th October*, 1885.)

The following details are but an extension of the former paper on the same subject which I had the honour of bringing before the Fellows on the 13th of May last.* It is more incomplete than I desire, but I think it will be found to extend the views previously announced, that the comma bacillus from cultures can pass in a living state through the digestive tracts of the insects experimented upon, and that under these conditions the insects become possible carriers of contagion, and may infect food by their dejections. Of course I am only supposing, not affirming, that Koch's views in reference to this particular microbe, and the part it plays in cholera, are correct.

Dr. Grassi, of Rovellasca, in the summer of 1883 published† the results of some interesting observations he had made, and contended that insects, especially flies, may be considered as veritable authors of epidemics and agents in infectious maladies. He put on a plate in his laboratory some ova of the *Trichocephalus*, and found they had been deposited with the excreta on bits of white paper placed in the kitchen, some little distance away. He captured some of the flies, and discovered the digestive tube full of masses of feculent matter abounding with the ova. Then he remarks on the danger the entire family were exposed to, if the ova could be afterwards developed. He also put segments of tape-worm, *Tænia solium*, that had been for some time preserved in alcohol, into water, some of the ova remained suspended, the flies drank of the fluid, and in less than one hour he found the ova in their intestines and also emitted in their dejections, and says, had they been living the family might have been infected. Flies, he states, can also transmit the ova of the small thread-worm, *Oxyuris*. He moistened sugar with *Lycopodium*, and allowed flies to feed on this, and also off the blood of frogs and toads, and then found the spores and the blood-corpuscles in their intestines. He therefore thinks, as the buccal passages permit of the transit of these large bodies, they could the more easily transmit the Schizomycetes. He let flies feed off some mildewed cream, and then found the *Oidium lactis* within them, and flies feeding off silk-worms dead of muscardine, after a short time, passed in their dejections the spores of the *Botrytis*, the cause

* See this Journal, *ante*, p. 602.

† Arch. Ital. Biol., iv. (1883) pp. 205–8. Bull. Soc. Entomol. Ital., xv. (1883) pp. 318–9. See this Journal, iv. (1884) p. 556.

of the disease. Dr. Grassi says it would be imprudent to suppose that the ingestion in the fly caused the death of the organism, for it does not suffice to kill the germs of mildews and schizomycetes, and that flies eat more than their gastric juice can destroy. He points out that they are likely to carry about the various organisms by their feet and proboscis. He remarks on the difficulty to arrive at positive proofs, on account of the numerous causes of error, and concludes by declaring that the agency of the earth, air, and water does not suffice for the diffusion of disease. Finally, he proposes that flies should be exterminated by trying to give them the malady in the spring of which they often die in the autumn.

These remarks stand in strong contrast with those of the late Frank Buckland, who in speaking of the acclimatization of rats and bluebottle flies without the aid of human agency, says, "when we come to consider the matter philosophically, rats and bluebottle flies are, in reality, among *the* most useful of created things to the human race. True it is, indeed, that we cannot *eat* them; but everything in this world was not made to be eaten, and these despised creatures really do great service to us by getting rid of decaying substances which would otherwise breed fever." *

My friend Mr. G. F. Dowdeswell has reminded me that M. Davaine found that flies by feeding off infected blood could convey the infection; while Dr. Manson, of China, has shown that mosquitoes are carriers of the ova of the *Filaria sanguinis hominis*, and that it is possible the dreadful tsetse fly of Central Africa may transmit infection to the animals it attacks.

Grassi seeing the many difficulties in establishing his views, intended to further prosecute his studies. How far I may have by patience and trouble contended against these difficulties, the results of the following experiments will determine:—

Having examined very many slides prepared from the natural excreta of sundry insects, *Eristalis tenax*, of the family of the Syrphidæ, was selected as one to experiment with (as this fly was found to support captivity fairly well, and I had discovered no curved bacillus in the dejections), and the common blowfly, *Musca vomitoria*, as the other, There was another reason that prompted me to choose *Eristalis;* part of its early career is passed in sewers or dirty waters, and it struck me that, although changed into a gay or flower-haunting fly, it might still have some predilection for impure food, or other than pollen and honey; also it was abundant in the garden during a part of July and August, in the sunny hours of the day.

For the culture material I am greatly indebted to the kindness of my friend, Dr. E. Klein, F.R.S., who purposely inoculated four of his sterilized tubes for me, two in gelatin and two in agar-agar,

* 'Life of Frank Buckland,' by Mr. G. C. Bompas. 4th ed., 1885, p. 130.

that I might have at hand a supply of the pure comma bacillus, and afterwards also furnished me with other uninoculated tubes, in order, if required, I might be able to complete my experiments.

Having for several days satisfied myself, by microscopical examination, of the non-existence of any comma or curved bacillus in the natural excreta of *Eristalis*, two of the insects, by way of control experiment, were put into captivity on the plan described in my former paper, and fed on a small freshly-cut lump of sugar, moistened with a recent watery solution of methyl-violet. On the 19th of July, that is twenty-four hours after, the first of the coloured dejections were examined, and found to contain numerous pollen-grains, small, straight, non-motile rods with blunt ends, bacteria and micrococci amongst much débris, but no curved rods.

On the 20th four similar insects were placed together in like captivity, and the dejections passed upon the square of glass before they were fed with a gelatin culture of the comma bacillus on sugar, were examined with a result agreeing with that of the control insects. Half an hour after being fed several dejections were noticed of a pale yellowish colour; on examination no curved bacilli could be found. On the 21st, about eighteen hours after being fed with the gelatin culture, nine dejections that had been settled on the glass were by a sterilized needle mixed in a droplet of freshly-boiled distilled water. Amongst the other organisms in the quantity examined only five motionless curved bacilli could be found in many fields. The plan adopted was to examine the excreta moistened, also dried, unstained and stained, and the stained counted for the numbers described, though the unstained wet and dry often furnished, as far as could be judged, higher figures; movement in the wet unstained slides was accepted as evidence of life. This plan was adopted throughout the experiments. On the 22nd, twenty-seven spots were mingled and examined; the curved bacilli were rather more numerous, but none seen in motion. There were only seven dejections on the 23rd, they afforded still a few commas, and one of these had a perceptible though slight motion, and in the excreta were very great numbers of minute oily-looking globules. Nineteen spots were examined on the 24th, the curved bacilli were very few, and only one seen to be active. A little alteration was now made. To the sugar, after damping with the gelatin culture, was added a droplet of freshly boiled distilled water, as the original culture appeared to dry up too soon. On the 25th there were seventeen dejections, these were passed on two squares of glass, as the insects by continually treading over the dejections seemed to weaken the number of microbes. The commas were still very rare, and it was doubtful if they were living. The pollen-grains had disappeared, the small straight bacilli were much less numerous, but the oily globules and micrococci had increased. The insects

appeared vigorous, and not to have suffered in any perceptible way by this unnatural food under their captivity, nor did the culture, as far as could be judged, have any temporary ill effect upon them, save the increased amount of oily globules, which I had learned to regard as indications of progressive debility. All the insects fed often off the moistened sugar, and only a few of the pollen-grains had been partially digested. The insects were killed by the vapour of chloroform, and were not examined. *Pari passu* with these examinations, the dejections of those fed with the anilin dyed sugar were daily examined, but no curved bacilli were noticed in their excreta. The two insects seemed perfectly well, and on the 25th were allowed their liberty. No attempt was made to cultivate the curved bacillus from any of the dejections.

On the 3rd of August, a large female blow-fly was put in captivity under a similar arrangement. It was at once fed with sugar moistened with a watery solution of methyl-violet. This was damped daily until the 9th with a drop of freshly boiled distilled water. The first dejections had a few long non-motile rods of medium size with blunt ends, a few thick short rods, and here and there a small fine straight rod, averaging in length the 1/10,000 in., abundant micrococci, and a few conidia probably of *Penicillium*, faintly stained. All the organisms diminished rapidly in number, and an abundance of narrow acicular crystals and minute oily-looking globules were noticed, the former closely resembling a bacillus, but unstained. On the 9th the fly appeared to be very weak, if it fell on its back it could scarcely rise. This was attributed to some detrimental action of the anilin dye, and it was feared the attempt to destroy all the organisms by it had been carried too far, and nearly killed the insect itself. When the vessels were changed it was fed off sugar damped with the gelatin culture of the comma bacillus, the same as was used for the other insects. The culture was much broken down, but contained plenty of the commas. The fly was watched to feed for more than ten minutes without cessation. The last dejection before the change of food was quite liquid, and the few organisms present only faintly stained, the oily globules being very abundant. Fearing the culture might not be well suited for the condition of the fly, it was changed for a fresh lump of sugar moistened with the culture from one of the agar-agar tubes, which abounded in the curved bacillus, and was not broken down like the other. The culture was diluted on the sugar, as it seemed scarcely fluid enough to carry the organisms into the interstices. The same forenoon, a male blow-fly was captured and put with the female fly, both were watched to feed off the sugar frequently but not for long periods. A few hours, about six, after feeding on the gelatin culture, there were six dejections found on the square of glass. They had fairly dried before ex-

amination; they furnished a large amount of scaly granular matter, some extremely fine motionless rods and a few well-marked curved bacilli, some in the double or S-shape, but without distinct movement, and the acicular crystals were very rare.

Early in the morning of the 10th, the flies were found in coitus, and at 1.30 P.M. the female was found dead. Before the fly was removed, the male made repeated attempts at coitus with his dead mate. It was not until five hours later that I could attend to the examination of the fly. Upon making a section of the posterior end of the abdomen and placing it in diluted potassic acetate solution, numerous spermatozoa, in bundles and free, were noticed. In the perivisceral fluid there was much fine granular matter, a very few short and stout, and also some thin motionless rods, and scarcely a curved bacillus to be found. When the contents of the cavity were removed with a mass of the ova capsules, the fine granular matter, possibly from their rupture, even when much diluted, was so abundant that nothing satisfactory could be determined. The death of this fly appeared to be due to the feeding for six days upon the anilin stained sugar, which it ill supported compared with *Eristalis*. The male fly was now detained by itself, and fed from the original agar-agar culture diluted on the sugar. The daily dejections when examined showed some short, straight, thick non-motile rods, some bright oval spores, a few germinating, and abundant micrococci. The comma bacilli present were few, and none seen to be motile; no acicular crystals. On the 15th, nine dejections found on the square were mingled, they were in whitish patches and quite dry; the micrococci were very numerous, with scarcely a straight rod present, and a few motionless commas, some double with the curvature on the same side. Five dejections of the 16th furnished a rather large number of the curved bacillus, more than in any previous dejections, and some of them had a rather sluggish motion, many appeared to be somewhat short and dumpy in shape or immature, a few were double; the straight rods were fewer, but the micrococci were numerous. It was found exceedingly difficult to so apportion the moisture that the sugar should remain just damp for some hours. The fly would often turn the small lump over, seeking for the moistest spot.

On the 17th eighteen dejections had been passed by the fly in less than twenty-four hours, they were dry, but when mingled together in a droplet of freshly boiled distilled water furnished several little colonies or clusters, containing from five to seven curved bacilli, also single and double ones. They varied a little in size and curvature; scarcely any of the short, thick, and straight rods were visible, and only a few fine small straight rods. As the fly had now been under observation for some days, and seemed lively, it was killed by chloroform vapour, in order to examine the

perivisceral fluid. This viscous secretion was abundant, but offered nothing of moment, save some small pale corpuscles of various sizes, which on the application of alcohol became finely granular, the fluid remaining transparent. The size of the corpuscles (lymph ?) varied from the smallest up to the 1/7000 in. When made to roll over they were seen to be doubly convex. Only four curved bacilli were seen in over fifty fields.

On the 11th of August, a second experiment was made with two fresh *Eristalis* put together, and fed from the agar-agar culture, diluted on the sugar. They were watched feeding several times. Two dejections passed about four hours later contained in the granular débris many pollen-grains, some small, short, non-motile blunt rods, a few bacteria of different sizes, and numberless micrococci. No curved rods to be seen. Between seventeen and eighteen hours after feeding on the culture, many micrococci in chains of four, and a few dumpy curved bacilli, single and in minute clusters, were noticed. Six other dejections were passed the same day, and only fourteen curved bacilli were counted in thirty-five fields on the stained slide. On the 13th, the pollen-grains were few in number, the straight rods pretty numerous. Many of the micrococci were surrounded by a pale hyaline outline; the curved bacilli were more abundant—none motile. The commas were still pretty plentiful on the 14th, but motionless among an abundance of minute fatty-looking granules, soluble in chloroform, and some partly broken pollen-grains, and on one of these was a tiny cluster of fine commas.

On the 15th seven dejections, small and very adherent, when examined, showed the commas and straight rods to be rare. There were numerous irregular lumps of a brownish semi-transparent resinous-looking substance, not soluble in dilute acetic acid or alcohol. They had the appearance of some forms of uric acid, and as if built up of imperfect crystals with rounded edges. Four dejections were examined on the 16th without any special difference being noted. On the 17th thirteen dejections were examined, the two most recent-looking separately; they furnished numbers of pale flat crystals with rounded corners. The commas were rare. The twelve other excreta contained the same semi-transparent resinous-looking little masses, and the curved bacilli were few and motionless, some double with one tiny mass. The dejections of the 18th differed scarcely at all from the last. The two insects were now killed by chloroform vapour, and the perivisceral fluid examined within three-quarters of an hour afterwards. This viscous fluid, unstained, showed various pale corpuscles which alcohol rendered slightly granular, and were little influenced by the methyl stain, but this rendered evident numerous pale motionless rod bacilli, consisting of four or five joints, and found in both insects; these

were difficult to be seen in the unstained state. There were a few large rods common to both, and one had some very small thin motionless rods, scarcely a curved bacillus could be found. The fluid remained tacky for many hours, and was easily dissolved away on washing the covers after staining. All attempts to cultivate the curved bacilli from the excreta of these two insects had failed, the micrococci supplanted everything in a few hours.

On the 19th a second experiment was made with a large female blow-fly. Before feeding with any culture, some dejections, passed within an hour after being placed in captivity, furnished a large number of motionless short straight rods, many micrococci, a few conidia, but no curved bacillus. It was now fed from sugar, damped with a recent culture inoculated from agar-agar into a neutral sterilized meat infusion. This contained large numbers of the commas. It fed freely, and twenty-four hours after, in six dejections which were dry, only a few motionless curved bacilli were present. Four hours after placing the culture on the sugar on the 21st, one liquid and three dry dejections were examined, the former alone. It contained a sensible number of curved bacilli, a few motile, the straight rods were rather abundant with an enormous number of micrococci. An inoculation was attempted with this into a ready prepared, sterilized, neutral meat infusion, and kept at 90° F., and further re-inoculated by another liquid dejection passed an hour later, and not examined microscopically. The dry excreta had a few commas, and some minute thin rhomboidal crystals. On the 22nd four dejecta were mixed and examined; upwards of thirty curved bacilli were counted on the stained slide, some with their concavities facing, forming a kind of open circle. The dejections were now unavoidably left over for examination until the 25th. They differed as regards the organisms in no essential particular from the previous days, save that the commas appeared proportionally fewer, and the oily-looking granules began to be abundant. On the 25th there were only four dejections, and these had scarcely a curved bacillus in them.

The fly was now fed from another four days old culture similar to the last. It fed freely, and three hours after passed a large, pale, slightly dirty-looking liquid dejection. It contained much fine débris, a scanty number of curved bacilli, and a few fine straight rods, besides the micrococci. This was used to inoculate a fresh sterilized meat infusion, as the former one had unknowingly been upset and rendered useless. This accident caused much disappointment, as the fly, although active on the wing, could scarcely crawl to the top of the tumbler, possibly getting weak from imperfect nourishment. The freshly inoculated tube was kept at a temperature averaging 90° F. On the 26th the fly, after again feeding from the freshly inoculated meat infusion,

passed a nearly clear fluid dejection, one hour later another, two hours later a similar one, and again within half an hour another liquid dejection with a little solid matter. As each of these had been found, microscopically, to contain a few curved bacilli, part of each dejection was used, under every precaution, to further inoculate the tube, which up to that time had remained perfectly clear. The fly was exceedingly restless. The clear meat infusion after thirty-two hours showed marked but not excessive turbidity, and was found to contain numbers of long and short motile rods, some exceedingly pale and fine in various stages of growth, also a few coarse, stout, short, motionless rods, and many long and short spiral or narrow undulating filaments or spirilla forms, similar to those found by the extension of the commas in filamentary union, common in some cultivations, also a few single curved commas and numberless micrococci. Only two of the spiral filaments were noticed in movement. They were not very readily seen in the unstained fluid, but a weak solution of rose anilin acetate showed them up beautifully, and enabled me to sketch them. For comparison another sketch was made of similar organisms from the agar-agar culture, diluted with a droplet of distilled water. From the 27th to the 29th, as the fly seemed somewhat revived, yet did not succeed in crawling to the top of the tumbler, it was fed from the pure agar-agar culture, with the addition of distilled water on the sugar.

Further experiments were still necessary, as I had not yet succeeded in inoculating a solid gelatin culture from the fly dejections. On the 31st, part of thirty-one semi-solid excreta passed in little over thirty-six hours, and containing only a few curved bacilli, were mingled in a droplet of distilled water, with a flattened sterilized platinum wire, and used to inoculate a solid gelatin culture, left at the ordinary temperature of the room, 65° F.

On September 1st, the examination of ten mixed dejections gave only a few commas and small rods beside the micrococci. On the 2nd there were fourteen excreta with one fluid one, seven were mixed with part of the fluid dejection and the minutest portion of freshly boiled distilled water, and used to inoculate another gelatin tube; the other seven were mixed in the same way and added to a similar gelatin culture rendered just fluid enough for plate cultivation, mixed and poured out on to four of the ordinary 3 × 1 in. slides, sterilized by over heating, and under the usual precautions set aside at the temperature of the room, 65° F. These slides on the third day were crowded with minute growths of micrococci, a few patches with the straight rods, but on one slide there were three distinct characteristic growths of the curved bacillus, none were found on the others. The gelatin tube which had been inoculated from the other seven dry dejections on the 2nd, and kept at the ordinary temperature of the room, about 65° F., had on the third day on its surface a whitish raised

warty-looking growth, with no appearance of the track of the wire beneath, and the gelatin only slightly softened. This contained rather large crooked rods in all degrees of curvature, from the straight rod to a complete ring, but not a single genuine *Spirillum* was detected, all were motionless, part of the specimen on the slide was crowded with minute micrococci, mingled with larger and brighter corpuscles, some apparently in the first stage of germination. This appearance led me to examine carefully an inoculation into a meat infusion that had been made from the same agar-agar culture on the 29th August, and which had been kept at the temperature of the room. It was turbid, had a *faint* stale odour, and abounded with similar organisms near the upper surface; lower down the organisms were smaller, still larger than the ordinary curved bacillus, no spores were visible. Whether this was a large variety of the comma bacillus or a contamination, I am uncertain, as in this case it appeared to have been derived from the agar-agar culture, which had been used to feed the fly and make the inoculation; later on this was transmitted through the fly retaining the same characters. The tube inoculated from the thirty-one dejections was soon turbid and broken down, abounding chiefly in micrococci, a few thin, non-motile, long rods, scarcely a short stout rod to be found, and no curved bacilli, which may perhaps be due to the dryness of the dejections. The excreta of the 3rd and 4th afforded a fair number of the commas. On the 5th and 6th the fly was fed from the fluid meat culture with the large crooked rods, and on the 7th the excreta, twenty-two in number, which contained some of the crooked rods, were inoculated, after being mingled with a droplet of freshly boiled distilled water, into a neutral sterilized meat infusion, and kept at the temperature of the room. In three days this was turbid and furnished an abundance of bacilli from straight to all stages of curvature, some of the free ones had motion, others in a zoogloea-mass appeared to be in a resting stage; there were also straight rods of two or three joints and a few short, stout rods with blunt ends, each motile, and scarcely any micrococci. In fluid media warmth appeared to greatly encourage the growth of the latter.

As the fly was seen to be very weak in crawling up the sides of the tumbler, and it seemed doubtful if I should keep it alive much longer upon the same food, the experiments were stopped, and the fly was fed from meat, meat infusion on sugar, fruit-jelly, &c., and quickly regained strength enough to continually crawl to the top of the tumbler. It was allowed its liberty on the 29th, having been in captivity forty days.

The results of these and the previous investigations point, I think, to the conclusion, that the comma bacillus from cultures can pass through the digestive tube of some insects in a living state,

and although I, unfortunately, omitted to inoculate a gelatin tube from the three patches of growths found on one of the slides, in the so-called plate culture, the growths and organisms were so distinct and characteristic of the comma bacillus, that the result was deemed sufficient to establish identity.

In conclusion it may perhaps be as well to offer some remarks upon sundry points connected with these investigations. From the appearance of the dejections and from watching the insects feeding, the gelatin and agar-agar cultures seemed less suited for the experiments than the more fluid media, as the meat infusion. The flies seldom remained for any time sucking the sugar when the agar-agar culture was used, and they would often turn the morsel of sugar over in search of the moistest portions. The gelatin cultures seemed to furnish very tenacious dejections, and possibly these drying so hard, the bacilli had less chance for rejuvenescence. In any future experiments I should suggest the use of fluid cultivations. Care had to be used in damping the sugar or it sank down into syrup; if not moist enough there was a chance of the material drying on it in a short time; there was also the risk of the organisms being left dry on the surface, the sugar acting as a kind of filter. The number of the comma bacilli passed did not appear to have any definite ratio to the number of dejections passed in the twenty-four hours. The same diet after a few days seemed to largely augment the number of oily granules, and these to precede a period of debility. The watery evacuations, and the rapidity with which they occurred, I could not distinctly refer to a large increase in the numbers of the bacilli, though I cannot say they were not in some way related. How far the action of the digestive juices may have been detrimental to the microbes, or how far they may have encouraged their growth, are uncertain points. I am rather inclined to believe they did to a certain extent hinder the rejuvenescence, and that they did not encourage the growth of the organisms, though I have no absolute proof to offer. The shortest period in which the curved bacilli were found in the dejections of the fly, after feeding on the culture, was six hours, though they may have been passed earlier. There was no reason in this instance, in which the male fly was placed in the same tumbler as the female, to suppose they existed in the natural excretion of the male fly, as they had not been found in any of the numerous examinations made of the ordinary dejections of the other flies. The non-success in the inoculations was a great source of trouble, and I feel pretty confident in the successful experiment; had I trusted to the single inoculation it would most likely have resulted, like so many others, in failure.

If it be true, and these experiments seem to me conclusive, that the curved bacilli can retain life in the intestines of the fly, we can

at once see, supposing it to be in any way pathogenic, how it *may* perhaps become a serious source of injury to animals, birds, and perhaps fishes. I am not aware of any remarks having been made upon the diminution of the domesticated feathered tribe during severe cholera epidemics. It would, if possible, be a point well worth ascertaining.

The *Eristalis*, though so hardy, did not seem as fit an insect for the experiments as the blow-fly. Investigations were made on some other insects, as young wasps, house-flies, and what I believe were mason bees, but they all too readily succumbed to captivity, and offered nothing satisfactory. I am well aware of the weak points in these investigations, and of the various sources of error in furnishing other bacteria than the curved bacilli. The sugar was not sterilized; the body of the insect under the constant toilet attentions might provide a variety of bacteria, which falling on, or being carried into the dejections, or deposited on the square of glass, might easily contaminate the rest, and vitiate the conclusions on some points, but not, I believe, in any serious way disturbing those relating to the curved bacilli.

Some may object to so much reliance being placed on the use of the Microscope. It was the readiest, if not the most perfect means of distinguishing the commas, and afforded much guidance in the many hundred examinations made, and would in any case of suspected infection from such a source be probably the first if not the only aid used. The micrococci from their abundance were a great source of trouble in these examinations, and in the cultures. Staining the sugar offered the chance of the dye proving hurtful to the microbes, but I fear it was also detrimental to the female fly that died. The mode of capture of the insects was by bringing suddenly a short wide-mouthed bottle, held in the right hand, over the insect at rest, and closing the mouth of the bottle with a folded handkerchief held in the left, the fly being turned out afterwards under the tumbler, its opening facing from the window. If the insect escaped it generally flew at once to the window, when the tumbler was placed over it and a clean piece of stout note-paper passed beneath it, and then carried to the saucer. Thus the insects were not touched by the hands. The used squares of glass and vessels were flushed with or placed in methylated alcohol, allowed to dry, and then cleansed with scalding water and washing soda. The waste cultures were burnt. The general magnification used was from 450 to 650 diameters, and all doubtful points further elucidated by the use of a 1/16 water immersion or 1/12 homogeneous immersion objective. The fine granular débris often needed considerable dilution. The examinations were long and tedious. The insects were generally watched to be sure that they had fed off any particular culture, which was blown on to the sugar

from a *fine* pipette. Great care was taken for cleanliness of all the vessels. The gelatin preparations, generally used for the rejuvenescence of the microbes, contained 10 per cent. Liebig's extract of meat neutralized by soda and potash or soda alone, with 10 per cent. hard gelatin, and no peptone. The fluid cultures had 12 per cent. of meat extract. These probably were not the best formulæ for the object in view, but I had rather to hinder than encourage growth, on account of the micrococci.

The beetle alluded to in the former paper died a few days afterwards; the excretions were of the same character as those described. The body was not examined. It will be readily seen that such investigations demand considerable time, and the difficulties to convert a simple supposition into a demonstration have been both tiresome and numerous.

## XX.—*On the Cholera "Comma" Bacillus.*

By G. F. Dowdeswell, M.A., F.R.M.S., F.L.S., &c.

(*Read 14th October*, 1885.)

The circumstances of the discovery of the so-termed cholera "comma" bacillus, by Dr. Koch, with the question of its relation to the disease in which it occurs, are so generally known that it is not necessary to recapitulate them here.

Since I first showed preparations of the microbe to this Society, some months ago, it has been the subject of increased attention and interest from the account of the investigations of Dr. Klein and the English Cholera Commission in India, whose conclusions on the point which in this subject is of paramount importance—viz. the ætiological relations of the microbe to disease—are directly subversive of the view which was somewhat generally accepted previously, on the authority of Dr. Koch. This interest too has been still further increased by the terrible devastation that is being worked by this disease on the continent of Europe, and immediately threatening our own country. I now offer to your notice what I have myself observed of the characters of this organism, and which from a purely mycological and microscopical point of view, render it one of the most interesting and remarkable yet described.

In the classification of Cohn this microbe is a *Spirillum*, the mature cells showing the character of that by no means well-known genus; the ordinary singly-curved, or so-termed comma-form, being evidently an early stage of development of the species. It is here somewhat variable in form and size in different conditions of nutrition, the composition of the cultivating medium, and other circumstances.

In a certain stage of development the cells are frequently so strongly curved as to form the distinct segment of a circle; in the earlier stages less so; it never, however, forms perfectly straight rods of any size, nor can be mistaken for a true *Bacillus*, though in any preparation a few cells may, to a superficial view, appear straight, as when a disc or circle is viewed edgewise. From the typical so-termed "comma" shape it assumes a sigmoid or sinuous form; some of these at first were rather difficult to understand; in many cases no doubt the somewhat frequent V-shaped form may be due to incipient fission of the cell which occurs largely at this stage; in others it is but the first coil or turn of the spiral, which is its mature form, but which is by no means attained by every individual cell or in every cultivation. These mature *Spirilla*, in natural or undried preparations, are very beautiful objects, the coils of the helix which, when dried, are generally flattened and distorted,

are remarkably regular, their height being usually nearly equal to their breadth; they attain a considerable length, often comprising 20 or 30 spirals or more.

I must here remark that the term "comma bacillus," though so well known that it would be superfluous to object to its use, is not even in a popular sense correct, the microbe is not a *Bacillus* in Cohn's definition of that genus,* which is one consisting of "straight filaments," nor is it in the usual acceptance of the term comma-shaped, the cells being uniformly cylindrical throughout. It has, however, been overlooked hitherto, that the term "comma" as applied to *Spirilla*, was first employed by Dr. Cossar Ewart and Mr. Patrick Geddes, in their account of the life-history of *Spirillum*;† the forms, however, which they figure are much more comma-like than any I have observed the cholera microbe to assume. This arises from the circumstance, that in their figures the first coil or turn of the spiral seems to commence near one extremity of the cell, whereas in Koch's microbe it occurs, to my observation, almost invariably about the centre.

In all stages of development it is motile, more actively so in the later than the earlier forms. It possesses a large and very distinct flagellum, as first stated by Mr. Nelson; this appendage or organ is relatively larger and more conspicuous than in any other schizophyte I have hitherto seen. It often occurs at both ends of the cell, and frequently forms a loop, which may be readily mistaken for a corpuscle or vesicle attached to the cell; this appearance is seen in some of Koch's photographs of septic bacteria.‡ How conspicuous the flagellum here is may be judged of by the fact that I have in some cases been able to draw it without difficulty through the camera lucida, as in the sketch here shown. On a future occasion I hope I may be able to demonstrate these flagella under the Microscope; to do so requires some care and deliberation, but it is a subject of interest from more points of view than one, to the microscopist.

The plasma of the unstained cell, in all stages of development, is usually homogeneous, but in preparations stained not too deeply, the ends are often seen to be more coloured than the central portion, as originally described by Koch.

Its methods of multiplication are in some respects obscure; usually this occurs by transverse fission, as is characteristic of this group of the lower fungi, and takes place largely in an early stage of development long before the mature *Spirillum*-form is attained. Dr. Klein, however, has observed and described another method of development, by longitudinal fission, in which the short curved

* Beitr. Biol. Pflanzen, Bd. i. H. ii. p. 173.
† Proc. Roy. Soc., xxvii. (1878) p. 484.
‡ Beitr. Biol. Pflanzen, Bd. ii. Pl. xi. fig. 5.

cell swells up, thickens, assumes a vacuolated form, remaining active, which shows that the appearance is not due to degeneration; then the corpuscle thus formed divides into two new curved cells. This occurs in cultivations of nutrient agar-agar at the temperature of the laboratory (15°–20° C.). The preparation under the Microscope (one of Dr. Klein's) shows these phases very beautifully. This observation is of the highest interest and quite unparalleled in the biology of the lower fungi, justifying the statement made, that this organism from a mycological point of view is the most remarkable yet noticed.

It does not form resting-spores, and thus its method of perpetuation is quite obscure, as in the case of *Bacterium termo*, and requires further careful investigation. There are appearances in some of the cells at different stages of growth, which simulate spores (or properly speaking conidia) very closely, and also in effete cultivations, aggregations of minute spore-like or coccoid bodies, which do not stain nearly as readily as the growing cells; but that they are not true spores or viable, is proved by the circumstance that the cultivations containing them, whether in gelatin or liquid bouillon, are sterile when inoculated into fresh nutrient media.

Beyond the occurrence of longitudinal fission no form-variations or involution phases have been established, the cells, however, ultimately split up into short "primitive segments." This is the origin of the beaded appearance sometimes observed in this and other microbes. It has, however, been stated* that the large "worm-like" bodies found in the intestines of guinea-pigs that have been injected with cultivations of Koch's commas, are a morphological variety of the same species; this appears clearly an error, for as I have before stated,† in the large intestine of these animals such organisms occur normally and commonly; fungi they may be, but they are very greatly larger than the cholera comma bacilli, and no grounds have been adduced for supposing that there is any genetic connection between them; were there any, it would merely further prove that the microbe is not pathogenic, as these forms occur normally in healthy animals.

As regards the habits of growth and behaviour of the organism in different cultivating media, I may point out that in plain bouillon it developes uniformly through the fluid, rendering it turbid; it forms no pellicle, but if pepton be added a slight scum appears for a time, which may be mistaken for the occurrence of contaminations. In nutrient gelatin, the macroscopical appearances have been often described and are well known; when inoculated into the substance of the medium with a needle or a pipette, there

* Brit. Med. Journ., 1885, p. 878. † Ibid., p. 588.

is the funnel-shaped depression of the liquefied gelatin, surmounted by an air-vesicle. Cultivated in nutrient agar-agar at whatever temperature, it grows as a light scum on the surface, it does not liquefy the material, and there is nothing at all characteristic in its usual habit of growth, though it is in this medium, as above stated, that the remarkable method of multiplication by longitudinal fission occurs.

It developes equally well in neutral and faintly alkaline media, but it will also develope in distinctly acid infusions, as in 1 per mille of free hydrochloric acid, though here uncertainly and slowly. It grows equally well, too, though not with the same rapidity, at different temperatures between 10° and 35° C., and is, as emphasized by Koch, rapidly killed by desiccation.

The cultivations which I originally obtained from Dr. Roux of Paris, through the kindness of Dr. Maddox, show both by their characters in nutrient gelatin, and by direct comparison of dried and stained specimens of Dr. Koch, identically the same characters; they are also the same as those of Dr. Klein.

The habits of growth of micro-organisms in solid cultivating media, have lately received much attention, and it was thought that here we had a ready and sure means of specific diagnosis, more sure and more distinctive as has been asserted, than the microscopical characters of these organisms. To my observation this is entirely erroneous; there are scarcely two species of the lower fungi, excluding perhaps micrococci, which may not be distinguished by competent microscopical examination, with adequate means. When a similarity of form and minute characters does occur, then observation of their growth may come in, but only as an auxiliary and secondary means of diagnosis; it cannot be of primary importance, because, firstly, the characters or appearances are not constant under slightly different conditions, and secondly, because different species of totally different form, as readily recognized under the Microscope, grow in identically the same manner in these cultivations, one instance of which I showed to this Society on a former occasion, and hope to illustrate the subject further on a future opportunity. The same thing applies equally to the characters of the colonies on the surface of gelatin on glass plates, or in cells, so that this means of diagnosis has only a very limited application and utility. As a method, however, of separating different species, and thus originating "pure" cultivations—the necessary basis for all exact observations on this subject—it is absolutely invaluable, and is in most cases far more reliable and less laborious than "fractional dilution."

It is, however, to its relations to Asiatic cholera that is due the interest which this microbe has excited and continues to excite throughout this country, the Continent, and indeed a large portion

of the civilized world, far exceeding that of any other micro-organism, or indeed almost of all those previously described combined. This is primarily a pathological or medical question, but as it cannot be excluded from a description of the organism, I shall now state what seems to me its present position, in as few words as possible, and the more readily because the subject, which has been warmly contested, appears to me to be now on its main point conclusively settled by the result of recent experiments.

As a result of his investigations in Egypt and the East Indies, Dr. Koch expressed the opinion that the comma bacillus which he had discovered was specific to, i. e. occurred only in, and was diagnostic of, Asiatic cholera; he also stated his belief that if not the true cause, it probably stood in some relation to the disease.* This opinion was based upon the fact, as he stated, that the microbe which occurred invariably and in vast numbers in certain situations in cholera cases, was specifically distinct from all other organisms of similar form which occurred elsewhere, and also by the circumstances of its distribution in the tissues of the intestine. Thus the hope was general that we had obtained knowledge of the utmost value on which to base the treatment for mitigating one of the greatest scourges to which mankind is subject.

As will be remembered Drs. T. Lewis and Klein were amongst the first who stated their conviction that the microbe found by Koch was not specific to cholera, but occurred elsewhere, and notably in the saliva of some healthy persons. This opinion has been fully justified, as Dr. Klein has since succeeded in obtaining pure cultivations of this microbe from the saliva of his own mouth, which both in their microscopical characters, and by the test insisted on by Koch, their habit of growth in solid cultivations, are in every respect identical with the so-termed cholera comma bacilli.

The views of Koch were also roughly shaken by the results of the English Cholera Commission with Dr. Klein in India, with respect particularly to the occurrence of this microbe in the tissues in cholera cases, examined immediately upon death, on which point the English was perfectly in accord with the French Cholera Commission, viz. that this organism does not by any means invariably occur in any great numbers in this situation.

With respect to the crucial test of the relations of any microbe to disease, the one so often effectively employed by Koch himself, viz. inoculating animals with pure cultivations of it, although it has been asserted in some instances on the Continent that choleraic symptoms have been experimentally induced in animals by this means, I think these may one and all be finally dismissed as inconclusive or erroneous, and we might have abided by the original and

* Deutsch. Med. Woch., 1883, No. 42, p. 616.

explicit statement of Koch himself in his address before the Berlin Congress, that such injections or inoculations made upon various animals, including monkeys, in whatever manner, were without result; and further, as he had satisfied himself by careful inquiry in India, and as indeed is notorious, that domestic animals generally are not susceptible to cholera.

More recently Dr. Klein has further confirmed and established his own conclusions on this point by a brilliant series of experiments, admirably conceived and carried out in conjunction with the Brown Professor of Pathology, by which he has produced a condition in monkeys, by ligaturing a loop of the intestine and injecting a small quantity of sulphate of magnesia, which induced a large development in this situation of Koch's cholera comma bacilli. A more conclusive solution of the question at issue, and proof of the harmless character of the microbe, it is difficult to conceive; and it is a brilliant termination to a most important scientific investigation, the value of which all will recognize, finally proving that the microbe is the result and not the cause of the disease in which it appears.*

In conclusion, I must say that, disappointing though it is that our knowledge of the ætiology of this disease is not advanced by recent investigations, we may yet hope that the microbe may be in some measure diagnostic of Asiatic cholera, as it has not yet been shown to occur in any numbers in the same situations in other diseases; though the recent demonstrations of its ubiquitous character necessitate further careful search for it. Should its diagnostic value be finally established, Dr. Koch will have conferred a benefit of the highest practical importance to every nation in Europe and Asia, as the result of his work, and will have greatly enhanced his previous pre-eminently high reputation as a microbiologist.

* If authority were wanting for this opinion, I might quote that of one of the most competent in this country, viz. Dr. Burdon Sanderson, in his address at the Royal Institution in May last, and in the July No. of the 'Contemporary Review.'

## XXI.—*Improved Form of Stephenson's Binocular Prisms.*

By C. D. Ahrens.

(*Read 14th October*, 1885.)

The arrangement of prisms for the Binocular Microscope devised by Mr. Stephenson has several advantages which make it, in my opinion, the best for microscopic purposes; for instance, the equal illumination of both fields, the equal size of the two images, and the fact that both images are always in focus together. It is also readily capable of being combined with an erecting arrangement; a combination which constitutes by far the most satisfactory mode of viewing objects under the Microscope. But the difficulty of keeping the prisms in adjustment is considerable, and is, I think, the reason why they have not come into more general use.

This difficulty I hope I have overcome by permanently cementing together the pair of prisms which divide the rays immediately on emergence from the objective. I construct the prisms of ordinary crown glass, and silver the reflecting surfaces by any of the usual methods which give a firm deposit. I then make a very acute glass wedge, of such an angle as to give precisely the proper inclination of the two main prisms to one another, and cement the whole firmly together, as shown in fig. 220.

Thus the combination can never get out of adjustment, and no cleaning of the reflecting surfaces is required; moreover, owing to the great angle of incidence and the brilliancy of the silver deposit on a well polished surface, there is very little loss of light.

Fig. 220.

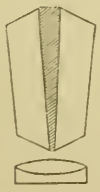
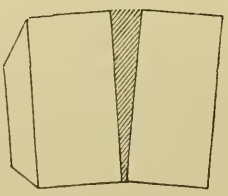


Fig. 221.



I also devised some years ago an improvement in the upper erecting prism, of which there is no published account. Instead of making the prism of one piece of glass only, and mounting it thus, I cut it in two and separate the two halves by a black glass wedge of suitable angle, cementing the whole together (see fig. 221). Then the central rays coming from the lower binocular prisms fall perpendicularly upon the surfaces of the upper prisms, and, emerging also at right angles to the upper surfaces, continue their course to the eye-pieces without sensible deviation or distortion.

## XXII.—*Remarks on Prof. Abbe's 'Note on the proper Definition of the Amplifying Power of a Lens or Lens-system.'**

By E. Giltay, Ph.D., Teacher of Botany at the State Agricultural School at Wageningen (Netherlands).†

(*Read* 11*th November*, 1885.)

Before dealing with the more immediate subject of this paper, I beg to reproduce in translation a portion of my recently issued book 'Introduction to the study of the Microscope,'‡ which deals with the meaning to be attached to the expression "linear amplification," and with the manner in which its value is to be ascertained.

"If a person is seen working with a Microscope, the first question asked him is, very often, 'How many times does that instrument magnify?' However simple this question may appear, it is not in fact so very easy to obtain a good idea of the meaning to be attached to the answer that should be given.

Let us simplify the matter by taking an object of very little complexity, namely, a line at right angles to the axis of the optical system.

It is easily seen that if an image of this line is formed by a lens or by a lens-system, it is impossible to say how many times the image will be larger or smaller than the object, *if no more be given.* For, according to well-known formulæ, the proportion between image and object is not only dependent upon the optical system, but also upon the distance at which the object is placed or at which the image is formed. But if the optical system is used as a Microscope, are not then those distances determined? Properly considered, no more so than in the former case; at the utmost they are limited, for the image must of course fall at such a distance, that the eye may be able to accommodate for it. But still in this case the distances may be very different. Let us consider for instance an emmetropic or normal-sighted eye with a normal power of accommodation;§ here it might appear that to every lens-system any power might be attributed. For, using the equation $A = 1 - \frac{\beta}{\phi}$ ($A$ = amplification, $\beta$ = distance of the image, $\phi$ = focal distance of the system), it is at once clear that A will be arbitrarily large, if only $\beta$ is large enough, i. e. if only the observing eye accommodates for a long enough distance. Hence it might appear useful, when using a

* See this Journal, iv. (1884) p. 348.

† The original paper is written by Dr. Giltay in English.

‡ 'Inleiding tot het gebruik van den Microscoop, door Dr. E. Giltay,' Leiden, E. J. Brill, 1885, § 44, pp. 76–80.

§ I. e. an eye which, when not accommodating, unites on its retina parallel incident rays (and therefore can see at a long distance), and which, if strongly accommodating, can see at a few inches distance.

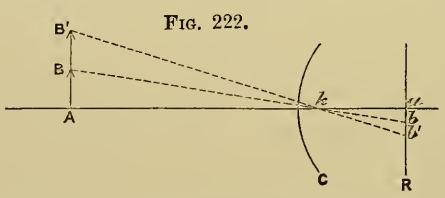
magnifying glass or a Microscope, not to accommodate at all. We must, however, take into consideration, that the image, as it enlarges, is at the same time formed at a larger distance; if in $A = 1 - \frac{\beta}{\phi}$, $\frac{\beta}{\phi}$ has once acquired such a high value that 1 may be neglected, then A increases even in the same ratio as $\beta$. And if an image, which I observe grows twice as large, I shall see no more detail if at the same time the image is formed at twice the distance, for then the image on the retina, and the number of nerve-ends which are used for its examination, remain the same.

We clearly see from this, that all depends on the dimensions of the retinal images; the dimensions of the image formed by eye + magnifying glass will have to be compared with those of the image formed by the eye alone. But where must then the object and the virtual image formed by the lens-system be placed in order that retinal images shall be obtained that are fit for the determination of amplifying power?

The determination of the amplifying power of an optical instrument is of course chiefly useful for the comparison of the value of such an instrument when used *with* the eye, with the value of the eye alone. To make this comparison correct, the eye, and eye + optical instrument, should be compared as much as possible under analogous circumstances, which for instance might be realized by comparing them while working as favourably as possible, i. e. giving the largest possible images on the retina. As to seeing by the eye alone, it would be sufficient to bring the object as near as possible to the eye, and then to divide the dimensions of the largest image that might be obtained while using the instrument by the dimensions of the retinal image. This would be a very good mode of determining the absolute value of an amplifying instrument for a single person. But the position of the nearest point which can be accommodated for, differs very much with the person; and the distance for which during a long time one can easily accommodate, will also be subject to much variation. Moreover, the meaning of determining the amplifying power is not so much to know the absolute value of a Microscope for a *particular* person, as to find an expression which is appropriate for the comparison of Microscopes in general, and which at the same time gives a direct notion of the power of enlarging the images on the retina *for the eye in general*; for a simple comparison of the power of microscope-systems their focal distances would suffice. In order to satisfy both conditions, it has been agreed to place the object at a distance conventionally fixed, a distance which is not too great for the retinal images to be near their maximum dimensions, and which is yet large enough for the great majority of eyes to

remain accommodated for it during rather a long time. This distance has been chosen as 10 in. (25 cm.), and it is generally called the 'distance of distinct vision.' This term often gives rise to erroneous notions, and was not chosen very happily; for at *every* distance, for which an eye can accommodate, it sees equally distinctly. The term may, therefore, be regarded as an abbreviation for the *shortest distance (suitable for the discrimination of minute details) for which a normal eye can accommodate for a considerable length of time, and which has been chosen arbitrarily for the comparison of amplification.* But what distance must then be given to the virtual image formed by the optical system? From the formula $A = 1 - \frac{\beta}{\phi}$ it is clear that if $\phi$ is small in comparison with $\beta$, A may be taken as proportional to $\beta$. When the virtual image enlarges in the same ratio as the distance at which it is formed, then the image on the retina of the eye, by which it is regarded, may be considered as remaining the same. Therefore what distance is given to the virtual image might be quite indifferent. It is only from a practical point of view that it is also placed at 10 in. from the eye, for then the number representing the value of the linear amplification is not only represented by the ratio of the two retinal images, but also by the ratio of the virtual image and of the object itself, which is of great importance in the practical determination. That this is really the case may be easily deduced from fig. 222. C is the cornea,

FIG. 222.




R the retina, A $k$ $a$ the axis of the observing eye; A B represents the dimensions of the object, A B' the dimensions of the virtual image when this lies in A, A $k$ being supposed to be the distance of distinct vision; $a\,b$ indicates the dimensions of the retinal image of the object, when seen by the eye only, $a\,b'$ when seen through the optical instrument which forms the virtual image A B'. If we now unite B and $b$, B' and $b'$, it may be shown that these two lines cross the axis at very nearly the same point, say $k$. And now we have $\frac{a\,b'}{a\,b} = \frac{\text{A B}'}{\text{A B}}$." *

* In the last part the translation slightly differs from the original, which was necessary on account of the fact that the original made use of laws which were explained in a previous chapter.

The linear amplification as it is here defined is exclusively a measure for the amplifying power of the system; and the comparison of the different linear amplification values of different systems gives a direct comparison between the value of the different systems with regard to their power of enlarging the images on the retina.

My definition of the "linear amplification" is not new; it is in complete accordance with the meaning which is commonly attached to the term; I only tried to treat the subject more amply than is generally the case in physical or Microscopical text-books, and to give a fuller account of the meaning that must be attached, according to my opinion, to the "distance of distinct vision" than has hitherto been done as far as I know of.*

Very often false notions have been attached to the amplification values of optical systems. I do not believe, however, that these false notions originated in any unfitness of the usual definition of amplification, but I think that the chief cause lay in the awkward ideas which are still too commonly found on even the simplest facts of theoretical microscopy.

These erroneous ideas with regard to the meaning of "linear amplification" are chiefly the following:—

1. The "linear amplification" is taken as identical with the *actual amplification* that the virtual image, which is observed when using the instrument, undergoes in each particular case.

2. These two kinds of amplification, the properly so-called linear and the actual amplification for a particular case, are again confused with the amplification which the image, which the observer "sees" before him, has undergone, and which is of a purely subjective nature.

Both points still need perhaps some explanation.

1. When any object is observed through an optical system, as for instance a Microscope, this instrument so alters the course of the rays emanating from the different points of the object, that an enlarged image is substituted for the latter. The place of this (virtual) image depends upon the relative position of the optical system and the object, and the latter is so regulated by the observer that the image in question falls at a distance which is in accordance with the refractive condition of the eye, in order that a well-defined image may be formed on the retina. As the refractive conditions of different eyes vary very much, the distance of the image is also very different; it may be a few inches, and it may be several yards. And as the quotient of the diameter of that image

* I must here add that the reasoning which I used to explain the term "distance of distinct vision," was not followed in the same way (as far as I know, at least) when the term was first brought into use. I only used the above line of argument because it seemed to me the fittest way to make the matter quite clear.

and of the object itself produces what I called the "actual amplification," this amplification is necessarily no fixed number for any given system, but varies with the distance of the image and depends upon the conditions of the observing eye.

The case is quite different with the "linear amplification." This value is constant for any given optical system and independent of the actual amplification in a particular case. That in general the "linear" and the "actual" amplification do not coincide is of no consequence whatever, for a change in the position of the virtual image formed by the instrument does not produce any real change for the observer's eye; for the image varies very nearly in the same proportion as the distance at which it is formed, so that (at least very nearly again) the diameter of the retinal image may be regarded as remaining the same.

2. Our idea of the diameter of objects with which we are not acquainted by experience, the diameter in which we "see" them, depends upon the dimensions of the image on the retina, and on the distance at which we estimate the object in question to be placed.

Now the idea is somewhat frequently met with that the linear amplification is in accordance with the dimensions in which we "see" the image, whilst these again are regarded as agreeing with the actual amplification.

It is not necessary to explain any further that these factors are quite independent of one another. The linear amplification will only agree with the subjective dimensions of the image, if we "see" the object at a distance for which the linear amplification is determined; whilst concordance with the actual amplification will only exist, if the virtual image lies exactly at the distance at which it is seen, which in microscopy will not very often be the case. For the image is seen in general at about the distance at which we know the object to be placed, independent of the refractive conditions of the eye, whereas its real place entirely depends upon the latter.

Prof. Abbe, in the above-named article, calls the generally adopted notion of "linear amplification at a certain distance" a "very awkward and irrational way of defining the amplifying power of a lens or a lens-system," and wishes to change it for another one. Accordingly he defines the amplifying power as the tangent of the visual angle, under which the unit of length is shown through the optical system.

As far as I can see, however, there is no great advantage in this way of defining the "power" in question, or rather, I think, the old way is preferable.

First, I must point out that according to my view the definition

of Prof. Abbe does not essentially differ from the older one. For it is clear that (fig. 223):

$$\tan u' = \frac{BC}{CD};$$

substituting this in the equation of Prof. Abbe:

$$\frac{\tan u'}{h} = \frac{1}{f}$$

we get

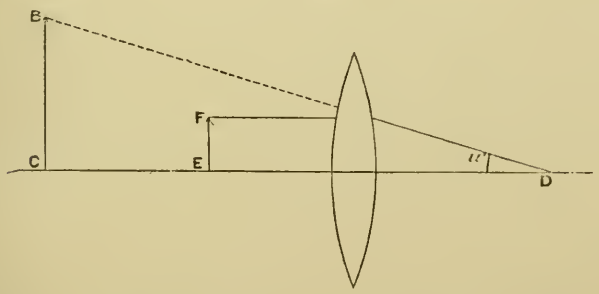
$$\frac{BC}{CD \times h} = \frac{1}{f},$$

or,

$$\frac{BC}{h} = \frac{CD}{f}.$$

Now, $\frac{BC}{h}$ is nothing else than the actual amplification of the object of the length $EF = h$, placed at E; if, therefore, $CD =$ the

Fig. 223.




usual distance for which the "linear amplification" is determined, then $\frac{BC}{h}$ is the "linear amplification" itself. And as in this case CD is a constant value, say C, we get,

$$\frac{BC}{h} = C \times \frac{1}{f},$$

wherefrom it is directly concluded, that the amplification numbers of Prof. Abbe (expressed by $\frac{1}{f}$) and those obtained by the old mode $\left(\text{by } \frac{BC}{h}\right)$ *are in a constant relation.* If, therefore, Prof. Abbe

says that his expression is "the rational expression of the magnification or 'power' of an optical system, because *every* observer will see every object enlarged through different systems in the exact proportion of the value of that quotient," it must be remarked that exactly the same service is done by the amplification numbers determined by the old method.

But I cannot see either that the *form* in which Prof. Abbe wishes to define the *notion* of "linear amplification" is distinguished advantageously from the commonly adopted way of defining that notion. At first sight it might appear that Prof. Abbe's definition is free from such an arbitrary factor as the value chosen for the distance of distinct vision, for which the "linear amplification" is determined; in reality this is not the case. For the numerical value of the ratio $\frac{\tan u'}{h} = \frac{1}{f}$ depends, of course, upon the value of the unit which is chosen. The value of $\frac{1}{f}$ is different if $f$ is expressed in millimetres, than if $f$ is expressed in centimetres, or in inches. In fact it is clear that the angle under which the unit of length is seen depends upon the dimensions of that unit. With any change in the choice of the unit, the numbers which indicate the amplifying power will therefore vary. The values, however, which are obtained for different systems, will always be in the same relation, independent of the exact value of the unit.

But does, in reality, such a difference exist between this and the old mode of determining the amplification, in which the numbers depend upon the value which is chosen for the "distance of distinct vision," whilst the amplification numbers of different systems are always in the same ratio, independent of the exact value of that distance?

Both methods, I think, are in so far identical, as they give for different systems numbers which represent the ratio of the dimensions of images on the retina, which are obtained when one and the same object is seen through these systems.

Yet it appears to me there is a practical difference between them.

Prof. Abbe himself has little hope that his expression for amplifying power will be generally adopted, as it will seem "too abstract." In fact I think it *is* too abstract.

The old method suggests to the mind to a certain extent a direct idea of the practical value of the lens-system. If I know, for instance, that the linear amplification of a system is 600, I can immediately recognize the effect of the system, if I consider that an object of 10 $\mu$ will be seen at 25 cm. as of the length of 6 mm. But I think the idea is at first sight less clear, if I only know that

an object of 1 mm. will appear under a visual angle whose tangent is 2·4.

I have had the opportunity of observing in another way that the expression of Prof. Abbe is not so well adapted to give a practical idea of the power of lenses.

For some time I have been accustomed to distinguish lenses in the way proposed by Prof. Abbe. In ophthalmology, lenses are, at least on the Continent, somewhat generally denominated by a decimal fraction, equal to a vulgar fraction whose numerator is 1 and whose denominator is the focal distance expressed in metres. It is not difficult to see that this manner of denoting lenses exactly coincides with Prof. Abbe's way of expressing the power of optical systems (for $\tan u' = \frac{1}{f}$, Abbe, l. c.).

Although this denomination is very convenient for finding, by the simple addition or subtraction of two lens-numbers, the value of the lens, which is equivalent to the added or subtracted action of the component lenses ; and although, therefore, this method is in ophthalmology very practical, yet I never could see that the numbers of spectacle-glasses give so good an idea of the lenses in themselves as the amplification numbers, or even as the values of the focal distances. Perhaps *this* is a subjective peculiarity of mine, but in that case my other remarks remain unaltered. I think, therefore, that if we have to choose between the old and the new mode of expressing power, we may give the preference to the former, if only the proper ideas which *can* be attached to its meaning *are* actually attached to it.

## XXIII.—*On the limits of Resolution in the Microscope.*

By Frank Crisp, LL.B., B.A., V.P. & Treas. Linn. Soc., Sec. R.M.S.

(*Read* 11*th November*, 1885.)

The claim is frequently made that lines have been resolved with a particular aperture in excess of the maximum number per inch given in the table at p. 325 of Vol. I. (1881) of the Journal. Very few of these claims are supported by any definite data. If it is *Amphipleura pellucida* that has served as the object, the lines have not been counted, though it is known that different specimens of the diatom vary in the closeness of the lines. The aperture of the objective has been only roughly estimated, and there has been a general deficiency of any kind of precision as to the essential data, that has rendered it unnecessary to consider the claim seriously. When a case is brought forward in which the lines have been counted, the aperture measured, the obliquity of the incident beam determined by observing its position within the clear aperture by means of the auxiliary Microscope, and the predominant colour of the effective light indicated, it will then, and not till then, be time to re-examine the diffraction theory.

There are, however, some features in connection with the claims in question, which show that misapprehension exists as to the limit of resolving power in the Microscope which it will be desirable to clear away.

There are three cases in which, as it is supposed, lines in excess of the theoretical maximum have been resolved, and these are (1) with monochromatic light, (2) with photography, and (3) with sunlight. The case of sunlight is distinct from the other two, which have a common explanation and which had better, therefore, be dealt with first.

The formula which gives the number of lines to the inch that can be resolved by a given aperture, with the maximum obliquity of illumination, is $\delta = \frac{\lambda}{2a}$ where $\delta$ is the distance apart of the lines, $\lambda$ the wave-length of the image-forming rays, and $a$ the aperture of the objective. It will be seen that to solve this equation a value must be given to $\lambda$ or the wave-length. This of course varies according to the portion of the spectrum made use of, the wave-length of the red end being longer than that of the blue end. The heading of the column of resolving power in the table expressly states that the figures apply to a value of $\lambda = 0{\cdot}52689\ \mu$; that is to the line E. The figures therefore represent the resolving power with ordinary *white light*.

Now consider what takes place when for white light is substituted *monochromatic* (*blue*) *light* obtained by shutting off, or at least considerably reducing, the red, yellow, and green rays by an ammonio-sulphate of copper cell or other appropriate agent.

Almost the only rays by which the object is now delineated are those near the line F. The wave-length is here shortened from 0·52689 $\mu$ to 0·48606 $\mu$, and the formula therefore gives a smaller value to $\delta$, i. e. the lines resolved are closer together, so that with monochromatic light a greater number of lines to the inch can be resolved.

The line F is at about the limit of this resolution, for although *theoretically* the resolving power would be increased if we utilized the darker blue rays to the exclusion of the brighter, this is *practically* impossible at present, as no means are known by which the bright blue rays can be stopped off, while the darker ones are admitted.

On a precisely analogous principle *photography* allows of a still more considerable increase in resolving power.

In the ordinary photographic process the chemical action is confined to the interval between the lines G and H, and has its maximum near the line *h*. This is the same thing as if we had stopped out from white light all the rest of the spectrum, and were working with monochromatic light of no greater wave-length.

Taking for a point near the line *h*, $\lambda = 0{\cdot}40000\ \mu$,* the resolving power in the case of photography as compared with white light is shown to be increased in the inverse ratio of 0·52689 to 0·40000.

As before stated, the table itself gives the particular line for which the column of resolving power was calculated, and the possible increase with shorter wave-lengths was duly noted with the first publication of the table,† but it will perhaps tend to prevent in future any misapprehension if two further columns are added, giving the figures of resolving power in the case of monochromatic light and photography as well as white light. Mr. J. W. Stephenson, who calculated the original table, has kindly prepared these additional columns, and the table will in future be printed as appended to this paper.

The case of *sunlight* still remains to be considered. It is undoubted that with sunlight greater resolving power can be obtained than with lamplight, but the explanation is entirely different from that which applies to monochromatic light and photography.

It seems to have been supposed that by using sunlight instead of lamplight we should virtually get the benefit of reduced wave-length, as although the difference of relative intensity of the various colours is very slight in the lower portion of the spectrum, it is large in the case of the upper portion, so that the intensity of the dark blue is greater with sunlight than with lamplight. This supposition, however, overlooks the fact that in the case of white light (whether lamplight or sunlight), the dark blue and violet have practically no action in the presence of the bright blue, green, and yellow. While, therefore, these colours form part of those in the

* For $H_1$, $\lambda = 0{\cdot}39680\ \mu$ and for *h*, $\lambda = 0{\cdot}41012\ \mu$.

† See this Journal, ii. (1879) p. 839.

field, the greater or less intensity of the dark blue and violet has no appreciable effect on the image, being drowned by the bright background produced by the other rays, and lamplight, containing as it does a sufficient quantity of those blue rays which are predominant, will not be inferior to sunlight *as regards the effective wave-length.*

Even with sunlight, however, no greater number of lines can be resolved than are shown in the original table for the line E. The superiority of sunlight is based, not upon a different limit of the active wave-length, but upon the fact that in consequence of the absolute intensity of the light it is possible to utilize the *full* aperture of the objective, which cannot be done with light of less intensity.

When lamplight or daylight is used the relatively lower intensity of the illumination renders it necessary to employ pencils of perceptible breadth. The axes of the pencils will therefore necessarily be at some distance from the margin of the objective's aperture as shown in fig. 224 (A, direct light and A′, diffraction

Fig. 224.

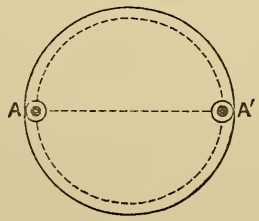
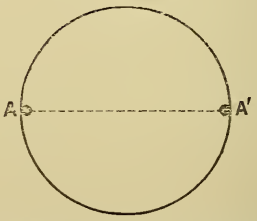



Fig. 225.




pencil). The extent to which the axes are within the margin represents so much lost aperture just as if it were reduced to the dotted line.

With sunlight, however, the intensity of the illumination is such that an image may be obtained by using only a very narrow incident pencil. The axis of such a pencil is practically at the margin of the aperture, and the full aperture is therefore utilized (see fig. 225).

This also shows that the figures given in the new table, whether for white light, monochromatic light, or photography, will only be attainable when the source of light is of great intensity; otherwise there will be a loss of aperture.

Although sunlight only has been referred to, it may be pointed out that the electric (arc) light is little, if at all, inferior to sunlight in regard to the utilization of the full aperture of the objective.

### *Note by Professor Abbe.*

Prof. Abbe, to whom I sent a proof of the preceding paper for his views as to continuing columns 3 and 4 to the lower numbers, writes:—

"There is one point as to which you may think that an explanation is advisable. As you say, in the case of fig. 224 the

effective aperture is necessarily reduced to the diameter of the dotted circle, i.e. the distance of the *axes* of the two pencils A, A′, but I doubt if everybody will at once see, without explanation, why this must be so. At first sight it would appear that the marginal zone, outside the dotted line, would at least add *something* to the resolving power. It might be thought that if with a given aperture (the direct pencil being assumed in the position A in fig. 226) the diffraction-pencil does not enter the aperture, but

Fig. 226.

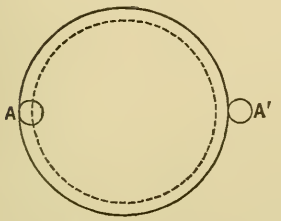
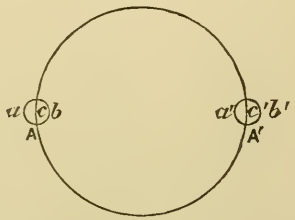


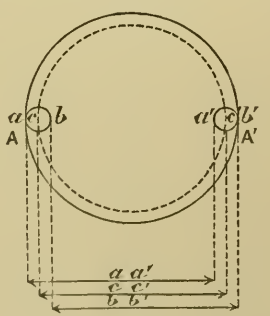

Fig. 227.




remains outside in the position A′, we could increase the obliquity of the incident pencil in order to obtain the position fig. 227, and that then we might expect an image of the lines from which the pencil A′ originates, because one-half of that pencil enters the aperture together with one-half of the incident pencil.

This is of course a fallacy: because those two halves (or semi-pencils) no longer contain *conjugate* rays, i. e. no pairs of rays which originate from one and the same incident ray. Pairs of conjugate rays are: $\overset{\frown}{a\,a'}$, $\overset{\frown}{c\,c'}$, $\overset{\frown}{b\,b'}$, but *not* $\overset{\frown}{b\,a'}$. Therefore, in the case of fig. 227, the two semi-pencils which are admitted are *not image-forming rays, except by an infinitely small portion,* $\overset{\frown}{c\,c'}$. Though we have within the aperture direct rays on one side, and diffracted rays on the other side, we have merely *dead* rays, not capable of interfering, because they do not originate from the same primary rays. These rays will afford a useless illumination of the field only.

Fig. 228.




In regard to fig. 224, the same considerations will show that *in order to obtain the image-forming rays corresponding to an incident pencil of a given diameter* $a\,b$, the *maximum* distance of a diffracted ray from the direct ray must not exceed the length $c\,c'$ (see fig. 228), i. e. the diameter of the dotted circle; and that, *if* the diameter $a\,b$ is *necessary*, in order to have sufficient light, the limit of resolution is given by that *reduced* aperture."

| Numerical Aperture. ($n \sin u = a$.) | Corresponding Angle ($2u$) for | | | Limit of Resolving Power, in Lines to an Inch. | | | Illuminating Power. ($a^2$.) | Penetrating Power. $\left(\frac{1}{a}\right)$ |
|---|---|---|---|---|---|---|---|---|
| | *Air* ($n = 1{\cdot}00$). | *Water* ($n = 1{\cdot}33$). | *Homogeneous Immersion* ($n = 1{\cdot}52$). | White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.) | Monochromatic Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.) | Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.) | | |
| 1·52 | .. | .. | 180° 0′ | 146,543 | 158,845 | 193,037 | 2·310 | ·658 |
| 1·51 | .. | .. | 166° 51′ | 145,579 | 157,800 | 191,767 | 2·280 | ·662 |
| 1·50 | .. | .. | 161° 23′ | 144,615 | 156,755 | 190,497 | 2·250 | ·667 |
| 1·49 | .. | .. | 157° 12′ | 143,651 | 155,710 | 189,227 | 2·220 | ·671 |
| 1·48 | .. | .. | 153° 39′ | 142,687 | 154,665 | 187,957 | 2·190 | ·676 |
| 1·47 | .. | .. | 150° 32′ | 141,723 | 153,620 | 186,687 | 2·161 | ·680 |
| 1·46 | .. | .. | 147° 42′ | 140,759 | 152,575 | 185,417 | 2·132 | ·685 |
| 1·45 | .. | .. | 145° 6′ | 139,795 | 151,530 | 184,147 | 2·103 | ·690 |
| 1·44 | .. | .. | 142° 39′ | 138,830 | 150,485 | 182,877 | 2·074 | ·694 |
| 1·43 | .. | .. | 140° 22′ | 137,866 | 149,440 | 181,607 | 2·045 | ·699 |
| 1·42 | .. | .. | 138° 12′ | 136,902 | 148,395 | 180,337 | 2·016 | ·704 |
| 1·41 | .. | .. | 136° 8′ | 135,938 | 147,350 | 179,067 | 1·988 | ·709 |
| 1·40 | .. | .. | 134° 10′ | 134,974 | 146,305 | 177,797 | 1·960 | ·714 |
| 1·39 | .. | .. | 132° 16′ | 134,010 | 145,260 | 176,527 | 1·932 | ·719 |
| 1·38 | .. | .. | 130° 26′ | 133,046 | 144,215 | 175,257 | 1·904 | ·725 |
| 1·37 | .. | .. | 128° 40′ | 132,082 | 143,170 | 173,987 | 1·877 | ·730 |
| 1·36 | .. | .. | 126° 58′ | 131,118 | 142,125 | 172,717 | 1·850 | ·735 |
| 1·35 | .. | .. | 125° 18′ | 130,154 | 141,080 | 171,447 | 1·823 | ·741 |
| 1·34 | .. | .. | 123° 40′ | 129,189 | 140,035 | 170,177 | 1·796 | ·746 |
| 1·33 | .. | 180° 0′ | 122° 6′ | 128,225 | 138,989 | 168,907 | 1·769 | ·752 |
| 1·32 | .. | 165° 56′ | 120° 33′ | 127,261 | 137,944 | 167,637 | 1·742 | ·758 |
| 1·31 | .. | 160° 6′ | 119° 3′ | 126,297 | 136,899 | 166,367 | 1·716 | ·763 |
| 1·30 | .. | 155° 38′ | 117° 35′ | 125,333 | 135,854 | 165,097 | 1·690 | ·769 |
| 1·29 | .. | 151° 50′ | 116° 8′ | 124,369 | 134,809 | 163,827 | 1·664 | ·775 |
| 1·28 | .. | 148° 42′ | 114° 44′ | 123,405 | 133,764 | 162,557 | 1·638 | ·781 |
| 1·27 | .. | 145° 27′ | 113° 21′ | 122,441 | 132,719 | 161,287 | 1·613 | ·787 |
| 1·26 | .. | 142° 39′ | 111° 59′ | 121,477 | 131,674 | 160,017 | 1·588 | ·794 |
| 1·25 | .. | 140° 3′ | 110° 39′ | 120,513 | 130,629 | 158,747 | 1·563 | ·800 |
| 1·24 | .. | 137° 36′ | 109° 20′ | 119,548 | 129,584 | 157,477 | 1·538 | ·806 |
| 1·23 | .. | 135° 17′ | 108° 2′ | 118,584 | 128,539 | 156,207 | 1·513 | ·813 |
| 1·22 | .. | 133° 4′ | 106° 45′ | 117,620 | 127,494 | 154,937 | 1·488 | ·820 |
| 1·21 | .. | 130° 57′ | 105° 30′ | 116,656 | 126,449 | 153,668 | 1·464 | ·826 |
| 1·20 | .. | 128° 55′ | 104° 15′ | 115,692 | 125,404 | 152,397 | 1·440 | ·833 |
| 1·19 | .. | 126° 58′ | 103° 2′ | 114,728 | 124,359 | 151,128 | 1·416 | ·840 |
| 1·18 | .. | 125° 3′ | 101° 50′ | 113,764 | 123,314 | 149,857 | 1·392 | ·847 |
| 1·17 | .. | 123° 13′ | 100° 38′ | 112,799 | 122,269 | 148,588 | 1·369 | ·855 |
| 1·16 | .. | 121° 26′ | 99° 29′ | 111,835 | 121,224 | 147,317 | 1·346 | ·862 |
| 1·15 | .. | 119° 41′ | 98° 20′ | 110,872 | 120,179 | 146,048 | 1·323 | ·870 |
| 1·14 | .. | 118° | 97° 11′ | 109,907 | 119,134 | 144,777 | 1·300 | ·877 |
| 1·13 | .. | 116° 20′ | 96° 2′ | 108,943 | 118,089 | 143,508 | 1·277 | ·885 |
| 1·12 | .. | 114° 44′ | 94° 55′ | 107,979 | 117,044 | 142,237 | 1·254 | ·893 |
| 1·11 | .. | 113° 9′ | 93° 47′ | 107,015 | 115,999 | 140,968 | 1·232 | ·901 |
| 1·10 | .. | 111° 36′ | 92° 43′ | 106,051 | 114,954 | 139,698 | 1·210 | ·909 |
| 1·09 | .. | 110° 5′ | 91° 38′ | 105,087 | 113,909 | 138,428 | 1·188 | ·917 |
| 1·08 | .. | 108° 36′ | 90° 34′ | 104,123 | 112,864 | 137,158 | 1·166 | ·926 |
| 1·07 | .. | 107° 8′ | 89° 30′ | 103,159 | 111,819 | 135,888 | 1·145 | ·935 |
| 1·06 | .. | 105° 42′ | 88° 27′ | 102,195 | 110,774 | 134,618 | 1·124 | ·943 |
| 1·05 | .. | 104° 16′ | 87° 24′ | 101,231 | 109,729 | 133,348 | 1·103 | ·952 |
| 1·04 | .. | 102° 53′ | 86° 21′ | 100,266 | 108,684 | 132,078 | 1·082 | ·962 |
| 1·03 | .. | 101° 30′ | 85° 19′ | 99,302 | 107,639 | 130,808 | 1·061 | ·971 |
| 1·02 | .. | 100° 10′ | 84° 18′ | 98,338 | 106,593 | 129,538 | 1·040 | ·980 |
| 1·01 | .. | 98° 50′ | 83° 17′ | 97,374 | 105,548 | 128,268 | 1·020 | ·990 |
| 1·00 | 180° 0′ | 97° 31′ | 82° 17′ | 96,410 | 104,503 | 126,998 | 1·000 | 1·000 |
| 0·99 | 163° 48′ | 96° 12′ | 81° 17′ | 95,446 | 103,458 | 125,723 | ·980 | 1·010 |
| 0·98 | 157° 2′ | 94° 56′ | 80° 17′ | 94,482 | 102,413 | 124,458 | ·960 | 1 020 |
| 0·97 | 151° 52′ | 93° 40′ | 79° 18′ | 93,518 | 101,368 | 123,188 | ·941 | 1·031 |
| 0·96 | 147° 29′ | 92° 24′ | 78° 20′ | 92,554 | 100,323 | 121,918 | ·922 | 1·042 |
| 0·95 | 143° 36′ | 91° 10′ | 77° 22′ | 91,590 | 99,278 | 120,648 | ·903 | 1·053 |
| 0·94 | 140° 6′ | 89° 56′ | 76° 24′ | 90,625 | 98,233 | 119,378 | ·884 | 1·064 |
| 0·93 | 136° 52′ | 88° 44′ | 75° 27′ | 89,661 | 97,188 | 118,108 | ·865 | 1·075 |
| 0·92 | 133° 51′ | 87° 32′ | 74° 30′ | 88,697 | 96,143 | 116,838 | ·846 | 1 087 |
| 0·91 | 131° 0′ | 86° 20′ | 73° 33′ | 87,733 | 95,098 | 115,568 | ·828 | 1·099 |

| Numerical Aperture. ($n \sin u = a$.) | Corresponding Angle ($2u$) for | | | Limit of Resolving Power, in Lines to an Inch. | | | Illuminating Power. ($a^2$.) | Penetrating Power. $\left(\frac{1}{a}\right)$ |
|---|---|---|---|---|---|---|---|---|
| | *Air* ($n = 1{\cdot}00$). | *Water* ($n = 1{\cdot}33$). | *Homogeneous Immersion* ($n = 1{\cdot}52$). | White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.) | Monochromatic Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.) | Photography. ($\lambda = 0{\cdot}4000\,\mu$, near Line *h*.) | | |
| 0·90 | 128° 19′ | 85° 10′ | 72° 36′ | 86,769 | 94,053 | 114,298 | ·810 | 1·111 |
| 0·89 | 125° 45′ | 84° 0′ | 71° 40′ | 85,805 | 93,008 | 113,028 | ·792 | 1·124 |
| 0·88 | 123° 17′ | 82° 51′ | 70° 44′ | 84,841 | 91,963 | 111,758 | ·774 | 1·136 |
| 0·87 | 120° 55′ | 81° 42′ | 69° 49′ | 83,877 | 90,918 | 110,488 | ·757 | 1·149 |
| 0·86 | 118° 38′ | 80° 34′ | 68° 54′ | 82,913 | 89,873 | 109,218 | ·740 | 1·163 |
| 0·85 | 116° 25′ | 79° 37′ | 68° 0′ | 81,949 | 88,828 | 107,948 | ·723 | 1·176 |
| 0·84 | 114° 17′ | 78° 20′ | 67° 6′ | 80,984 | 87,783 | 106,678 | ·706 | 1·190 |
| 0·83 | 112° 12′ | 77° 14′ | 66° 12′ | 80,020 | 86,738 | 105,408 | ·689 | 1·205 |
| 0·82 | 110° 10′ | 76° 8′ | 65° 18′ | 79,056 | 85,693 | 104,138 | ·672 | 1·220 |
| 0·81 | 108° 10′ | 75° 3′ | 64° 24′ | 78,092 | 84,648 | 102,868 | ·656 | 1·235 |
| 0·80 | 106° 16′ | 73° 58′ | 63° 31′ | 77,128 | 83,603 | 101,598 | ·640 | 1·250 |
| 0·79 | 104° 22′ | 72° 53′ | 62° 38′ | 76,164 | 82,558 | 100,328 | ·624 | 1·266 |
| 0·78 | 102° 31′ | 71° 49′ | 61° 45′ | 75,200 | 81,513 | 99,058 | ·608 | 1·282 |
| 0·77 | 100° 42′ | 70° 45′ | 60° 52′ | 74,236 | 80,468 | 97,788 | ·593 | 1·299 |
| 0·76 | 98° 56′ | 69° 42′ | 60° 0′ | 73,272 | 79,423 | 96,518 | ·578 | 1·316 |
| 0·75 | 97° 11′ | 68° 40′ | 59° 8′ | 72,308 | 78,378 | 95,248 | ·563 | 1·333 |
| 0·74 | 95° 28′ | 67° 37′ | 58° 16′ | 71,343 | 77,333 | 93,979 | ·548 | 1·351 |
| 0·73 | 93° 46′ | 66° 34′ | 57° 24′ | 70,379 | 76,288 | 92,709 | ·533 | 1·370 |
| 0·72 | 92° 6′ | 65° 32′ | 56° 32′ | 69,415 | 75,242 | 91,439 | ·518 | 1·389 |
| 0·71 | 90° 28′ | 64° 32′ | 55° 41′ | 68,451 | 74,197 | 90,169 | ·504 | 1·408 |
| 0·70 | 88° 51′ | 63° 31′ | 54° 50′ | 67,487 | 73,152 | 88,899 | ·490 | 1·429 |
| 0·69 | 87° 16′ | 62° 30′ | 53° 59′ | 66,523 | 72,107 | 87,629 | ·476 | 1·449 |
| 0·68 | 85° 41′ | 61° 30′ | 53° 9′ | 65,559 | 71,062 | 86,359 | ·462 | 1·471 |
| 0·67 | 84° 8′ | 60° 30′ | 52° 18′ | 64,595 | 70,017 | 85,089 | ·449 | 1·493 |
| 0·66 | 82° 36′ | 59° 30′ | 51° 28′ | 63,631 | 68,972 | 83,819 | ·436 | 1·515 |
| 0·65 | 81° 6′ | 58° 30′ | 50° 38′ | 62,667 | 67,927 | 82,549 | ·423 | 1·538 |
| 0·64 | 79° 36′ | 57° 31′ | 49° 48′ | 61,702 | 66,882 | 81,279 | ·410 | 1·562 |
| 0·63 | 78° 6′ | 56° 32′ | 48° 58′ | 60,738 | 65,837 | 80,009 | ·397 | 1·587 |
| 0·62 | 76° 38′ | 55° 34′ | 48° 9′ | 59,774 | 64,792 | 78,739 | ·384 | 1·613 |
| 0·61 | 75° 10′ | 54° 36′ | 47° 19′ | 58,810 | 63,747 | 77,469 | ·372 | 1·639 |
| 0·60 | 73° 44′ | 53° 38′ | 46° 30′ | 57,846 | 62,702 | 76,199 | ·360 | 1·667 |
| 0·59 | 72° 18′ | 52° 40′ | 45° 40′ | 56,881 | 61,657 | 74,929 | ·348 | 1·695 |
| 0·58 | 70° 54′ | 51° 42′ | 44° 51′ | 55,918 | 60,612 | 73,659 | ·336 | 1·724 |
| 0·57 | 69° 30′ | 50° 45′ | 44° 2′ | 54,954 | 59,567 | 72,389 | ·325 | 1·754 |
| 0·56 | 68° 6′ | 49° 48′ | 43° 14′ | 53,990 | 58,522 | 71,119 | ·314 | 1·786 |
| 0·55 | 66° 44′ | 49° 51′ | 42° 25′ | 53,026 | 57,477 | 69,849 | ·303 | 1·818 |
| 0·54 | 65° 22′ | 47° 54′ | 41° 37′ | 52,061 | 56,432 | 68,579 | ·292 | 1·852 |
| 0·53 | 64° 0′ | 46° 58′ | 40° 48′ | 51,097 | 55,387 | 67,309 | ·281 | 1·887 |
| 0·52 | 62° 40′ | 46° 2′ | 40° 0′ | 50,133 | 54,342 | 66,039 | ·270 | 1·923 |
| 0·51 | 61° 20′ | 45° 6′ | 39° 12′ | 49,169 | 53,297 | 64,769 | ·260 | 1·961 |
| 0·50 | 60° 0′ | 44° 10′ | 38° 24′ | 48,205 | 52,252 | 63,499 | ·250 | 2·000 |
| 0·48 | 57° 22′ | 42° 18′ | 36° 49′ | 46,277 | 50,162 | 60,959 | ·230 | 2·083 |
| 0·46 | 54° 47′ | 40° 28′ | 35° 15′ | 44,349 | 48,072 | 58,419 | ·212 | 2·174 |
| 0·45 | 53° 30′ | 39° 33′ | 34° 27′ | 43,385 | 47,026 | 57,149 | ·203 | 2·222 |
| 0·44 | 52° 13′ | 38° 38′ | 33° 40′ | 42,420 | 45,981 | 55,879 | ·194 | 2·273 |
| 0·42 | 49° 40′ | 36° 49′ | 32° 5′ | 40,492 | 43,891 | 53,339 | ·176 | 2·381 |
| 0·40 | 47° 9′ | 35° 0′ | 30° 31′ | 38,564 | 41,801 | 50,799 | ·160 | 2·500 |
| 0·38 | 44° 40′ | 33° 12′ | 28° 57′ | 36,636 | 39,711 | 48,259 | ·144 | 2·632 |
| 0·36 | 42° 12′ | 31° 24′ | 27° 24′ | 34,708 | 37,621 | 45,719 | ·130 | 2·778 |
| 0·35 | 40° 58′ | 30° 30′ | 26° 38′ | 33,744 | 36,576 | 44,449 | ·123 | 2·857 |
| 0·34 | 39° 44′ | 29° 37′ | 25° 51′ | 32,779 | 35,531 | 43,179 | ·116 | 2·941 |
| 0·32 | 37° 20′ | 27° 51′ | 24° 18′ | 30,851 | 33,441 | 40,639 | ·102 | 3·125 |
| 0·30 | 34° 56′ | 26° 4′ | 22° 46′ | 28,923 | 31,351 | 38,099 | ·090 | 3·333 |
| 0·28 | 32° 32′ | 24° 18′ | 21° 14′ | 26,995 | 29,261 | 35,559 | ·078 | 3·571 |
| 0·26 | 30° 10′ | 22° 33′ | 19° 42′ | 25,067 | 27,171 | 33,019 | ·068 | 3·846 |
| 0·25 | 28° 58′ | 21° 40′ | 18° 56′ | 24,103 | 26,126 | 31,749 | ·063 | 4·000 |
| 0·24 | 27° 46′ | 20° 48′ | 18° 10′ | 23,138 | 25,081 | 30,479 | ·058 | 4·167 |
| 0·22 | 25° 26′ | 19° 2′ | 16° 38′ | 21,210 | 22,991 | 27,940 | ·048 | 4·545 |
| 0·20 | 23° 4′ | 17° 18′ | 15° 7′ | 19,282 | 20,901 | 25,400 | ·040 | 5·000 |
| 0·15 | 17° 14′ | 12° 58′ | 11° 19′ | 14,462 | 15,676 | 19,050 | ·023 | 6·667 |
| 0·10 | 11° 29′ | 8° 38′ | 7° 31′ | 9,641 | 10,450 | 12,700 | ·010 | 10·000 |
| 0·05 | 5° 44′ | 4° 18′ | 3° 46′ | 4,821 | 5,225 | 6,350 | ·0025 | 20·000 |

# SUMMARY

OF CURRENT RESEARCHES RELATING TO

# ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

# MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Development of Sexuality.**†—As the result of observations on the development of the sex-glands in the higher vertebrates, and especially in birds, M. F. Laulanié seeks to establish a strict parallelism between the ontogenetic and phylogenetic history. In the chick he distinguishes three great stages in the development—(1) a period of germiparity, (2) hermaphroditism, (3) differentiated unisexuality, which he regards as recapitulating the great steps in the historic evolution.

1. For the first period of germiparity from the fourth to the sixth day the designation "sexual neutrality or indifference" is inappropriate, since the "cortical ovules" of the germinal epithelium have from the first the precise morphological significance of germs or female elements, and in the female proceed by proliferation to form the ovary, while in the male they degenerate.

2. In the period of hermaphroditism, beginning with the seventh day, in the male the male elements appear in the form of reticulated cellular strands—the future seminal tubules—arising in the medullary or mesodermal, and not in the cortical layer: with them are associated primordial male ovules, morphologically like the above cortical ovules, but originating in the mesoderm, whence they are designated "ovules medullaires." At the same time, but yet distinct, there are seen certain "cortical" (i. e. female) ovules persisting in the germinal epithelium. Similarly in the ovary of the female the medullary layer, strictly separated by a partition of connective tissue from the oviparous layer, contains a large number of medullary (i. e. male or

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† Comptes Rendus, ci. (1885) pp. 393–5.

mesodermal ovules) imbedded in the stroma, and particularly abundant at the level of the hilum.

3. The above hermaphroditism is of but short duration, the cortical or female ovules disappear from the testes by the eighth or ninth day, and the medullary or male ovules have by the tenth day disappeared from the ovary. In regard to mammals he affirms, with some peculiarities, the same three stages of germiparity, hermaphroditism, and unisexuality, alike for ontogeny and phylogeny.

**Formation of Spindles in Mammalian Ova during the Degeneration of the Graafian Follicle.***—Dr. W. Flemming commences his paper by a short description of the methods employed in hardening the ovaries for histological investigation. It appears that in ova from normal follicles there are never any caryokinetic figures in place of the nucleus, and that, since these latter do occur in the ova of degenerating follicles, the few instances where they have been described in normal mammalian ova are probably due to some pathological condition. It seems probable that the ova with caryokinetic figures were in no case living ova, since they were flattened and abnormal in shape, and the follicle itself was evidently undergoing a process of retrogression. It is by far the most natural hypothesis that the degeneration of the follicular epithelium is the primary process, and that by reason of this abnormal vital processes were caused in the ova; the result being a premature and perhaps not typical formation of directive-spindles.

**Significance of Cell-nuclei in the Processes of Heredity.†**—Prof. A. Kölliker reminds the reader that in his Text-book of Embryology (2nd edition, 1882) he insisted on the fact that the first nucleus of the embryo, arising by the conjugation of a male and female nucleus, is the sole means by which we can explain the processes of inheritance.

The spermatozoa are first discussed, and it is pointed out that the filament gradually grows out from the nuclei of the cells, that it is not comparable to a cilium, inasmuch as it may be found rolled up within its formative cells; and in many cases a number of the filaments arise within one cell.

The author propounds the following questions, and considers the answers to them: What portion of the spermatozoon is the fertilizer? What share is taken in fertilization by the germinal vesicle, and the modes of union of the spermatic and ovarian nuclei? After discussing the opinions of various authors, the writer suggests that the removal of certain constituents of the germinal vesicle diminishes the disproportionate size of the female nucleus, so that the idioplasm of the two nuclei is more evenly balanced.

Kölliker is of opinion that the processes of heredity are to be understood solely by a reference to the phenomena of reproduction; the fertilizing organisms hand over to the fertilized a morphologically definite substance of typical composition, the activities of which

* Arch. f. Anat. u. Phys., 1885, pp. 321–4 (2 pls.).
† Zeitschr. f. Wiss. Zool., xlii. (1885) pp. 1–46.

affect the whole form of the produce; this inheritance-substance (idioplasm) is contained in the germinal vesicle of the ovum and in the spermatozoon, both of which have the significance of nuclei; the first nucleus formed by them is to be regarded as hermaphrodite; from it there arise all the nuclei of the complete creature in unbroken series, and they are, therefore, representatives of both the producing organisms. The special activities of the smallest particles of which they are composed are the conditions of the multiplication-phenomena of the cells and of their growth. The typical forms of organs and of organisms are the consequence of definite combinations of cell-divisions and cell-growths and these are ruled by the nuclei.

The writer discusses the chemical constitution of the nuclei, and concludes with the aphorism that there are many cells in the organism which are either embryonic in character, or may be regarded as such.

**Development of the Opossum.***—Having succeeded in keeping a large number of North American opossums alive for a lengthened period, Prof. E. Selenka obtained material for a detailed study of their development. Reserving the main embryological results, which will doubtless throw much light on the development of the placental mammals, he communicates a few preliminary notes of which the following seem the most important.

1. *Spermatozoa.* There are in each sperm-cell two spermatozoa remaining long united, even within the vagina, where they at length violently separate in consequence of the increased rapidity of their tail-vibrations.

2. *Fertilization* occurs in the lower end of the oviduct five days after copulation. Gestation lasts eight days, and then the young are transferred to the pouch.

3. *Segmentation* is intermediate between partial and total. While division is proceeding a nutritive yolk collects at the aplastic pole of the ovum, and this, at first quite outside the ectoderm, is in three days covered in by the adjacent ectoderm and mesoderm cells, though never coming within the umbilical vesicle. Remains of this yolk persist till three days before birth.

4. The ova, which exhibit a most rapid growth and development, are at first scattered in the uterus, and on the fourth day when fertilization has begun, they become loosely fixed to the uterine epithelium.

5. The number of embryos varies from nine to twenty-seven, but in the marsupium there were never more than six young opossums.

**Karyokinesis in Segmentation of Axolotl Ovum.†**—Prof. J. Bellonci describes the nuclear changes in the segmentation of the ovum of axolotl. The nucleus is at first ellipsoidal with a notch at one side, and with a relatively small quantity of chromatin. As karyokinesis begins, chromatin filaments form the familiar ball of coils; some achromatin threads appear within, the star-shape is then

* Biol. Centralbl., v. (1885) pp. 294–5.
† Arch. Ital. de Biol., vi. (1885) pp. 52–7 (1 pl.).

exhibited, and the looped chromatin filaments dispose themselves parallel to the achromatin threads of the spindle and recede towards the poles where some of them bend in a bow-shaped fashion. There small spheroidal vesicles are formed from the chromatin, which is not, however, spread regularly over their surface, but in minute accumulations here and there, the interspaces being probably occupied by achromatin. These little vesicles unite and fuse to form the new nuclei, and the active protoplasm of the cell gathers round each in a star-like form, round which again the pigment-granules are radiately disposed. The active protoplasm thus collected colours readily on being treated with Schweigger-Seidel's acid-carmine in chromo-acetic acid preparations, the forming nuclear substance colours intensely, the spindle only very slightly, so that Bellonci would infer some chemical change of the nuclear substance during karyokinesis. As the spindle is about to divide the pigment covers it, hiding and then replacing the connecting filaments, across which a cellular plate with an abundant deposit of pigment eventually appears. The peculiarity of the process consists in the formation of the small vesicles of chromatin, and probably also of achromatin, which unite to form the two new nuclei, but this is only a slight modification of the ordinary karyokinesis observed in the somatic cells.

**Epidermic Cells of Tadpoles.***—Dr. A. Kölliker has discovered in the tail of young frog larvæ, numerous epidermic cells, each with a stiff process projecting on the exterior; the superficial flat cells of the epidermis are so arranged as to leave a series of small holes, through which the tips of these processes protrude. These cells appear to be peculiar to the Anura, and were not found in any Urodeles; they are chiefly aggregated in the lateral line, but are found elsewhere; these cells are undoubtedly sensory and have been proved to be connected with nerve-fibres.

**Early Developmental Stages of Torpedo.**†—Dr. A. Swaen finds that in *Torpedo ocellata* the mesoblast arises from the front end of the embryo from a layer of cells termed the secondary hypoblast; the secondary hypoblast forms the upper wall of the archenteric cavity, its lower wall consisting of the primitive hypoblast, which appears to correspond to the "lower layer cells" of Balfour. The formation of the chorda and of the mesoblast, derived as they are from the walls of the archenteron, is similar to the mode of formation of the same structures in *Amphioxus*, except that they are not hollow, and are not therefore precisely diverticula of the archenteron.

The first traces of the vascular system are to be found in the peripheral portion of the extra embryonal zone; they arise as "blood-islets" in the cells of the hypoblast, but afterwards grow into the mesoblast and become shut off from all connection with the hypoblast; the hypoblastic cells form the blood-corpuscles, but the walls of the tubes are at least partly mesoblastic.

The portion of the secondary hypoblast which remains over after

* Zool. Anzeig., viii. (1885) pp. 439–41.

† Bull. Acad. R. Sci. Belg., ix. (1885) pp. 385–416 (16 figs.).

the segregation of the chorda dorsalis, and of the mesoblast plates, together with the primitive hypoblast, form the cells of the gut, and may be termed the endoblast.

With reference to the formation of the mesoblast, it is to be noticed that the secondary hypoblast from which it arises is composed of cells partly hypoblastic and partly epiblastic.

**Position of the Yolk-Blastopore as determined by the Size of the Vitellus.***—Mr. J. A. Ryder, who has already shown that in the Teleostei the portion of the point of closure of the blastoderm in relation to the original position of the germinal disc is largely determined by the size of the vitellus, now considers other vertebrates. In two large yolked types—the Elasmobranchs and the Sauroids—the embryo is displaced in position in reference to the margin of the blastoderm. In them the embryo is partially folded off, whereas in other fishes and in Amphibians the embryonic axis extends back to the point where the yolk-blastopore closes; the difference is due to the great difference in the bulk of the yolk.

The germinal disc of Sauroids is relatively much larger than that of Teleosteans, so that proportionally it probably does not spread over a much larger vitelline surface in the one than in the other case; the two forms of closure may be distinguished as teleporous and ateleporous. "The ova of the two extremes of the vertebrate series—Branchiostoma and Mammalia—are yolkless, except those of the Monotremata, which are probably ateleporous"—the band of tissue from the vitelline end of the umbilical stalk to the edge of the blastoderm-rim in Elasmobranchs, and the primitive streak in Sauroids and mammals are probably homologous structures. The Sauroids present other differences in the fact that the germinal wall is not carried quite to the border of the blastoderm all round, as in the Ichthyopsida, and this again appears to be due to the quantity of yolk.

The blastopore observed by Van Beneden in mammalian ova is not a true blastopore; the degenerate condition of the yolk of these eggs may probably be due to the development of the so-called uterine milk, by which the egg is nourished before the fœtal vessels are developed.

On the other hand, viviparity has not affected the development of the yolk in Teleosteans, and it seems to be quite conceivable that the mammalian vitellus, like the ambulatory or prehensile organs of parasitic organisms, may have been atrophied in consequence of the perfectly parasitic connection which obtains temporarily between the maternal organism and the embryo.

**Development of Viviparous Osseous Fishes.†**—Mr. J. A. Ryder gives a lengthy summary of our knowledge respecting the best known of the truly viviparous osseous fishes characterized by an intrafollicular or intra-ovarian development. New observations are recorded on the changes undergone by the embryos of the Embiotocoids during gesta-

* Amer. Naturalist, xix. (1885) pp. 411–5.

† Proc. U.S. Nat. Museum, viii. (1885) pp. 128–55 (4 pls.).

tion, which relate to the development of the intestine and the vascular supply of the median fins.

The paper is subdivided as follows:—I. Development of *Anableps*. II. Development of the Embiotocidæ of the Pacific coast. III. Hypertrophied hind-gut of Embiotocoid embryos and its subsequent diminution in relative size. IV. Intra-ovarian respiratory function of the vertical fins of Embiotocoid fish embryos. V. Development and intrafollicular gestation of *Gambusia patruelis*, concerning which a number of points that had been left undecided have been determined:—(1) Fertilization of the egg of *Gambusia* occurs within the ovarian follicle, the spermatic fluid being apparently introduced into the ovary or abdominal cavity by the male, which is provided with an intromittent organ consisting of the anal fin much modified, and the spermatozoa find access to the egg through a wide opening in the follicle which answers to a micropyle, but which may be called the follicular pore. (2) There is no evidence, as in the case of *Anableps* and the Embiotocidæ, that the ovarian follicles are ruptured until the development of the young embryos is approximately completed, since the most advanced fœtuses of *Gambusia* studied have the scales, fins, fin-rays, and cranium remarkably well developed, even before the yolk is all absorbed. (3) Little or no nutriment is derived from the parent, as in *Anableps* and the Embiotocidæ; or, in other words, the embryo of *Gambusia* grows entirely at the expense of the material contained in the yolk-sac, and does not form villi upon the latter nor enlarge after the yolk has been absorbed, as in *Anableps;* neither does the rectum or hind-gut hypertrophy, nor do the fins expand and develop prolongations of the interradial membranes as in the Embiotocidæ. (4) As is the case with all viviparous forms, the number of embryos produced seems to be diminished in correlation with the protection which the young receive in consequence of their peculiarly complete development within the body of the parent. VI. Habits of *Gambusia* during the breeding season. VII. Viviparity of *Fundulus*.

**Origin of the Spermatozoids in the Seminiferous Canals.***—Dr. D. Biondi has carried out some investigations with the view of throwing some light on the origin of the spermatozoids in the seminiferous canals, a question on which the views of physiologists have been widely divergent. By appropriate use of processes of hardening, fixing, and colouring (among which the advantages of Flemming's fluid are specially mentioned) Dr. Biondi arrived at results which corroborated none of the views formerly put forth, but which explained the earlier observed facts.

In accordance with these results the author endeavoured to distribute diagrammatically the contents of the seminiferous canals into columns, which, proceeding from the wall towards the central cavity, might be grouped into three layers. In the first stage of development, a stage always met with, in particular, in animals not yet mature, the extreme layer lying on the wall of the canal consisted of round primitive cells, which were very rich in karyokinetic figures,

* Berlin Physiol. Soc., 1885, July 31. See Nature, xxxii. (1885) p. 544.

and the third innermost layer consisted of a large number of small round daughter-cells. In a second stage of development observable in mature glands, the nuclei of the daughter-cells were seen converted into spermatozoids, the exterior half of the nucleus becoming the head and the other interior half the middle part and tail of the spermatozoon. The protoplasm of the daughter-cells took no part in this transformation, and enveloped the bodies of the spermatozoa, making them cohere into bundles, from which the tails of the spermatozoa projected towards the central canal. These masses of protoplasm enveloping the bodies of the spermatozoa resembled the figures described by the earlier observers as "spermatoblasten." In this stage the above diagrammatic column consisted, from the outside inwards, of the primitive cell, the mother-cell, and the bundle of spermatozoa. In the next stage of development the formation of the spermatozoa, arising always in the same manner from the nucleus of the daughter-cells, was pushed farther outwards, so that the column now consisted of but one large round cell on the outside and bundles of spermatozoa on the inside. The formation of the seminal corpuscles advanced still farther, and at last the whole column, as far as the wall of the canal, consisted of spermatozoa, the bodies of which were agglutinated into bundles by masses of protoplasm, their tails being directed inwards. Primitive cells out of neighbouring columns now intercalated themselves between the wall of the canal and the spermatozoa, pushing the latter towards the middle. By the development of the mother- and daughter-cells the spermatozoa were pressed and discharged into the central canal. The process thus described then began anew.

Dr. Biondi examined this structure of the seminiferous canals, and development of the spermatozoids in the bull, the swine, the cat, the rabbit, the guinea-pig, the rat, and other mammalia; and in all these cases he had found the same results.

**Wandering Cells in Epithelium.***—The presence of wandering leucocytes in epithelium, shown by Stöhr to be normal in the case of the follicular glands and tonsils, and also observed by Bockendahl in the trachea, has been noted by Dr. J. H. List in three instances where it is apparently constant and normal. (1) In the epithelium of the barbules and upper lip of *Cobitis fossilis* he observed the abundant occurrence of leucocytes in all the layers from the connective tissue of the corium outwards, even to the surface. They lay sometimes in numbers in small dilated cavities, but were found usually between the epithelial cells, and the thin extended nucleus observed in many of them would seem to be the result of the migration outwards between the cells. (2) In the epithelial layers of the ordinary epidermis of *Cobitis fossilis* the leucocytes occurred abundantly between the epithelial cells or between them and the frequent club-shaped cells. (3) In the cloacal epithelium of Elasmobranchs (*Torpedo marmorata*, *Raja miraletus*, *Squatina vulgaris*, &c.) List observed the migratory corpuscles from the mucosa, where they were heaped up, through the

* Arch. f. Mikr. Anat., xxv. (1885) pp. 264–8 (1 pl.).

lower epithelial layers, where they were most abundant, even to the surface, where they seem to form mucous corpuscles. In shape, both of leucocyte and nucleus, there was evidence of the influence of the pressure to which they were subjected in their migration between the epithelial cells, and the quaint shapes of the nuclei may possibly, he suggests, in some cases betoken direct division.

**Comparative Histochemical Observations on Glycogen.***—Dr. D. Barfurth believes that the origination of glycogen from breaking-down albuminoids or from still more complicated substances is rendered probable not only by the feeding experiments of various physiologists, but also by the following facts:—

1. Glycogen is found in all classes of animals and in all kinds of tissues; this shows that it is a normal product of the metabolism of the cell.

2. It is widely distributed and largely stored up in fœtal tissues.

3. Hairs of a tuft may differ in size and growth, and those that are best grown are richest in glycogen.

4 & 5. The presence of glycogen in cartilage and in secreting glands is animadverted on.

6. It appears to have some relation to muscular force.

## B. INVERTEBRATA.

**Phosphorescence of Marine Animals.**†—Prof. W. C. M'Intosh deals with this subject in his address to the Section of Biology of the British Association, and gives an historical and descriptive summary of the various animals in which phosphorescence occurs, followed by some general remarks.

The causation of phosphorescence is complex. In one group it is due to the production of a substance which can be left behind as a luminous trail, clearly pointing to other causes than nervous agency; in certain Annelids, on the other hand, it is purely a nervous action, probably resembling that which gives rise to heat.

As to the purposes of this provision, which by some has been connected with the special economy of the deep sea, it is to be noted that phosphorescent animals do not appear to be more abundant in the depths of the sea than between tide-marks or on the surface, the latter perhaps presenting the maximum development of those exhibiting this phenomenon. Very many of the young that have been indicated as so brilliantly luminous become surface-forms soon after leaving the egg, and thus at their several stages more or less affect the three regions of surface, mid-water, and bottom.

A survey of the life-histories of the several phosphorescent groups affords at present no reliable data for the foundation of a theory as to the functions of luminosity, especially in relation to food. No phosphorescent form is more generally devoured by fishes and other animals than that which is not, and, on the other hand, the possessor

* Arch. f. Mikr. Anat., xxv. (1885) pp. 261–404 (4 pls.).

† Nature, xxxii. (1885) pp. 476–81.

of luminosity, if otherwise palatable, does not seem to escape capture. An examination of the stomachs of fishes makes this clear, except perhaps in the case of the herring, which, however, is chiefly a surface fish. Further, it is not evident that such animals are luminous at all times, for it is only under stimulation that many exhibit the phenomenon.

Moreover, the irregularity of its occurrence in animals possessing the same structure and habits in every respect strengthens the view just expressed. Thus, while *Pholas dactylus* has been known from the days of Pliny to be luminous, the common *Pholas crispata* is not so endowed. Two Annelids abound between tide-marks (*Harmothoë imbricata* and *Polynoë floccosa*), and closely resemble each other in habits and appearance; yet one is brightly luminous, while the other shows no trace. Instead of luring animals for prey, or affording facilities for being easily preyed upon, the possessors of phosphorescence in the Annelids are often the inhabitants of tubes, or are commensalistic on star-fishes. Indeed, every variety of condition accompanies the presence of phosphorescence in the several groups, so that the greatest care is necessary in making deductions, especially if these are to have a wide application.

**"Latent period" of unstriped Muscle in Invertebrates.***—By a series of experiments on a large number of animals, M. H. de Varigny has shown that a very short "latent period" is not uncommon. The length of the period varies (1) with the intensity of the current, (2) with the mode of excitation, neural, direct, or ganglionic, (3) with the weight lifted by the muscle, and (4) with a number of conditions of temperature, degree of fatigue, lapse of time since isolation, &c., which are familiarly known to affect the length of the "latent period" of striped muscle. In the more perfect unstriped muscle of the higher groups, e. g. Cephalopoda, the length of the "latent period" is shorter, the duration of contraction also decreases, and the number of excitations required to produce tetanus is of course greater. His interesting research goes to show that there are among the invertebrates unstriped muscles, comparable to the unstriped muscles of vertebrate intestine, stomach, lung, ureter, &c., in length of "latent period," "duration of contraction," and production of tetanus; and further that in Cephalopoda and Vermes there are unstriped muscles similarly comparable to vertebrate striped muscle. All degrees of efficiency may be observed in the invertebrate unstriped muscle from the very lowest to an equality with striped muscle, so that to explain the physiological differences between them, as due to their diverse histological structure, is inadmissible, simply because the former may altogether disappear.

**Symbiosis of Worms and Sea-Anemones.**†—Mr. W. A. Haswell last year described a new and remarkable species of *Phoronis* which inhabited channels in the substance of a wide tube about 6 in. long, formed of felted threads, and having a smooth interior, the heads of

* Comptes Rendus, ci. (1885) pp. 570–2.

† Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 1019–21.

the Gephyreans projecting externally. The tube when first discovered was quite empty, and the object of it was unexplained. Recently, however, it has been found that the inhabitant of the cavity of the tube in the substance of which the *Phoronis* grows is a large sea-anemone, of the genus *Cerianthus*. The tube in which the anemone dwells is not formed by it alone, but partly by the *Phoronis*, as is proved by an examination of the texture of the tube.

We have thus a very remarkable instance of mutual co-operation in two animals belonging to widely different classes. The advantage derived by the Gephyreans from association with one of the Actinidæ is dependent on the power of the latter of killing small organisms by its thread-cells, a plentiful supply of food being thus provided both for the anemone itself and the colony of *Phoronis*, common enemies being at the same time warded off. In return for this the *Phoronis* helps to build and to strengthen the protecting case in which the *Cerianthus* lives.

**Thompson's Bibliography of Protozoa, Sponges, Cœlenterata, Worms, and Molluscoida.***—Carus and Engelmann's 'Bibliotheca Zoologica' ends with the year 1860, since which time no attempt has been made to provide a list of the books and papers on Invertebrates, and workers have been obliged to search through the yearly volumes of the 'Zoological Record.' Prof. D'Arcy W. Thompson has therefore collected the titles of the books and papers published from 1861 to the end of 1883, relating to the above classes of Invertebrates. The book will be very useful to naturalists, and it is to be regretted that there appears to be no prospect of extending it to the remaining classes or to Vertebrates.

## Mollusca.

**Fecundation in Cephalopoda.**†—M. L. Vialleton has observed that in the female *Sepia* the spermatophores are not identical with those that are found in the male, but have the form of elongated flasks, the contents of which escape by the open necks; they are chiefly to be found in the ventral half of the buccal membrane, and especially near the two ventral lobes. A little below the top of each of these there is a pit, which is the opening of an elongated gland, formed by a longitudinal canal round which are inserted acini, filled with a whitish fluid. This fluid is composed of spermatozoa in a colourless fluid. The glands are to be regarded as copulatory pouches.

In *Loligo subulata* the author has been able to observe the spermatozoa being guided by the folds of mucous membrane and making their own way into the pouch; in *L. vulgaris*, females have been often seen, after having expelled their ova by the funnel, to retain them between their two ventral arms in front of the mouth, and it is possible that they then voluntarily fertilize them with the

* Thompson, D'A. W., 'A Bibliography of Protozoa, Sponges, Cœlenterata, and Worms, including also the Polyzoa, Brachiopoda, and Tunicata, for the years 1861–83,' viii. and 284 pp., 8vo, Cambridge, 1885.

† Comptes Rendus, ci. (1885) pp. 619–21.

spermatozoa from their copulatory pouch. Fecundation, in fact, is effected by a special adaptation of a lobe of the buccal membrane, which is nothing else than a rudimentary arm.

**Loligopsis and Allied Genera.***—Mr. W. E. Hoyle comes to the conclusion that the genus *Loligopsis* admits of no adequate diagnosis, and must therefore be used for the type species only—*L. peronii* of Lamarck. Synonymous with the generic name *Taonius* given by Steenstrup are *Desmoteuthis* of Verrill, *Procalistes* of Lankester, and *Phasmotopsis* of de Rochebrune, and in it are to be placed *T. pavo* and *T. hyperboreus* which some naturalists have assigned to *Loligopsis*. A definition of this genus, as of *Leachia*, is given in terms which will satisfy the requirements of modern zoologists.

The term "Verrill's organ" is applied to an apparatus found in all but one species of *Taonius;* it consists of two pads lying within the funnel, near its base, and a little posterior to them in the middle line there are one or two tubercles. *Loligopsis chrysophthalmos* and *L. zygæna* are two small Cephalopods of uncertain generic position, and it seems to be doubtful whether we shall ever know enough about them to give them a definite allocation.

**Distribution of Chitin.**†—Dr. C. F. W. Krukenberg has investigated the presence of chitin in the Cephalopoda, &c. In *Sepiola rondeletii*, as in *Octopus*, *Eledone*, *Sepia*, and *Loligo*, it is only present in the jaws. In *Spirula* the septa of the shell and the siphon are chitinous, while the general covering of the shell contains but little of this substance. No chitin could be found in the shell of *Argonauta*, while that of *Nautilus* contained plenty, though there was no such specialization in chemical structure of the different regions of the shell as in *Spirula*. The Brachiopoda contain abundant chitin; in *Lingula anatina*, not merely the shell but the stalk are largely composed of chitin. Among the Lamellibranchiata the shell of *Mytilus edulis* appears to contain no chitin, and indeed this order, as well as the Gastropoda, are characterized by the absence of chitin.

**New Cephalopoda.**‡—Mr. W. E. Hoyle continues his diagnosis of the new species of Cephalopods collected by the 'Challenger,' some of which are represented by one example only, and have not always been completely dissected. The two new genera *Promachoteuthis* and *Histiopsis* have been already indicated in the 'Narrative' of the 'Challenger' Expedition; there is a new subgenus of *Sepia*—*Metasepia*.

**Anatomy of Dentalium.**§—Prof. H. de Lacaze-Duthiers referring to Prof. Fol's inability to find the efferent canal for the genital products which the former had described, describes the method of preparation by which this canal, which is very difficult to detect, can be made out. He fully understands that the apparatus is one which may be very easily overlooked. Prof. Fol had employed the method of sections,

* Proc. R. Phys. Soc. Edin., 1885, pp. 313–33.
† Zool. Anzeig., viii. (1885) pp. 412–5.
‡ Ann. and Mag. Nat. Hist., xvi. (1885) pp. 181–203
§ Comptes Rendus, ci. (1885) pp. 296–300.

"Is it, therefore, necessary to admit that that which a section does not show does not exist? is this not exaggeration? for often, very often, it is very difficult, if not impossible, to light on certain special points of an organ which one is cutting, and consequently to see arrangements which may escape the razor, but which do not the less exist."

Prof. de Lacaze-Duthiers justifies the term of Solenoconchs which he has proposed for the group of which *Dentalium* is the representative, and objects to those of Scaphopoda and Cirribranchiata which are based on erroneous views.

**Anatomy of Fissurella.***—M. L. Boutan communicates the results of an anatomical investigation of the alimentary canal, the organ of Bojanus, and the reproductive organs of this Gastropod.

(*a*) *The alimentary canal* agrees with that of *Haliotis* in having an anterior mouth with two "jaws" and a radula, an œsophagus with voluminous lateral diverticula, a stomach with three distinct regions, a lining of cilia throughout, except on the stomach walls, and a rectum traversing the heart and opening on the dorsal surface between the gills. There are, however, only two radular cartilages instead of four, the two first œsophageal diverticula are absent, and the other two, which were always empty and provided with well-developed double valves and with internal ramified glands of great delicacy, seem to be purely digestive in function, and incapable of affording lodgment for the food. The anus lies on the median line on a level with the opening of the organ of Bojanus; the liver has two lobes united on the ventral surface of the stomach and discharges its products by several orifices into the first stomachic region; the salivary glands are arborescent tubes, and there are two other organs in the mouth also with ciliated cells and probably representing an anterior pair of salivary glands.

(*b*) *The organ of Bojanus* is median in position, with a larger right lobe. Anteriorly and dorsally it adheres to the floor of the branchial cavity and extends almost to the œsophageal diverticula. In its median portion it divides into two lobes, following the contour of the pericardium, covering the dorsal surface of the liver, while its inferior right portion extends to the level of the genital gland. It opens along with the generative organs to the right of the anus. A single layer of large cubical cells, with very large nuclei and with yellowish granules, lines the various cavities of the gland.

(*c*) *The reproductive organs.*—The crescentic sac of the ovary lies inferiorly, with a superior surface intimately embracing the liver, and resting laterally on the foot and epipodium. The essential portion consists of stalked cells, each forming an ovum, and originating on the wall of the gland not in contact with the liver. From the right side of the ovary a loose delicate duct leads to the common excretory and generative aperture. On the wall of this oviduct a whitish albumen gland with large ciliated cells is readily distinguished. In the mature state the two sides of the ovary have increased greatly in size, ascending each side of the body, compressing the liver and ali-

* Comptes Rendus, ci. (1885) pp. 388–91

mentary canal, and reaching up to the level of the œsophagus. The male organs exhibit the same plan.

(*d*) *The ova* are small and black, issuing at the anterior end of the branchial cavity, and deposited (in *Fiss. reticulata* at least) by aid of undulatory movements of the foot, in a single layer on flat stones, &c., to which the enveloping glairy substance causes them to adhere. There is no copulation, the spermatozoa issue in whitish jets from the apical aperture, and the ova are fertilized after they are laid. An account of their development is reserved.

**Respiration of Truncatella.***—In order to settle the disputed question of the mode of respiration in this minute mollusc, M. A. Vayssière examined a number of specimens of *Truncatella truncatula*, and discovered a distinct gill with twelve to fifteen triangular ciliated lamellæ, lying attached to the roof of a dorsal respiratory cavity. The gill lies transversely to the longitudinal body-axis, the lamellæ admit of separate movement, and as the water stored within the respiratory sac can only evaporate slightly in the moist environment of *Truncatella*, the animal may remain for a considerable time without renewing its supply. M. Vayssière has also investigated the complete anatomy of this mollusc, of which the largest specimens hardly attain the size of 4 mm., but his research has not discovered any notable peculiarity of organization.

**Spawning of Fulgur perversus.†**—Mr. J. Willcox describes the spawning of *Fulgur perversus*, which takes place in the month of March. When the mollusc is about to spawn, it first descends into the sand deeply, and attaches the egg-case to a bivalve shell. As the process of extrusion permits, it ascends until its siphon reaches the surface of the sand. In this position it remains until the spawning is complete. During the process of formation the egg-case is forced upward, appearing in the form of a loop above the sand, though no portion of the parent is then visible. When completed, one end of the string of egg-cases floats freely in the water. As only four or five of the egg-cells are found in the body of the parent at one time, in the process of formation, it is presumed that the whole series of cases requires a long time in its development.

**Glycogen in "Vesicular Cells" of Molluscs.‡**—One of the results of Mr. E. R. Blundstone's investigation of the connective-tissue and vascular system of Mollusca is the demonstration of glycogen in those cells of the connective tissue which Lankester described as "vesicular." The connective tissue is either composed of irregular cells joined by the tips of their processes, or of still more irregular cells formed into lamellæ by being imbedded in a thin film of intercellular ectoplasm, from which, however, some ("vesicular") cells of enormous size project into the blood. In these cells as obtained from the simplest regions of the mantle of *Anodon*, or as readily observed by spreading out the "mesentery" of *Helix*, glycogen was not only extracted, but

* Comptes Rendus, ci. (1885) pp. 575–7.
† Proc. Acad. Nat. Sci. Philad., 1885, pp. 119–20.
‡ Proc. Roy. Soc., xxxviii. (1885) pp. 442–5.

was localized in the individual cells by staining with iodine solution. The vesicles are very large, round or oval cells, and it is the metaplasm, and not the protoplasm or nucleus which is stained. They are especially associated with the arteries of Molluscs, and the author maintains the probability of their wide Invertebrate distribution.

As to their theoretic import, Mr. Blundstone points out (1) that if the lacunar system of molluscs is partly enterocœlous, the presence on the lacunar walls of the vesicular glycogenous cells is interesting, since glandular surfaces seem specially characteristic of ectoderm and endoderm; (2) that since the specific gravity and nutritive quality of the blood could be maintained by the discharge of the glycogenous vesicles, a great objection against water inception by molluscs is removed; (3) that here one of the characteristic functions of the vertebrate liver is readily discharged by widely distributed individual cells.

## Molluscoida.

### a. Tunicata.

**Eggs of Ascidians.***—M. A. Sabatier finds that the ovary of Ascidians is primitively composed of an agglomeration of mesodermal nuclei united by a small quantity of clear intermediate substance; it has, therefore, the constitution and characters of an embryonic connective tissue in which the "protoplasmic atmospheres" are not distinctly limited. In adults this structure is found in those portions of the ovary in which there is a fresh formation of ova. The ova arise from corpuscles of this embryonic connective tissue; and these, in which are developed one or two granulations which become nucleoli, form the nuclei of the ova. Around the nucleus a transparent colourless layer of protoplasm becomes set, and the egg is completed. Around the egg there is formed a very delicate primary membrane which appears to belong to the intermediate substance of the connective tissue of the ovary; it forms the amorphous capsular membrane. Below this membrane, and on the surface of the yolk, there appear follicular elements which become the follicular cells. They are not of foreign origin, but are formed in the yolk itself and eliminated by it; they become individual cells by each acquiring nucleus, granulations, and limiting membrane; as they multiply they form a continuous layer round the egg; they may remain stationary or grow considerably, when they project from the surface of the egg. Below them, and at their expense, a second membrane is formed; this subcapsular membrane becomes more or less thick; in some cases the follicular cells remain flattened, become hardened, and so form a thick structureless envelope. The so-called testa-cells, or granular cells, represent an eliminated element; they are imperfectly developed, and may be called celluloid globules. The intravitelline corpuscles are masses of clear finely granular protoplasm which are formed by concentration within the yolk, and, by passing towards the surface, are at first follicular and afterwards granular cells.

* Mem. Acad. Sci. Montpellier, x. (1885) pp. 429–80 (4 pls.).

## Arthropoda.

### *a.* Insecta.

**Influence of Magnetism upon Insect Development.***—Mr. J. W. Slater in view of the experiments † showing that the eggs of fowls are not normally developed if subjected to magnetic currents during incubation, tried the effect of magnetic action upon the development of caterpillars. Having found six caterpillars of the common large cabbage white, all evidently of the same brood, three of them were put in a box, 5 in. in length, between the opposite poles of two bar-magnets. The other three were placed in a similar box at such a distance that they could not be affected by the magnets. Both boxes were placed under exactly identical conditions as regards light, heat, and supply of food. Two of those between the magnets shrivelled up and died without passing into the pupa-state. Thinking they might have been attacked by some parasite, the author removed them into another box and kept them for some time. As no ichneumons or other parasites made their appearance he dissected the bodies carefully under the Microscope, and found no traces of parasitic injury.

The remaining caterpillar, and all the three which were not exposed to the magnets, became pupæ in due course and came out in May. The non-magnetized ones were perfectly normal and healthy, and when released after examination flew away; but the survivor of the magnetized set was a cripple. It had merely rudimentary stumps in place of antennæ, the wings on the left side were expanded, and the legs on the same side were smaller than those on the right side.

**Flight of Insects.**‡—Dr. R. v. Lendenfeld some years ago opposed § the theory of Marey that the changes in the shape of the wing during flight were caused by the mechanical action of the resisting air without any muscular action of the insect itself coming into play. This view having been recently contested by some physiologists, the author has made some observations which are well adapted, he thinks, to prove the fallacy of the mechanical theory.

When at rest the wings of Diptera are more or less askew. When a fly is immersed in turpentine it is immediately made insensible, and lies motionless. Tetanic movements, after a short time, cause slight movements of the legs; and then the wings, although remaining in the same position relative to the body, turn their face round in such a manner that they firstly become quite flat and then askew in the opposite direction to the original position. This movement is slow, and can easily be observed. When the fly is dead the wings collapse again, and return to their ordinary shape.

The same movement for which a mechanical action of the resistance of the air is considered the sole cause, is here executed in a manner which precludes the possibility of such a cause.

* Trans. Entomol. Soc. Lond., 1885.—Proc., p. xv.
† See this Journal, iv. (1884) p. 861.
‡ Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 986–7.
§ See this Journal, ii. (1882) p. 184.

**Foot-glands of Insects.***—In a careful research Herr J. Dahl discusses the interesting problem of the climbing of insects on smooth surfaces, and reports the varied arrangement of foot-glands, hairs, &c., in different groups. Among beetles (e. g. *Saperda*) the attaching hairs are seen to be but slightly modified chitinous hairs expanded at the lower end. Interiorly the hollow hair-tube is filled with a very spongy chitinous mass, which is limited at the expanded end by an extremely fine membrane. The upper surface of the terminal expansion is very generally beset with small hairs or warts, and the occurrence of a single wart is apt to be mistaken for an opening. Even the much modified sexual suckers of male *Carabidæ*, *Dytiscidæ*, &c., are shown by transitional series and even by the minute homologies of their structure to be nothing more than ordinary chitinous hairs, variously modified and strengthened by the occurrence of internal rods and external folds or knobs.

In connection with the attaching hairs there are marked cells productive of a secretion different from the blood; these cells form the foot-glands. Between each hair and the gland which supplies it, there runs a canal which enlarges slightly just at the root of the hair and divides into as many (2–4) branches as there are supplying cells. Besides the cells furnishing the attaching secretion of the hairs, there are in the *Coleoptera* abundant skin-glands present all over the body as well as on the feet. They are probably analogous to sebaceous glands, and unlike the former open directly to the exterior between the hairs. The attaching glands originate from connective tissue cells with the exception of the copulatory suckers of some *Coleoptera*, which seem to arise from the matrix. Besides the (1) glands or foot-glands proper and the (2) skin-glands, a third kind of glandular cell is frequently present, e. g. in *Feronia*. These occur towards the upper surface of the foot imbedded in the matrix, and have no canal.

In the other orders of insects the foot-glands are all formed from the modified matrix. The whole of the modified portion forms to a certain extent a single gland instead of each cell acting independently. In the *Orthoptera* the gland lies on the sole of the foot, which thus acts as attaching organ; in the *Diptera* it lies in two special attaching lappets; in the *Hymenoptera* and *Lepidoptera* it lies above the claw-bending sinew in the last joint of the foot, while the attaching organ has the form of a lappet between the claws.

As regards the actual physical process, Dahl maintains (1) that an adhesive fluid is exuded from the glands; (2) that this is different from the blood, containing probably a larger proportion of fatty stuff; (3) that the attaching hairs have delicate, soft-skinned ends; (4) that the quantity of fluid between the end of the hair and the smooth surface to be climbed on is generally very slight; (5) that while there is also adhesion and cohesion the chief process may be best described as capillary attraction.

**Morphology of the Mouth-organs of Hymenoptera.**†—M. J. Chatin comes to the conclusion that, even if the gnathites of the

* Arch. f. Mikr. Anat., xxv. (1885) pp. 236–63 (2 pls.).
† Comptes Rendus, ci. (1885) pp. 259–61.

Hymenoptera sometimes differ very markedly from those of other mandibulate insects, there are many points of close affinity. The changes undergone by the organ ought to be principally regarded as due to the more and more close union which is to be observed between the galea and the intermaxillary.

**Homing Faculty of Hymenoptera.**—Sir J. Lubbock, in an article* on the habits of ants, bees, and wasps, discusses the question whether they find their way home merely by their knowledge of land-marks, or by means of some mysterious faculty usually termed a "sense of direction." The ordinary impression appears to be that they do so in virtue of some such sense, and are therefore independent of any special knowledge of the district in which they may be suddenly liberated; a view apparently corroborated by the experiments of M. Fabre. The conclusions drawn from these experiments, however, appear to Sir John unwarranted by the facts.

Dr. G. J. Romanes† has repeated the experiments with certain variations, and in the result is satisfied that the bees depend entirely upon their special knowledge of district or land-marks, thus fully corroborating those which were made by Sir John. Bees from a hive kept at a house some hundred yards from the coast were liberated at sea, on the shore, and on the lawn between the shore and the house, but none returned. Those liberated in different parts of the garden did return, though many of them had to fly a greater distance to reach the hive than was the case with those liberated on the lawn.

**Insects as Fertilizers.**‡—Herr E. Löw publishes the result of a long series of observations on the visits of bees and humble-bees to flowers in the botanic garden at Berlin; classifying them, according to their constancy or otherwise in the species they visit, as *monotropic*, *oligotropic*, and *polytropic*. He considers that H. Müller lays too exclusive stress on the length of the proboscis as determining the species visited by bees; several other factors also come into play.

**Unusual number of Legs in the Caterpillar of Lagoa.**§—Dr. A. S. Packard calls attention to the unusual number of legs in the caterpillar of *Lagoa*. The first abdominal segment is footless; the second bears rudimentary feet; segments three to six bear normal "prop legs"; the seventh bears a pair of rudimentary legs; segments eight and nine are footless, while the tenth bears the fully developed anal or fifth pair of genuine prop legs. While the two pairs of rudimentary legs, which form soft tubercles, differ from the normal legs in being much smaller and without a crown of curved spines, they are protruded and actively engaged in locomotion, and in situation as well as the presence of basal tufts are truly homologous with the normal abdominal legs.

In the embryo of *Sphinx* there are ten abdominal legs, of which one-half disappear before hatching, leaving the five pairs usually

* Contemporary Review, 1885, November, 14 pp.

† Nature, xxxii. (1885) p. 630.

‡ Jahrb. K. Bot. Gart. Berlin, iii. (1884). See Journal of Science, vii. (1885) p. 543.

§ Amer. Naturalist, xix. (1885) pp. 714–5 (1 fig.).

present, and it seems that the two pairs of rudimentary legs in *Lagoa* are survivals of these embryonic temporary feet. Although the prop legs are not popularly regarded as true legs, they are undoubtedly so, as embryology proves. In the lower Noctuidæ, such as *Catocala*, *Aletia*, &c., the larvæ are at first geometriform, having but three pairs of prop legs; in the Geometrids there are but two pairs, while in the Cochlidiæ there are not even any rudimentary feet, thoracic or abdominal. The primitive lepidopterous larva must have had a pair of feet on each abdominal segment, and may have descended from Neuroptera-like forms allied to the Panopidæ as well as Trichoptera.

**Orientation of the Embryo and Formation of the Cocoon of Periplaneta orientalis.***—M. P. Hallez understands by the "orientation of the embryo" the exact determination of the relations which exist between the organic axis of the egg, the principal axis of the embryo, and that of the maternal organism. He finds that the egg falls into the genital armature with its caudal pole inferior; this pole is that which is opposite to the line of dehiscence in the cocoon. From this it follows that the organic axis of the egg is the same as the principal axis of the embryo, and that it has the same orientation as the mother, for its anterior pole corresponds to the head of the embryo, and the opposite pole to its caudal extremity. The author thinks that we may agree to his general conclusion that every histological element possesses the two polarities of the animal, polarities which would persist in the egg-cell after it has ceased to be part of the maternal tissues.

**Physiology of the Alimentary Canal of Blatta periplaneta.†**—Dr. A. B. Griffiths finds that the secretion of the salivary glands is alkaline to test-paper, and has the power of transforming starch into dextrose sugar but has not the power of dissolving albumen. Further, the secretion gave indications of sulphocyanates and calcium, showing that it resembles to a certain extent that of the salivary glands of the Vertebrata.

The secretion of the chylific ventriculus is slightly acid, due to the presence of hydrochloric acid. It also contains a substance which has the power of dissolving albuminous substances, such as white of egg, casein, fibrin, &c., producing turbid solutions which are like the peptones produced by the secretions of the stomachs of the higher animals. This substance, from its various reactions, is similar to pepsin. The investigation proves that the chilific ventriculus is a true stomach.

The secretions of the Malpighian glands contain uric acid and urea, as crystals of both substances were extracted from the glands, as from *Astacus* and *Anodonta*.

**Uses and Construction of the Gizzard of Larvæ of Corethra plumicornis.‡**—Mr. T. B. Rossiter describes the structure of the anterior part of the enteric tract of the larvæ of *Corethra plumicornis*,

* Comptes Rendus, ci. (1885) pp. 444–6.
† Chemical News, lii. (1885) p. 195. ‡ Paper read 14th Oct. 1885.

and compares his accounts with those of Leydig and Weismann, which he partly criticizes. He denies that the larva inverts its pharynx, and cites experiments in defence of his view; he finds the brush-like processes of the pharynx to be of use in cleansing the oral orifice from undigested food. He makes some additions to Weismann's account of the anatomy of the stomach in describing the leaflets, which are covered internally with minute spicules; the action of these organs remains to be detected; like the gizzard, they disappear during the change from the larval to the pupal stage.

**Structure of the Wings of Vesicating Insects.***—M. Beauregard remarks that vesicating insects present a remarkable softness of the elytra and of the integument in general. The explanation of this fact is not to be found in the chemical but in the histological characters of the wings. Between the two layers, which are connected at their edges by chitin, there is a somewhat considerable space, and the two layers are connected by chitinous pillars, which are thin and delicate, and merely form supports, whereas in other insects the chitinous layers are thick, the pillars large and numerous, and the spaces almost nil.

**Larvæ and Larva-cases of some Australian Aphrophoridæ.†**—Mr. F. Ratte describes the larval state of some small species of Rhynchota, belonging to the genus *Ptyelus*, nearly allied to *Aphrophora*. An examination of their larva-cases and of some of the larvæ discloses a feature probably quite new.

The cases of these insects, unlike those of insects generally, are true shells, containing at least three-fourths of carbonate of lime, some being helicoidal and others conical, resembling some fossil and recent *Serpulæ*. The conical shells are fixed on the branches (generally a little above the insertion of a leaf) of some species of *Eucalyptus*, the opening turned upwards and the larva being placed in it with the head downwards. In the helicoidal shells the insect lies horizontally for the greater part of its larval life. In both instances it follows that the larva instead of presenting its head at the entrance of its shell, like a mollusc, presents its hind region. It introduces its suctorial apparatus into the bark of the stem and sucks the sap. For this purpose the shell is provided with a longitudinal slit. It emits from time to time by its anus a drop of clear water at the entrance of the shell. The lime which enters into the composition of the shell is evidently provided from the sap of the tree.

### δ. Arachnida.

**Muscular and Endoskeletal Systems of Limulus and Scorpio.‡**—Prof. E. Ray Lankester, with the assistance of Mr. W. B. S. Benham and Miss E. J. Beck, has another contribution to our knowledge of *Limulus*, especially as compared with *Scorpio*. It was to be expected

* Journ. Soc. Scientifique, i. (1885) p. 209.
† Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 1164-9 (2 pls.).
‡ Trans. Zool. Soc. Lond., xi. (1885) pp. 311-84 (12 pls.).

that the muscles of the appendages of the mesosoma, which are large in *Limulus*, would be almost or altogether suppressed in *Scorpio*. The most remarkable agreements are to be found in the large number of muscles attached to the prosomatic entochondrite, in certain of the muscles attached to the pectines in *Scorpio* and the first gill-bearing appendages of *Limulus*, and in the muscles arising from the pericardium and inserted into the investment of the great venous sac, which in the one case lies at the base of a gill-book, and in the other case forms the investment of the in-sunken lung-book.

In a comparison of these two forms it is to be recollected that in both cases we have to do with highly specialized conditions; the common features of the less modified ancestor are sketched, and the lines of development pointed out; some of the muscles must be looked upon as new developments in *Limulus*, where they appear to be more largely represented than in *Scorpio;* in the former there has been a peculiar consolidation of the merosomatic region and the combination of natatory with branchial functions in its appendages; in the scorpion development and modification are most apparent in the limbs of the prosoma.

In conclusion, Prof. Lankester has some observations on those characters of the group which are useful in classification; here account must be taken not only of Peter's characters—form of the sternum and dentition of the cheliceræ—but also of the disposition of the segmental ganglia with their great nerves, and the sculpturing of the lamellæ of the lung-books. The class Arachnida is regarded as consisting of two grades: A. *Delobranchia* (*Limulus* and Eurypterines), and B. *Embolobranchia* (Orders 1. Scorpionidea; 2. Pedipalpi; 3. Araneidea). The Scorpionidea consist of a single family, divisible into the Scorpionini and Androctonini. Fifteen points are mentioned which are regarded as of importance in the systematic descriptions of these arthropods.

**Sense-organ of Spiders.** — Prof. W. Schimkewitsch describes* briefly a sense-organ on the limbs of certain spiders, which was first noticed by Dahl. These structures are found on most of the joints of the limbs both in males and females; they consist of a thin chitinous plate with a thick border, the opposite sides of which are connected by parallel thickenings. A transverse section shows round these organs a layer of remarkably tall pigmented cells, between these are ganglion cells with prolongations directed towards the chitinous layer. These organs appear to be comparable to the "chordotonal organs" of insects described by Graber.

Dr. P. Bertkau claims priority† in the discovery of the sensory organs on the limbs of spiders referred to by Schimkewitsch. A brief recapitulation of his results is given.

**Seasonal Dimorphism in Spiders.**—Dr. P. Bertkau states‡ that it is not a new discovery of Dahl's that *Meta segmentata* and *M. mengei* are two broods of the same species,§ but it has been known and recorded

* Zool. Anzeig., viii. (1885) pp. 264–6.
† Ibid., pp. 537–8.
‡ Ibid., pp. 459–64.
§ See this Journal, *ante*, p. 830.

by several observers. Dahl also pointed out that *Micrommata virescens* and *M. ornata* are dimorphic varieties of the same species; the fact that both species are sexually mature at the same time, and that specimens of each, the same age in both species, have been found at the same time at once negatives this view.

Dr. F. Karsch calls attention * to the writings of O. Herman, who has stated, and has priority in the statement, that *Meta segmentata* has two generations; other species are mentioned by the same writer which have two generations, without, however, exhibiting a marked seasonal dimorphism; some of them are *Epeira umbratica*, *Cyrtophora conica*, *Tetragnatha extensa*. *Micrommata ornata* is, on the contrary, stated by Herman to be undoubtedly the young male of *M. virescens*.

**Australian Pycnogonida.**†—Mr. W. A. Haswell describes one new genus (*Nymphopsis*) and eight new species of Australian Pycnogonida, bringing up the list to eighteen species.

### ε. Crustacea.

**Alimentary Canal of Crustacea.**‡ – Herr J. Frenzel reviews in a lengthy memoir the histological structure of the alimentary canal of Crustacea, and especially of the mid- and hind-gut, which have not yet been studied in such detail as the other portions. He discusses the general anatomy of the tract, noting the extreme shortness of the mid-gut with its two associated glands, the large double liver with two ducts, and the much smaller variously-shaped diverticula, which open somewhat dorsally just where the hind-gut begins. A section of the hind-gut reveals a number (six or so) of thick bands, which run spirally within, narrowing the lumen of the gut. A cross section of the hind-gut exhibits from within outwards (1) a chitinous cuticle, (2) the epithelial layer of the matrix or hypodermis, with cylindrical cells, (3) interspersed sinewy strands, probably of connective tissue origin, and in association with (4) muscle-bands, some of which run obliquely, and are not therefore seen continuously in a single section, while others sometimes occur running longitudinally; (5) glandular structures; (6) abundant fibro-cellular connective tissue, usually with lacunæ containing blood; (7) a sheath of circular muscles; and (8) an external layer of connective tissue, firmer and more fibrous than the internal one, and penetrated by vessels which supply the lacunæ of the former.

The ridges do not extend into the mid-gut, though the transition is not abrupt. A cross section of the mid-gut exhibits (1) the cylindrical epithelium, of endodermic origin, with a covering of small bristles; (2) a thick, strongly refracting, double-contoured membrane, the basement membrane, or *tunica propria;* (3) a circular muscle-sheath of several layers, not well developed, or even absent on the appendages of the mid-gut; (4) a connective tissue layer, sometimes exclusively fibrous. The details of the complicated passage

* Zool. Anzeig., viii. (1885) pp. 532–3.
† Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 1021–34 (4 pls.).
‡ Arch. f. Mikr. Anat., xxv. (1885) pp. 137–90 (2 pls.).

from mid-gut to fore-gut, where the epithelium of the former is replaced by a chitinous coat, and other changes occur, do not admit of summary, while the structure of the fore-gut has been thoroughly studied by previous investigators.

Frenzel proceeds to review the various tissues—connective, muscular, and epithelial.

1. *The connective tissue.* Since the chitin serves to a large extent the same function as is elsewhere discharged by connective tissue, the development of the latter in the Crustacea is relatively small, and its character as supporting tissue is not well marked. Frenzel distinguishes three kinds: (*a*) *fibro-cellular*, where from the cells fibres originate, becoming more or less predominant, remaining loosely connected or girt together into a firm network, with interspaces or blood-lacunæ; (*b*) *fibrous*, where the lacunæ have disappeared and the fibres, which alone remain, have been drawn close to one another; (*c*) *membranous or elastic*, forming a completely closed membrane, probably permeable only by fluids.

2. *The muscular tissue*, of cross-striped fibrils, is in no way peculiar.

3. *The epithelial tissue.* (*a*) *The intestinal* (*salivary*) *glands* of the fore- and hind-gut, which were discovered by Braun, resemble ordinary salivary glands both in structure and secretion. A number of cells form a round acinus with a central canal. The cells are sometimes markedly more granular towards the lumen, and the nucleus lies always at the broad basal end.

(*b*) *The hypodermis* (matrix, chitinogenous membrane). This epithelium, which secretes the chitin, is noteworthy on account of its extreme variability, exhibiting sometimes most beautiful cylindrical cells, and in other species a hardly recognizable cellular character. The cells never exhibit any contents which could be regarded as absorbed food, so that the theory of their possible efficiency in this direction does not seem to receive corroboration.

(*c*) *The epithelium of the mid-gut* consists of well-developed cylindrical cells, whose regularity is disturbed only by the occurrence of small villi, &c., and by mutual compression. The cells are markedly granular, sometimes extremely fine at the top, but decreasingly so in the middle and lower third of the cell, and becoming very coarse at the base under the nucleus. The very varied shapes and the frequently enormous size of the nuclei are remarkable. The cell-border is in some cases resolvable into rows of small bristle-like rods, expanded at their bases, and uniting so as to form a membrane.

From this detailed histological investigation Frenzel goes on to discuss the problem of *the regeneration of the epithelial cells of the mid-gut.* Though the secretion of digestive fluid in the mid-gut has been mainly transferred to the liver, there are epithelial mid-gut cells which yield up their whole mass as a secretion, and are in turn replaced by others. The simplest mode of replacement is exhibited when one of the small cells lying next the *tunica propria* simply divides; sometimes, however, the cells grow up first for some distance among the epithelial cells and then divide, but frequently the division

of the nucleus is so unequal that it is difficult to know whether to call it "direct" nuclear division or nuclear budding. The apparent absence of marked changes in the nuclear structure leads Frenzel to regard it as direct.

In a brief physiological review he notes that since the function of the mid-gut gland is rather pancreatic than hepatic, the name of liver is too definite. He disputes the probability of the absorption of food taking place altogether within the short mid-gut, and, though positive facts are not in his favour, thinks it probable that this is also effected by the fore- and hind-gut.

**Development of Atyephira compressa.***—Mr. Chiyomatsu Ishikawa has investigated the development of this fresh-water Macrurous Crustacean, which is abundant near Tokio.

The female generative organ has the form of two elongated sacs, the ducts of which arise at about the middle of their length, and open to the exterior on the internal face of the basal joint of the third thoracic leg. It is possible to distinguish in the ovary a germogen, which has the form of a narrow transparent band, from a vitellogen in which the yolk-elements are firmest. The wall of the tube consists of two sets of layers, more or less separated from each other; blood passes into these spaces and into the vitellogen, but no trace is to be found in the germogen. The distribution of the blood-vessels has been made out in the ovary of *Panulirus*.

The youngest eggs are perfectly transparent, and measure about 0·01 mm. in diameter: all, or at any rate the majority of cells in the pouch are destined to become eggs. The germinal vesicle is at first more than one-half, but later it comes to be only one-fifth of the diameter of the egg; it never has more than three germinal dots.

When the eggs are 1 mm. in diameter they pass into the vitellogen to be charged with nutritive elements, and here they grow very rapidly and take on a dark-green colour. The deposition of yolk takes place endogenously. The protoplasm of the egg collects at two points, one around the nucleus and the other at the periphery; the former spreads out like rays towards the latter and unites with it. The germinal vesicle disappears rapidly when the egg attains a certain size. There are two covering membranes, one formed by the hardening of the peripheral protoplasm of the egg, and the other by the epithelial cells of the oviduct. The freshly laid egg has no nucleus and is therefore a cytod.

After describing the mode of oviposition, the author proceeds to give an account of the process of segmentation; this begins by a slight notch on one side of the egg transverse to the long axis; it gradually elongates in both directions until the egg is divided into two equal parts. The two halves next approach one another; after three or four hours the line becomes again uppermost, and immediately a second line, at right angles to it, divides the egg into four equal parts. When there are 256 segments, the segments at one pole

* Quart. Journ. Micr. Sci., xxv. (1885) pp. 391–428 (4 pls.).

divide faster than the rest, and that area becomes a little depressed. When the cells multiply most rapidly, invagination occurs, and a gastrula is formed, the cavity of which soon becomes comparatively deep. Later on, the blastopore closes; somewhat in front of it, a fresh invagination gives rise to the permanent anus. On the opposite side we get the first indications of the cephalic lobes which gradually travel upwards (or, morphologically, backwards). The order of formation of the parts of the embryo is — abdomen, mandible, cephalic lobes, carapace, antennæ.

The stomodœum is, like the proctodœum, a formation apparently independent of the blastopore, and is at first a narrow blind tube; later on, other appendages appear; the heart seems to be mesodermic in origin.

The embryo, when just hatched, measures about $3\frac{1}{4}$ mm. in length; the broad carapace is produced anteriorly into a rostrum, at the base of which is the simple eye; the compound eyes are large, and supported on very short stalks, the telson is still united with the last segment. Four pairs of thoracic appendages are already formed, but no trace of abdominal appendages is to be detected. In its later changes the embryo agrees largely with *Palæmonites*, as described by Faxon.

**Sense-organs of Calanidæ.***—Dr. O. E. Imhof has some notes upon the antennary olfactory organs of the genera *Heterocope* and *Diaptomus*.

These appear to have been discovered in *Heterocope* by Gruber; in *Diaptomus* they exist in all the species examined, and have a characteristic distribution which is the same in all the species, and may, perhaps, serve as additional definition of the genus. The form of the organs in *Diaptomus* is a little less complicated than in *Heterocope;* they resemble very closely the corresponding organs of *Pontella* described by Claus.

**Polymorphism in the Amphipoda.†**—Mr. C. Chilton states that the Amphipod *Microdeuteropus maculatus* of Thomson, which is the same as *Aora typica* of Kröyer, has three forms of the male and only one of the female. The males all differ from the female in having the meros of the first gnathopod produced into a long spine reaching to the end of the carpus; in the first form of male (*Aora typica* K.) the carpus is longer but no broader than the propodos, and the basos has a tooth projecting forwards on the anterior margin; in the second (*Microdeuteropus maculatus* ♂ Chilton) the carpus is larger and broader than the propodos, and the meros has a small tuft of setæ on the posterior margin; in the third (*M. mortoni* Haswell) the carpus is longer and broader than the propodos; the meros is hollowed anteriorly, and has each lateral margin densely fringed with setæ, while the dactylos is as long as the propodos, and has two or three tufts of setæ on its concave border.

* Zool. Anzeig., viii. (1885) pp. 353-6.

† Ann. and Mag. Nat. Hist., xvi. (1885) pp. 368-76 (1 pl.).

**Australian Crustacea.**—In a revision of the Australian Læmodipoda * Mr. W. A. Haswell gives a list of ten species as being well ascertained Australian forms, and describes in full two new species of *Proto* (*P. condylata* and *P. spinosa*), as well as *Protella australis*, with notes on other species.

Mr. Haswell also gives † a revised list of the seventy known Australian species of Isopoda (including two varieties), with descriptions of new species of *Anceus*, *Paratanais*, and *Paranthura*, and of a remarkable new Sphæromid, *Bregmocerella tricornis* n. gen. and sp., having the head armed with three prominent horn-like processes, the two lateral ones being about one-fifth the length of the mesial.

In a further paper on the Australian Amphipoda ‡ Mr. Haswell deals with the genera *Talitrus*, *Allorchestes*, *Neobule*, *Aspidophoreia*, *Stegocephalus*, *Ampelisca*, *Lysianassa* and *Anonyx*, *Eusirus*, *Leucothoe*, *Atylus*, *Dexamine*, *Megamoera*, *Moera*, *Xenocheira*, *Haplocheira*, *Harmonia*, and *Cyrtophium;* several new forms are also described, including a genus allied to *Cyrtophium* (*Dexiocerella*), but distinguished by the presence of an appendage on the superior antennæ, and the multi-articulate character of the flagellum.

Mr. C. Chilton has a short paper § on some Australian Edriophthalmata, with descriptions of three new species, *Glycerina affinis*, *Moera festiva*, and *Paratanais ignotus*.

## Vermes.

**Pelagic Annelids.**‖—M. C. Viguier reports the principal results of his study of Annelid species in the Bay of Algiers. Before defining an Annelid as pelagic, it has to be noted that (1) some, such as the Heteronereidæ, and Syllidæ without alternation of generations, are surface forms only during the period of reproductive activity; that (2) others, viz. the sexual stolons of Syllidæ with alternation of generation (the Polybostricæ and Sacconereidæ), are indeed pelagic, but that the short period of their life is really the equivalent only of the reproductive period of the former; and that (3) there are others apparently true surface forms throughout their whole life. This third group contains only Alciopeæ and Phyllodoceæ, including with the latter *Tomopteris* and *Sagittella*. The list of known pelagic Phyllodoceæ M. Viguier has increased from one to six, which exhibit a beautiful gradation in the concentration of their postcephalic rings and in the disposition of their appendages. He has discovered two new Alciopes. There are some forms, such as *Ophryotrocha puerilis* and a species of *Polynoe*, about which it is difficult as yet to decide whether they are truly pelagic or whether they migrate in adult life to greater depths. He gives a catalogue of the observed species.

* Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 993–1000 (2 pls.).
† Ibid., pp. 1001–14 (4 pls.).
‡ Ibid., x. (1885) pp. 95–114 (9 pls.).
§ Ibid., ix. (1885) pp. 1035–44 (2 pls.).
‖ Comptes Rendus, ci. (1885) pp. 578–9.

**Coloration of the Anterior Segments of the Maldanidæ.***—Prof. A. Harker, while studying the circulation and respiration of Annelids at Naples, was especially interested in the Maldanidæ, from their partially tubicolous habit, and the brilliant coloration of their anterior segments. The bands of colour usually ornament the anterior segments, beginning with the second or third, and continuing to the ninth; but the distribution of the coloured bands differs widely in the different species. The colour in living or freshly killed specimens is of a rich rose-madder colour, shading off in each segment to a brighter rose-pink hue. Quatrefages attributed a physiological value to these coloured bands, describing them as being connected with the respiratory function. In connection with the whole subject of cutaneous respiration in Annelids, it appeared important to settle this question, and the author made sections of the anterior segments in the Maldanidæ, and found the colour to be due to a special pigment, whose behaviour under various reagents he described. On the other hand, the author had studied the blood-vessels and their distribution in the living Chætopod, and is satisfied that it extends equally in those portions of the cuticle which are uncoloured as in those which are. The coloured bands do not appear, therefore, to be in any way connected with the function of respiration.

**Nephridia of a new species of Earthworm.**†—Mr. F. E. Beddard describes the peculiar disposition of the "segmental organs" in a new species of earthworm belonging to Perrier's genus *Acanthodrilus*. The eight setæ of each segment form eight longitudinal rows, separated by nearly equal intervals, and with each seta a nephridium is associated. The dorsal nephridia are quite distinct, those belonging to the ventral pair of setæ adhere continuously to the intersegmental septum. A nephridium passes up close to each seta, imbedded in the surrounding loose connective tissue; the tube passes out between the longitudinal and circular muscular coat, and opens by a minute orifice readily detected by the alteration in the character of the epidermis, by the disappearance of the large, oval, glandular cells, and by the close packing and inbending of the narrow, columnar cells. The coiled tubule of the nephridium is lined by uniform rows of cells; only the extreme distal end differs from the rest in being surrounded by a flattened epithelium of very small cells and is in all probability lined by a continuation of the external cuticle. Eisig's discovery in certain *Capitellidæ* of numerous pairs of nephridia in each segment, has thus been extended to the *Oligochæta*.

The homology between nephridial and genital ducts maintained in some cases by Claparède, and applied, in spite of Claparède's denial, by Lankester to the earthworms, in regard to which he suggested that the copulatory and genital ducts were derived from a second dorsal series of nephridia which had disappeared except in the genital segments, has been criticized by Perrier though apparently corroborated by the anatomical facts revealed by his own investigation of

* Nature, xxxii. (1885) p. 564. (Paper read before the British Association.)
† Proc. Roy. Soc., xxxviii. (1885) pp. 459–64.

various genera. Supporting Lankester's position, Mr. Beddard reviews the difficulties suggested by Perrier, that nephridia and copulatory pouches occasionally coincide at the same seta, and that the vasa deferentia pass through several segments each with distinct nephridia. But Mr. Beddard extends Lankester's statement by affirming the probability, suggested by the present and other instances, that to *each* seta, and not to each *pair* of setæ, there corresponds a separate nephridium.

In regard to the question whether a quadri-serial arrangement of setæ comparable with the Polychætous parapodia, or a complete ring of setæ as in Perichæta, is the more primitive state, Beddard inclines, against Perrier, to the latter supposition. While, on the one hand, the two pairs of setæ in the earthworm certainly resemble the dorsal and ventral parapodia of a Polychæte, and while the young Perichæta have not a complete ring of setæ as in adults, he points out, that in the Urochæta the setæ, anteriorly in eight rows, are posteriorly quincuncial, and have between them small glandular bodies, which from their analogy with similar structures in the Anachæta evidently replace setæ, previously therefore more abundant, and that further since from the above results there seems to be no connection between the *pair* of setæ and the nephridium, as there is in the Polychæta between parapodium and nephridium, the resemblance is more probably adaptive than genetic, and the more generalized condition is probably the more primitive.

**Organization of Pachydrilus enchytræoides.***—M. Remy Saint-Loup describes this small Annelid, which is found abundantly on algæ at Marseilles, as having four rows of setæ, two to eight in each group; these setæ are not hooked at their ends. There are about thirty-five segments; the anus opens at the base of a funnel-shaped cavity. There is a dorsal and a ventral blood-vessel, united at either end, and there are three pairs of anastomosing canals. The œsophageal is the only differentiated portion of the digestive tract, but the hinder has a smaller number of "hepatic cells" than the median portion. The cœlom is divided into compartments by incomplete septa. The nerve-chain has the ganglia in the segments behind the first three reduced to mere swellings of the cord. In the fifth, sixth, and seventh segments there are large glands which occupy the whole of the body-cavity, and appear to be analogous to the septal glands of Véjdovsky.

**Parasite of the Rock Oyster.**†—Mr. W. A. Haswell, on examining some samples of oysters which were dying in large numbers, found that most of them, when opened, presented on the inner surface of the shell one or more discoloured blisters. In some these were of small extent with a narrow sinuous form, while in many instances a large part of the valve was affected. In some cases, where the extent of the shell invaded was not large, the oysters did not seem at all affected by it; in other cases the animal was found to be dead,

* Comptes Rendus, ci. (1885) pp. 482–5.
† Proc. Linn. Soc. N. S. Wales, x. (1885) pp. 273–5.

and in a few cases the shell was completely empty. In the interior of the blisters were found one or more specimens of a very small Annelid, by which the mischief had been effected—*Polydora ciliata*. One specimen of a second species was also obtained, *P. polybranchia* n. sp. which the author describes.

**Anatomy and Histology of Aulophorus vagus.***—Mr. J. Reighard gives an account of the structure of this American worm, the first description of which we owe to Prof. Leidy; the animals are either found single, or composed of two to four zooids joined by "bud-zones"; no other mode of reproduction than that by budding has yet been observed.

Unicellular dermal glands are found in the region of the head, and the other dermal appendages are stylets, bristles, hairs, and cilia; the muscular system consists of layers of annular and longitudinal fibres, together with special muscles for moving the bristles, the pharynx, and the supra-œsophageal ganglia. The pharynx is described as forming a highly specialized organ, used both for seizing the food and in locomotion, and also as a sucking-disc; in the œsophagus the cilia are so long as almost to fill its lumen. The "liver-cells" are lens-shaped and have a large nucleus; they contain numerous golden-brown drops in a part of the intestine.

The vascular system consists of a dorsal and ventral vessel, united by a plexus in the head, and one in the region of the pavilion, and by numerous vessels surrounding the alimentary canal. The dorsal vessel is contracted, as are the lateral branches, in the eighth, ninth, and tenth segments; when one of these vessels is distended its walls are seen to contain large, prominent nuclei, evidently belonging to the muscular elements; when contracted the walls of the vessels show longitudinal and transverse striæ. Respiration is principally effected by the pavilion, or posterior expansion, which is thickly covered with cilia, and contains numerous muscular elements; its digitiform appendages are hollow, and their cavities are continuous with the cœlom; as the walls of the intestine are richly covered by a network of blood-vessels, and bathed by a strong stream of water, they are doubtless also respiratory in function. The ventral nerve-cord has on its upper surface three giant fibres; these are, for most of their course, simple, empty tubes. The author was unable to trace a connection between the lateral lines and the œsophageal commissures, as has been done by Semper for *Nais*.

As in various other parts of its organization, so, too, in its segmental organs *Aulophorus* recalls the description of *Dero obtusa* as given by Prof. Perrier. It is possible that the cells covering part of the walls of the nephridial tubes form the basis of the tubes in which the animal lives; but it is to be borne in mind that similar cells are found in forms that are not tube-formers.

**Angiostomum.**†—Dr. O. von Linstow gives an account of the species of the genus *Angiostomum*, which appears to stand midway

* Proc. Amer. Acad., xx. (1885) pp. 88–106 (3 pls.).
† Arch. f. Naturgesch., li. (1885) pp. 1–13 (2 pls.).

between the parasitic and the free-living Nematoids, having affinities on the one hand with *Dochmius*, and on the other with *Rhabditis*.

**Gordius verrucosus.***—Prof. F. J. Bell has a short note on a specimen of this species collected by Mr. H. H. Johnston on Kilimandjaro, in which he indicates its very wide distribution, and compares it with the *Tænia* of the rhinoceroses.

**Experimental Breeding of Tænia Echinococcus.†**—Dr. J. D. Thomas reports the results of several successful experiments in which the *Echinococcus* scolices of man were bred in dogs. He discusses the specific character of the different forms of *Echinococcus*, and recapitulates the history of experimental researches on the subject, pointing out their relative indecisiveness. The careful experiments of the author on four dogs yielded successful results with three. The dogs were examined at intervals of 20, 32, and 42 days after feeding, and the *Tæniæ* found corresponded in development to the time elapsed.

**Frequent occurrence of Tænia Echinococcus in Domestic Dogs (Australia).‡**—Dr. J. D. Thomas reports the results of examinations of dogs at four places in South Australia, three of which were in the district most highly infected with hydatid disease. Out of 30 vagrant dogs 40 per cent. were infested with *Tœnia Echinococcus*. Out of another series of nine which had been better cared for, only one case was found, while five out of ten stray dogs in Melbourne were infested. This great prevalence fully explains the frequency of the cystic form in man and the domestic Herbivora in these localities.

**Trematoda.§**—M. J. Poirier finds, from a study of the muscular system of *Distomum clavatum*, that the dorso-ventral muscles are broken up at their ends, and are fixed to internal projections of the cuticle, which serve as fulcra; these muscles contract in such a way as to produce a series of nodes along the muscular fibre. The suckers have a muscular system which is much better developed than has been hitherto supposed; they are always, or nearly always, completely enveloped by one or two elastic membranes, to which are attached the various muscular bundles of the organ. He describes in detail the extrusive muscles which act on the suckers, and which have hitherto been almost entirely neglected by zoologists.

The glandular cells which are found in the external layer of the parenchyma are not to be confounded with those which sometimes (as in the fluke) form a continuous layer beneath the muscular coat. The digestive apparatus is always lined by long cells which are united only at their base, and which have excessively delicate walls which allow of the easy absorption of nutrient fluids. The œsophagus, which is constantly found behind the pharynx, has very muscular walls which are lined internally by a cuticle. An exaggerated value has been ascribed to the so-called cirrus-pouch, which is often

* Proc. Zool. Soc. Lond., 1885, p. 236.
† Proc. Roy. Soc., xxxviii. (1885) pp. 449–57. ‡ Ibid., pp. 457–8.
§ Arch. Zool. Expér. et Gén., iii. (1885) pp. 465-624 (12 pls.).

wanting; its chief function is to contain and separate from the rest of the parenchyma a more or less large part of the unpaired efferent canal; this last, from the nature of its walls, ought to be divided into three, not two divisions. The uterus, near its cloacal end, is always surrounded by a delicate layer of glandular cells, and its extremity has the function of a seminal vesicle. The canal of Laurer is not a vagina, and it may contain spermatozoa, yolk-globules, or even ova; it may be regarded as a kind of safety-duct which allows of the passage to the exterior of a superabundance of genital products. The only possible mode of fecundation is an external "autofecundation."

The excretory system is disposed in similar manner in all the members of the group. The spongy cords which have been the subject of so much discussion, are definitely regarded as being nerve-fibres. The large multipolar cells which are so abundant in some parts of the body are evidently nervous in nature, and cannot by any means be allowed to be gland-cells, or annexes of the vascular system.

M. Poirier discusses in a note* the recent observations of Dr. Guffron, and expresses his belief that the German naturalist has been a little hasty in his generalization that the nervous system of Trematodes consists of six posterior longitudinal trunks; in various Distomes the lateral nerves appear to be wanting, and the dorsal nerves only extend over the anterior half of the body; while the dorsal and ventral nerves have a distinct origin in the cerebral ganglia.

**Anatomy of Bilharzia hæmatobia.**†—Dr. G. Fritsch describes briefly the structure of this parasite, which, as is well known, has the male and female sexual organs in different individuals.

The surface of the body of the *female* is beset with fine hairs; the alimentary canal commences with the mouth-sucker which leads into the pharynx; the intestine is narrow and soon divides into two branches which afterwards reunite and terminate blindly. The excretory apparatus opens through a large cavity at the hinder end of the body; from this arise two lateral and median trunks. With regard to the generative organs, they are not widely different from those of other *Distoma*.

The *male* has a simpler structure on the whole than the female, the alimentary canal is, however, identical in form with that of the other sex. The sexual organs are extraordinarily simplified; they consist of about five testicular sacs which unite into a short vas deferens provided with a vesicle; there is no penis; the male generative aperture is in common with the excretory pore.

**Small Rod-like Cell-contents of certain Cercariæ.**‡—Dr. P. Sonsino in investigating the histology of some *Cercaria*-forms has discovered a probable function for the cells containing small rod-like structures ("cellules à bâtonnets"), which have been noted by several

* Arch. Zool. Expér. et Gén., iii. (1885) pp. xxvii.–ix.
† Zool. Anzeig., viii. (1885) pp. 407–11.
‡ Arch. Ital. de Biol., vi. (1885) pp. 57–61.

observers. Finding that these bodies were present before the encystment of the larva, but had disappeared when the *Cercaria* was liberated from its cyst, he concludes that these cells function in the encystment, that the rods give the cysts greater solidity and power of resistance, and that they are probably most characteristic of those *Cercariæ* which encyst exteriorly like those of *Fasciola hepatica* and *Amphistomum subclavatum*.

**Deep-water Turbellarians of Lakes.***—Dr. O. E. Imhof records the fact that a particular species of Turbellarian apparently agreeing very closely with *Mesostomum rostratum* Dugès was found in deep water in numerous lakes in Switzerland. The same species occurs also in several of the Austrian lakes. Another dendrocœl Turbellarian, greyish black in colour, was found in very deep water in Lej Sgrischus and Lej Carloccio; it is briefly described.

**Development of Nemertines.†**—Dr. A. W. Hübrecht describes briefly the development of *Lineus obscurus*. After the formation of the gastrula a number of free cells are given off by epi- and hypoblast, which wander through the blastocœl and are the commencement of the mesoblast. The cubical epiblast cells become in several regions palisade-like through multiplication, and form the rudiments of the four larval discs which subsequently are covered by a continuous layer of the original epiblast. The brain and lateral cords are developed entirely from mesoblast cells. The proboscis grows back above the intestine into the blastocœl; its sheath is formed of mesoblast cells. The blood-cavities arise in the blastocœl. The sexual organs arise from a mass of tissue below the nerve-cords and in contact with the spine; they probably arise from the epiblast. The body of the Nemertine has no body-cavity except the cavities already mentioned, which arise from the blastocœl.

**Nervous System of Accœlomate Planarians and new Sensory Organ of Convoluta Schultzii.‡**—M. Y. Delage describes the nervous system of *Convoluta Schultzii* in the following terms. Around the otocyst there is a bilobate ganglionic mass which forms the chief portion of the central system; attached are two smaller masses which lie about it connected with it by a pair of large connectives, and with one another by a transverse commissure. The fibres found in the centre of these masses are extremely fine, the cells, which are peripheral, are best developed at the postero-inferior part of the chief mass, and form a continuous layer around the otocyst.

The peripheral system is formed by six parallel longitudinal nerves and their branches; they are situated immediately below the layer of zoochlorellæ, and are arranged by pairs; the trunks are connected by transverse anastomoses, which are ordinarily more numerous at a greater distance from the head; at the lower end the cords converge and form a plexus.

In addition to the otocyst and the two pigment or eye-spots, there is another sensory organ which its discoverer calls the frontal

* Zool. Anzeig., viii. (1885) pp. 434–5. † Ibid., pp. 470–2.
‡ Comptes Rendus, ci. (1885) pp. 256–8.

organ; it has the form of an ovoid mass, and is clear and refractive; it is bounded at the sides by a double layer of ganglionic cells, and a few are to be found in its interior. The whole apparatus is very mobile, and the animal seems to be incessantly testing by means of the papillæ which terminate it. It is best developed in young specimens which have just escaped.

The nerves are everywhere surrounded by an endothelial sheath, the cells of which are continuous with those of the reticulum; between the nerve and its sheath there is a cavity which is continuous with a system of lacunæ that occupy the whole layer of zoochlorellæ. Each of these algæ is contained in a free cavity, the spaces between which are formed by the lacunæ.

Phœnicurus.* — In studying *Tethys leporina* Prof. de Lacaze-Duthiers found a number of the incompletely known parasite which has been named *Phœnicurus*. After a short description of the external form of the animal, and an account of the incessant changes to which it subjects it, he describes the nervous system as consisting of two ganglia united by a long transverse commissure; each gives off two primary nerves, one of which goes to the region of the mouth, and the other (lower) to the tail. The ganglia are small, and contain a small number of large nerve-cells. There are a number of secondary nerves which arise from the ganglia and pass to all parts of the body; they are ordinarily very delicate, very long, and generally wavy, a condition which is to be correlated with the changes in dimension which are undergone by the body. The two superior primary nerves give off, on their course, delicate branches which pass into the subcutaneous tissue of the buccal fossa; as they get to some distance from their centre they are seen to have ganglionic swellings, which vary considerably in size, and are composed of one, two, or three cells which are elongated along their great axis, which lies parallel to the direction taken by the nerves. It is very remarkable that no two individuals are entirely alike in the composition of their nervous centres; sometimes there is one median ganglion, sometimes a kind of chain of three or four, and in one case there were as many as seven ganglia, united by a plexus. It is not rare to find only one buccal nerve, which is then of large size. In fact, the position of the nervous system is constant, but its forms vary infinitely.

*Phœnicurus* is acœlomate, and a fibrillar cellular tissue containing a number of nuclei takes the place of the body-cavity. Under the skin and a layer of connective tissue there are longitudinal muscular bands, which form a dorsal and an abdominal layer, and extend from one end of the body to the other. In addition there are transversely set external bands, which form a complete network. On either side there are aggregations of muscular fibres which run perpendicularly to the surface, and aid in limiting the central space.

In this space lies the digestive tube, the central nervous system, and a special gland. The tube commences with an orifice placed in the buccal fossa, and extends to the tail; its arrangement is dendro-

* Comptes Rendus, ci. (1885) pp. 30–5.

cœlous. Its walls are exceedingly delicate, and there appears to be no anus. There is appended to it what may be a salivary gland. The animal fixes itself to the papilla of the venous system of the *Tethys*, and so obtains its nourishment.

Prof. de Lacaze-Duthiers considers that *Phœnicurus* is a dendrocœlous worm, but it is not yet possible to definitely fix its zoological position, as he has not been able to study the history of its development. He sought for generative organs in the month of May, but was unable to discover them. It is possible that *Phœnicurus* is only a period or stage in the whole life-history of the animal, and that its development is accomplished under different conditions to any yet observed. Next year the author hopes to be able to fill up the present lacunæ.

**Relationship of Rotifers and Nematodes.***—Dr. O. Zacharias emphasizes the parallelism in the development of these two groups. In comparing the segmentation of the ovum of *Anguillula aceti* with that exhibited in the Philodineæ, he noted the same unequal division and epibolic gastrulation, and probably too, the same origin of the mesoblast in the form of two small rounded cells near the blastopore. The larva or the "palm-form" stage, with its expanded head portion and narrowed trunk, is equally characteristic of both groups. The affinity thus hinted at is corroborated by anatomical resemblances, e. g. in the arrangement of the muscles and of the excretory canals. The absence of cilia in the Nematodes is explained as a degenerative change which finds its counterpart in the unciliated rotifer, *Apsilus lentiformis*.

In the embryos of *Anguillula aceti* Dr. Zacharias observed on the trunk portion a superficial segmentation, which disappears as the trunk or abdominal region proceeded to grow out at the expense of the head. This process seems to him exactly comparable with the development of, e.g. *Polygordius* from the free-living *Trochophora*. The expanded head-portion of the nematode and rotifer larva is, according to Zacharias, the homologue of the head of the free-living *Polygordius* larva; on both rotifer-larva and *Trochophora* the cilia appear on that head-portion. He opposes the possible suggestion that the head-portion of the rotifer and Nematode larva is purely trophic, of physiological and not of morphological import; and maintains the common origin of the two groups from an ancestral type resembling the "palm-form" stage, with ciliated head-portion and long narrow tail or trunk.

**Development of Rotifers.**†—Miss C. Pereyaslavtseff, the Director of the Sebastopol Zoological Station, publishes an interesting paper on this subject, which has been rather neglected, M. Zaleski's paper on the history of the development of *Brachionus urceolaris* not being a complete solution of the question.

Miss Pereyaslavtseff's method differs from most of those hitherto recorded; she does not select one or another phase of development as

* Biol. Centralbl., v. (1885) pp. 228–33.

† Mem. Novorossian Soc. Naturalists, ix. (1884) 19 pp. (1 pl.). Cf. Nature, xxxii. (1885) pp. 579–80.

being the most important, but placing several rotifers and *Lepadellæ* under the object-glass she waited until one of them would lay an egg; and the development taking about three days from the beginning of the segmentation until the issue of the new animal from the egg, she observed it continually throughout the first thirty to thirty-five hours, with only short interruptions of two to three hours in the observation of subsequent phases. This method has of course its inconveniences by preventing sleep for two nights. It cannot be applied also to those rotifers which live an errant life. These last do not survive confinement, and must be kept in watch-glasses until they lay their eggs, which last are then brought under microscopic investigation.

Ten different species were studied in this way, and proved to undergo the same development, so that *Rotifer inflatus* has been given as a type of the development of the egg. The stages are all figured in forty-eight drawings on the plate accompanying the memoir.

**New Rotifer.***—Mr. W. Milne describes a new rotifer, which he places in the genus *Pleurotrocha*, though the jaws are each three-toothed, and names *P. mustela*. It is exceedingly vigorous and active in its movements, as well as most ferocious, striking out with trap-like jaws at everything that comes in its way. When the jaws are shot out they open as they leave the oral opening and close with a snap before the recoil; but when irritated so swift is the stroke that nothing of this can be seen. If the object struck is not too large or hard the teeth fix and the head sucks into the victim "in the most weasel-like way imaginable," holding on even when whirled round and round. A case of *lockjaw* was observed by the author. In the ovary may be seen only one perfect egg at a time, as large as one-third of the body, and it is extruded before segmentation takes place.

The male is much smaller than the female, and has no mastax or digestive apparatus.

### Echinodermata.

**Variation in Holothurians.†**— Dr. K. Lampert in announcing the preparation of a systematic monograph of Holothurians, discusses the variability of some of their organs. He points out how the arrangement of the ambulacral suckers varies with age; he finds that the calcareous deposits are much more constant, and mentions only two cases of variation, to which *Cucumaria frondosa* at any rate might have been added. He is dissatisfied with the earlier classifications, but accepts completely Bell's proposed arrangement of the Dendrochirotæ by the aid of their tentacles, and carries it further by proposing to form two divisions to be called Monocyclia and Heterocyclia, according as the tentacles are in one or two circlets. He takes the hint of Semper, to which Bell had directed attention, as to the necessity of forming a fresh genus for some of the Cucumariæ,

* Proc. Phil. Soc. Glasgow, xvi. (1885) pp. 188–93 (1 pl.).
† Biol. Centralbl., v. (1885) pp. 102–9.

and proposes the name *Semperia* for those in which two tentacles are smaller than the rest, and sucking feet are found in the interambulacra as well as the ambulacra.

**Morphology of Echinoids.***—Dr. W. Haacke thinks it is not yet certain whether the "regular" sea-urchins are bilaterally or radially symmetrical. The matter will probably be decided by the examination of as many abnormalities as possible, and with this end in view Dr. Haacke has collected over 1000 examples of the Australian genus *Amblypneustes*. The questions to be answered are stated in full, but until the answers are forthcoming it will be useless to state the questions here.

**Larval Form of Dorocidaris papillata.†**—In his study of the development of this Echinoid M. H. Prouho sheds light on the hitherto little known larval form of the *Cidaridæ*. The ova, which were laid in February, are of a whitish-yellow colour and slightly transparent. The complete and regular segmentation results in an ellipsoidal gastrula, with the blastopore at one flattened pole and a group of very long cells at the other. The Pluteus form is perfected three months after fertilization. The endoderm lining the alimentary tract is ciliated throughout. Three different elements are distinguishable in the mesoderm: (1) colourless cells, with irregular prolongations; (2) colourless globular cells, from which the spicules originate; (3) amœboid mahogany-coloured cells, like those of the blood, probably originating from the ectoderm, where colour appears on the fifth day. The ectodermic cells are large and flat, with polygonal contour. Cilia are not abundant except on the long straight cells of the ciliated band.

The vaso-peritoneal vesicles originate as usual as two diverticula from the enteric canal; each divides at an early stage into two lobes, one of which is applied to the œsophagus, while the other descends along the stomach and intestine. The left vesicle is in communication with the exterior by the dorsal pore. The lining cells resemble the colourless cells of the mesoderm.

There are four pairs of arms—(1) posterior, (2) anterior, (3) antero-lateral, (4) antero-internal. There are also independent calcareous structures, of which the most remarkable are the arched and branched spicules supporting the "cupola," and in association with contractile cross fibres. It is interesting also to note the presence of an unpaired, median irregular spicule in the same position as the unpaired arm of the Spatangoid larvæ.

There are no ciliated epaulettes, but the lobes along which the ciliated band extends are very well developed. He distinguishes (1) three lobes in the angle of the posterior arms, of which the middle one is specially large; (2) two pairs of dorso-lateral lobes; (3) one pair of lateral lobes between the posterior and antero-lateral arms. These lobes, along with the reticulated spicules and the much flattened cupola, give the larva a very characteristic appearance.

* Zool. Anzeig., viii. (1885) pp. 490–3. † Comptes Rendus, ci. (1885) pp. 386–8.

**Structure and Function of the Sphæridia of the Echinoidea.***—Mr. H. Ayers supplements the observations of Lovén by a large number of structural facts, which, besides allowing of greater accuracy in determining the function of these peculiar organs, furnish an example of a highly specialized organ in this group that is comparable to the otolith sacs of *Synapta*.

**Japanese Echinoidea.**†—Dr. L. Döderlein enumerates and gives an account of the forty-seven species collected in the Japanese seas, an extraordinarily large proportion of which are described as new; some of these will no doubt be found to be varieties of some of the very variable members of this class.

**Brisingidæ of the 'Talisman' Expedition.**‡—Prof. E. Perrier finds that the new forms of Brisingidæ collected by the 'Talisman' fill up some of the lacunæ which separated this group from the rest of the Asteroidea; a new genus *Freyella* contains a species *F. sexradiata*, which leads directly to *Pedicellaster*, with its five or six arms; *Coronella* recalls exactly the appearance of *Asterias tenuispina* and its allies, and has, like them, a reticulated dorsal skeleton; the ambulacral tubes are, however, disposed in two rows. In the development of the dorsal skeleton we have the following ascending series:—*Hymenodiscus Agassizii*, *Brisinga mediterranea*, *B. elegans*, *B. endecacnemos*, *B. coronata*, *B. semicoronata*, *B. robusta*, *Labidiaster radiosus*, *Brisingaster robillardi*, *Pedicellaster typicus*, *Coronaster Parfaiti*, and *Asterias tenuispina*. The *Freyellæ* form an aberrant series.

**Asteroidea of Mauritius.**§—M. P. de Loriol has published the second part of his 'Catalogue Raisonné' of the Echinoderms of Mauritius, in which old as well as new species are described and figured.

### Cœlenterata.

**Development of Agalma.**‖—Mr. J. W. Fewkes states that, in the course of its development, the egg of *Agalma* passes through three very distinct stages: the primitive larva, the *Athorybia*-stage, and the larva like the adult but still retaining certain provisional structures. The first stage is alone here considered, and it is regarded by the author as giving us the key to the phylogeny of the Oceanic Hydrozoa. The observations on impregnation and cleavage are described in detail; towards the end of the segmentation period extraordinary protoplasmic elevations are to be observed from the surface of the egg.

When the development of the primitive or larval hydrophyllium is at its maximum the yolk of the egg is still spherical and little reduced; the egg is almost completely invested by the helmet-shaped

* Science, vi. (1885) p. 226. Since published in Quart. Journ. Micr. Sci., xxvi. (1885) pp. 39–52 (1 pl.) *post*.

† Arch. f. Naturgesch., li. (1885) pp. 73–112.

‡ Comptes Rendus, ci. (1885) pp. 441–4.

§ Mem. Soc. Phys. et d'Hist. Nat. Genève, xxix. (1885) 83 pp. (16 pls.).

‖ Bull. Mus. Comp. Zool. Camb., xi. (1885) pp. 239–75 (4 pls.).

hydrophyllium, which is free on either side; near the end of the primitive cavity there is a spherical organ, which is the future float; it is inclosed by a layer of hypoblastic cells. The primitive hydrophyllium is supposed to pass, "by a few modifications in its external contour, into some other organ, probably a differently formed covering scale."

**Cyclical Development of Siphonophora.***—Prof. C. Claus criticizes the results of Chun on the development of certain Siphonophora. In a recent work Dr. Chun has stated that in *Monophyes irregularis* and *M. gracilis* the primary swimming-bell falls off and is replaced by a second, and that this fact is against Claus's view that *Muggiæa Kochii* is not a Monophyid but a Diphyid. If the swimming-bell of *Monophyes irregularis* and *M. gracilis*, both undoubtedly Monophyids, corresponds to a second heteromorphic bell, the young form of *Muggiæa* with a primary bell cannot be a Monophyid. The question is gone into in considerable detail, and Claus points out that an animal without mouth or alimentary canal could hardly conceivably be the "nurse" of a future generation, but is evidently merely an immature form.

**Structure of Velella.**†—M. Bedot has already contributed a short paper upon this subject, which has been noticed in this journal.‡ The present communication is an extension of some of the results formerly obtained. The "central organ" in the adult *Velella* is surrounded by a vascular zone, on which are attached the gasterozoids; this zone is absent in the young, where the central organ is present as a small mamilla; its lower surface is almost entirely occupied by the central gasterozoid; above it, as in the adult, is a layer of epithelium which lines the pneumatophore. The canals have a regular symmetrical disposition, and communicate with the central gasterozoid by five secondary canals. The greater portion of the central organ is formed by a mass of cnidoblasts. The pneumatocyst is divided up into a number of chambers, which send off diverticula into the central organ.

**New Minyas.**§—Prof. F. J. Bell explains that a justification is to be found for describing a single new species of *Minyas*, *M. torpedo*, in the rarity of members of this interesting group of floating Anthozoa, very few being found by the 'Challenger' (or, it may be added, by the German corvette 'Gazelle'). The morphological interest of the species lies in the fact that it makes yet another exception to the rule that the Actiniaria in their adult state present a hexamerous arrangement of their parts.

**Metamorphosis of Bolina Chuni.**‖—Dr. R. v. Lendenfeld describes the postembryonal development of this new species of Ctenophora, one of the few species of Ctenophora found in Australian waters.

* Zool. Anzeig., viii. (1885) pp. 443–8.
† Recueil Zool. Suisse, ii. (1885) pp. 237–51 (1 pl.).
‡ See this Journal, iv. (1884) p. 576.
§ Journ. Linn. Soc. Lond., xix. (1885) pp. 114–6.
‖ Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 929–31 (2 pls.).

The most striking feature of the adult is the great bulk of the lobes, which are thicker than the body and nearly circular.

**Beroid of Port Jackson.***—Dr. R. v. Lendenfeld redescribes *Neis cordigera* Lesson, first described in 1824 by the naturalists of the 'Coquille,' and not since found.

He considers that *Neis* represents a genus quite distinct from *Berce*. Its sexual cells are matured in the vascular reticulation exclusively, to which place the ova migrate from the meridional canals. The style-cells, described as sensitive elements by R. Hertwig and Chun, he considers to be "poison-thorns," and the glands surrounding these cells to be poison-glands.

**Australian Hydromedusæ.**†—Dr. R. v. Lendenfeld describes and figures eight new species and a few previously insufficiently known ones, the paper forming an addendum to the monograph of Australian Hydromedusæ previously published. It brings the total number of Australian species up to 240, distributed amongst seventy-four genera. A second addendum ‡ contains some alterations in the author's classification.

## Porifera.

**Histology and Nervous System of Calcareous Sponges.**§—Dr. R. von Lendenfeld describes the three layers of calcareous sponges. The mesoderm is stated to consist of "gallert of a pretty high degree of density," and is never fibrillar, as in some other sponges; it contains stellate or rarely bipolar cells, which perhaps represent the muscular element. The structures of the spicules are best studied after treatment with "chloride of gold-potassium" for twelve hours, which reveals the presence of small parallel radially-arranged prisms. Spiral muscle-cells form contractile sphincters by which the pores can be more or less closed. Amœboid cells are to be found in all Calcarea; the ova are transformed amœboid cells, which, when mature, are inclosed by endothelium; the first stages of development are passed through in the body of the parent. The gland-cells are either single, or arranged in small branches; highly refractive granules are to be found in their interior. Spindle-shaped mesodermal cells, which protrude beyond the outer coating of ectoderm, are to be found in the Heterocœla, and are regarded as sensory. Multipolar ganglion-cells have been observed in several species.

**Reproduction of Spongilla lacustris.**‖—Dr. W. Marshall communicates a preliminary note as to the reproductive processes in this fresh-water sponge.

(*a*) *Formation of gemmulæ.*—The gemmulæ or winter embryos are formed in the neuter autumn *Spongillæ* from wandering nutritive amœboid cells ("trophophores") which accumulate in the inhalent canals or in the ciliated chambers, whence they pass into mesoderm,

* Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 968–76.
† Ibid., pp. 908–24 (4 pls.).
‡ Ibid., pp. 984–5.
§ Ibid., pp. 977–83.
‖ SB. Naturf. Gesell. Leipzig, 1884, pp. 22–9.

becoming grouped round one or more mesoderm cells as centres. Round each clump or pseudomorula of nutritive cells a thin cuticle is differentiated, outside which the mesoderm forms an endothelium in which the horny and flinty materials of the capsule appear. After the formation of the gemmulæ the mesoderm degenerates, and by the end of autumn the whole *Spongillæ* usually breaks up.

(*b*) *Structure and escape of the embryo.*—The embryo within the capsule is at first a morula-like mass of round uniform cells, with abundant food-granules. With inception of water the cells become polyhedral through the mutual pressure of growth, and gradually come to form a mass with indistinguishable cell-boundaries. The further growth of this syncytium is marked by the protrusion of a large pseudopodium from the "microdiode," "omphaloporus," or capsule aperture. This process probably increases in size till it draws the rest of the embryo out with it. The sponge embryo escapes from the capsule in April or the beginning of May, and has the form of a flattened sphere, in which it is possible to distinguish the cells both of the clear ectoderm and of the granular inner substance, the endoderm. In most cases the young sponge remains seated for twenty-four hours or so on the forsaken but still intact capsule, over which the clear outer sheath sends out pseudopodia, which are probably effective in abstracting from the gemmula the rudiments of the flinty skeleton of the embryo.

(*c*) *Further growth of the liberated embryo.*—After leaving the capsule the embryo increases in size at the expense of the store of nutritive granules in the inner mass. It exhibits no demonstrable power of active locomotion, and after floating about, in some cases for two days, it settles down and exhibits a series of further changes, of which the details seem to be somewhat variable, the characteristic processes of other sponges being here united in the one form. In the internal mass or cœnoblast an enteric cavity is developed either with or without, and either before or after osculum and inhalent apertures. By the end of May or first half of June the young *Spongillæ* are sexually mature, and that unisexually. It seems probable that the males are destitute of enteric cavity and mouth, with both of which the more abundant and more spheroidal female forms are usually provided. From these spring sexual forms the summer *Spongillæ* are developed in a manner closely resembling that previously described in the case of *Reniera filigrana*. After fertilization the males seem to perish, while the females after bearing the neuter forms increase greatly in size till about the beginning of August, during which growth the enteric cavities and mouth-openings are reduced in size and not unfrequently disappear. There is thus in *Spongilla lacustris* a seasonal alternation of generations; the winter gemmulæ form spring sexual *Spongillæ*, which produce asexual forms in which arise the winter gemmulæ.

**The Phoriospongiæ.***—Dr. R. v. Lendenfeld has obtained in Australia the two sponges described by W. Marshall as repre-

* Proc. Linn. Soc. N.S. Wales, x. (1885) pp. 81–4.

sentatives of the new genus *Phoriospongia*, which is characterized as sponges containing a large amount of foreign particles, sand, &c., and also possessing siliceous spicules of the monactinellid type. Marshall was inclined to consider all these sponges, described by himself and others, as boring sponges, which, however, do not live in rocks or shells as the true *Vioa*, but which live in sand. They perforate the sand in all directions, and so produce a mass similar to a sponge, and containing both the spicule of the sponge and the sand in which the sponge took up its abode.

Dr. Lendenfeld, however, considers the two sponges (as well as others which he found) as Ceraospongiæ, belonging to the group with arenaceous irregular fibres. There are many Australian sponges with a skeleton consisting of arenaceous fibres forming an irregular network, thus connecting the *Phoriospongiæ* with the ordinary horny sponges.

The author discusses the hypothesis put forward by Vosmaer,* that the horny sponges are the descendants of the siliceous Monactinellida, and upholds his previous view,† deriving the latter from the former.

**Sponges of the 'Willem Barents' Expedition.**‡—Dr. G. C. J. Vosmaer describes and enumerates the thirty-eight sponges collected by the 'Willem Barents' Arctic expedition in 1880 and 1881. They were not, unfortunately, so well preserved as to enable the writer to make many anatomical or histological observations; at the same time the carefully prepared plates offer numerous points of interest. *Weberella bursa* is the representative of a new genus, in which the connective tissue is highly developed, and so makes the sponge compact and resistent. Another new genus is *Artemisina* (*A. suberitoides* n. sp.), which has much of the appearance of a *Suberites*, but possesses the anchors which are characteristic of the *Desmacidinæ*. The author makes use of the stenographic system of describing the spicules which he has done so much to bring into use, and the whole essay is characterized by a desire to add to our knowledge of incompletely known forms, and to refrain as much as possible from the establishment of new genera or species.

**New Sponges from South Australia.**§—Dr. R. v. Lendenfeld in reference to Mr. H. J. Carter's description of sponges from the neighbourhood of Port Phillip Heads, S. Australia,‖ contends that *Halisarca australiensis* is not a sponge at all, but that the crusts described are the ova of Boltenias surrounded by their follicula.¶ The rest of the paper is mainly a criticism on the new species established by Carter, many of which are claimed to be identical with previously recognized forms. Of the new genera, *Holopsamma* is the same as Marshall's *Psammapemma*, and *Sarcocornea* not properly established.

* See this Journal, *ante*, p. 75.
† Ibid., iv. (1884) p. 394.
‡ Bijdragen tot de Dierkunde, xii. (1885) 47 pp. (5 pls.).
§ Proc. Linn. Soc. N.S. Wales, x. (1885) pp. 151–6.
‖ See this Journal, *ante*, p. 465.
¶ Ibid., p. 233.

**Fresh-water Sponge from Mexico.*** — Mr. E. Potts describes *Meyenia mexicana* n. sp. collected by Prof. E. D. Cope in Lake Xochimilco, about seventeen miles south of the City of Mexico. It differs from the familiar *M. fluviatilis* chiefly in the far greater length of the shafts of the birotulate spicules. It is further interesting as being only the second species of fresh-water sponge to reach the hand of specialists from that region of N. America.

**Australian Sponges.†**—Dr. R. von Lendenfeld's third part of his monograph contains a preliminary description and classification of the Calcispongiæ; he accepts with some modifications Poléjaeff's sub-orders Homocœla and Heterocœla, which depend on the facts that the endoderm in the one is, and in the other is not, differentiated histologically. *Grantessa* is a new genus of Uteinæ, and a new sub-family Vosmaerinæ is instituted for the new genus *Vosmaeria*, which, with the appearance of a Syconid, does not form colonies; the new genus *Polejna* appears as the type of the Polejnæ. Various new species are described, and some of what others have regarded as varieties are elevated to species.

In his fourth part‡ the author deals with the Myxospongiæ, which he divides into the Myxinæ (identical with the Halisarcinæ of O. Schmidt) and the Gumminæ, in which the Chondrosidæ are alone found. The structure of *Bajulus* (*B. laxus*) n. gen. is fully described, and there are descriptions of *Chondrosia ramsayi* and three new species of *Chondrilla*.

### Protozoa.

**Experiments on Formation of Pseudopodia.§**—Dr. O. Zacharias reports a number of interesting results obtained by modifying the environment of certain cells.

*a*. The cylindrical spermatozoa of *Polyphemus pediculus*, subjected to a 5 per cent. solution of sodic phosphate in distilled water, lengthen out, acquire pseudopodia at both ends, slowly contract again with vigorous motion of the pseudopodia, become spherical and clad with vibratile processes only describable as cilia. There was thus a passage from a more or less quiescent to a pseudopodic and thence to a ciliated phase, and Zacharias notes its interest as showing how little essential difference there is between pseudopodia and cilia.

*b*. The amœboid cells of the intestinal epithelium of *Stenostomum leucops*, which have a spherical form and are provided with a bunch of long cilia, were similarly treated with the result that they became like flagellate infusorians, each with a long, thick, rapidly moving process, beside which two or three cilia were sometimes seen beating at the original much slower rate. In some *Flagellata* a similar formation of pseudopodia sometimes occurs, as in *Cercomonas ramulosa* St., and (*c*) the intermediate form *Hæmatococcus pluvialis* Fltw assumes

* Amer. Natural., xix. (1885) pp. 810-11.
† Proc. Linn. Soc. N. S. Wales, ix. (1885) pp. 1083-1150 (9 pls.).
‡ Ibid., x. (1885) pp. 3-22 (5 pls.).
§ Biol. Centralbl., v. (1885) pp. 259-62.

under certain conditions, e. g. in the stagnant water of old cultures, an amœboid form. Zacharias notes the interesting corroboration thus obtained of the phylogenetic origin of the *Flagellata* from amœboid forms.

*d.* Schneider has shown how the spermatozoa of Nematodes become amœboid in albumen, and covered with little undulating projections in salt solution.

*e.* Brass has shown how the formation of long thin pseudopodia results from the treatment of *Amœbæ* with weak solution of alum.

*f.* Kühne was also able to stimulate the formation of pseudopodia in the plasmodia of Mycetozoa with dilute sugar solution, 0·1 per cent. solution of common salt.

These experiments of Zacharias and others are interesting as illustrations of the readiness with which cells may pass from one phase to another in response to environmental influences, and are thus full of suggestion in relation to normal and pathological cell-variation, affording additional experimental proof of the theory of a primitive cell-cycle, advanced by Geddes.

**Coleps hirtus.***—M. E. Maupas gives a careful account of this infusorian; he has been unable to come to any conclusion as to the chemical characters of its carapace, so as to be certain whether there is a true integument or cytoderm; he doubts the presence of the fine membrane connecting the large modified oral cilia which has been mentioned by Entz. *Coleps* is sometimes carnivorous, and sometimes herbivorous. To study the structure of the nuclein it is best to kill the animal with the vapour of osmic acid, wash with 1 per cent. chloride of gold solution, and clear up with glycerin; to kill directly with chloride of gold; or to replace the wash with gold by one with 2 per cent. chromic acid.

After reviewing the opinions of various authors as to the zoological position of *Coleps*, M. Maupas ranges himself with Ehrenberg, who formed a family Colepidæ, based on the presence of the solid carapace, which is a special and dominant structure. The only known method of multiplication is by transverse fission, and in this division the carapace takes an important part.

**Supposed new Infusorian.**†—Mr. G. J. Burch, in March 1884, found in a ditch at Oxford an animalcule apparently undescribed, and belonging to the Flagellata Eustomata.

Each colony consisted of a compound stem, no portion of which was contractile, bearing from 10 to 50 heads upon branchlets somewhat thinner than the main stem. These heads appeared in most positions of an irregular pear-shape, the broad end projecting on one side into a blunt proboscis from which arose a single stout flagellum. About the centre of the creature was a very strongly refracting oval spot with a somewhat corrugated surface. Between this and the mouth, which lies in a cup-shaped depression close under the proboscis, was a passage the walls of which could be distinctly seen even when there

* Arch. Zool. Expér. et Gén., iii. (1885) pp. 337-67 (1 pl.).
† Journ. Quekett Micr. Club, ii. (1885) pp. 163-4.

was no food in it. The creature was remarkably active and snatched its prey in a peculiar manner. If found to belong to an old genus the specific name *raptor* is suggested for it, or if a new genus, *Harpakter socialis*.

**Erythropsis agilis.***—Dr. E. Metschnikow remarks that a Protozoon described by himself under the same name is probably not identical with Hertwig's *Erythropsis agilis;* it is a scarce species belonging to the Acinetæ, and only occurred in one instance out of a daily examination of the surface water lasting for six months. The species, like *E. agilis*, has a conspicuous eye, which differs in possessing a conical body beneath the pigment sheath, which is perhaps the first differentiation of a nervous apparatus. The species occurred near Funchal, in Madeira.

**Flagellata and allied Organisms.**†—Dr. C. Fisch has studied eleven forms, among which are *Chromulina woroniniana* n. sp., *Chilomonas paramœcium*, *Bodo jaculans*, *Monas guttula*, and *Amœba diffluens*. Although the form of the body differs considerably in details, yet it is possible to "orient" them all in the same way, and to distinguish the following constituent parts; cytoplasm, tegumentary layer, nucleus, one or more contractile vacuoles, cilia, and, generally also, nutrient vacuoles.

The cytoplasm is ordinarily homogeneous and generally finely granular; no special structure can be made out in it; it is ordinarily pretty firm, and may be markedly so. The cilia seem to have the same chemical constitution as the integumentary layer, but are not so intensely coloured by iodine; they are not, as is ordinarily represented, more delicate at the tip than elsewhere; they are the most sensitive organs of the Flagellata and are destroyed by the removal of oxygen. The nucleus has a definite position, and is most often vesicular in form. As a rule there is but one contractile vacuole, and it, like the nucleus, has a definite position in the body.

The author describes the chromatophores, but denies the presence of eye-spots. He is of opinion that the green algæ are allied to the Flagellata.

Dr. Fisch enters with great detail into the special history of a number of species, among which there are, in addition to those already mentioned *Cyathomonas truncata*, *Codosiga botrytis*, *Paranema trichophorum*, *Arhabdomonas vulgaris*, *Grassia ranarum*, and *Protochytrium spirogyræ*. As to the last it seems to be most closely allied to "*Monas amyli*." It is not to be denied that the zoosporous Monadina are low Flagellata, but they have no relation to *Vampyrella*.

**Marine Rhizopoda.**‡ — Prof. O. Bütschli commences with an account of some observations on the nuclei; the first subjects are *Peneroplis pertusus* and *P. planatus;* in one case several nuclei were seen in one organism, and a finely plexiform arrangement of the

* Zool. Anzeig., viii. (1885) pp. 433-4.
† Zeitschr. f. Wiss. Zool., xlii. (1885) pp. 47-125 (4 pls.).
‡ Morphol. Jahrb., xi. (1885) pp. 78-101 (2 pls.).

nuclear substance could be made out. The author's observations on *Orbitolites complanata* were made before the publication of Dr. Carpenter's recent work; he met with great difficulties in his investigations, but was able to detect in all the forms he examined a number of small nuclei in the protoplasm; by the aid of sections and staining with hæmatoxylin or saffranin he saw that the nuclei were rounded or oval, or occasionally elongated; in structure they were plexiform and the only difference between those of different sizes were that the meshes were more numerous in those that were larger. No definite evidence as to the presence of nucleoli was obtained. The peripheral chambers were, as a rule, found to be best provided with nuclei. In one of Bütschli's preparations of *Lagena elegans* a large number of rounded bodies were found in the protoplasm, but he cannot definitely assert that they were nuclei.

A species of *Textularia* from Villefranche afforded evidence that the primitively simple nucleus underwent multiplication. *Spirillina vivipara* was observed in a living condition; the protoplasm, like the shell, was completely colourless, and contained a number of small colourless highly refractive granules; the protoplasm exhibited evidence of a centrifugal and a centripetal stream; there were a number of nuclei, which were often elongated in form, and had more or less highly coloured contents; the nuclei were so exceedingly small as to make it very difficult to get a clear idea as to their structure.

The large and fine Rotaline *Calcarina splengeri*, from Kerguelen and Fiji, contained only one nucleus, and that not especially large, though generally easy to see; it appears to gradually wander from the central into the successively younger chambers, just as in forms already studied; it is oval in shape, and has a distinct plexiform basis; the central part may be seen to be formed of a much finer meshwork.

With regard to the structure of the protoplasm in marine Rhizopods, the author insists on its plexiform character; although he has not been able to examine their pseudopodia, yet in *Actinosphærium* he has been able to see that, at any rate, the thicker proximal parts of the pseudopodia exhibit a plexiform structure; in the finer terminal parts he sometimes distinctly saw a row of very small vacuoles in the middle of a pseudopodium.

Parasitic cells are to be found in the protoplasm, and in the *Orbitolites* there were a number of small spherical structures, very regularly distributed; often, indeed, the proper protoplasm of a chamber is quite pushed into the background. As his specimens were preserved in alcohol, he cannot speak absolutely as to their original colouring matter, but he has no doubt that it corresponds to that of the so-called zooxanthellæ. In a living *Peneroplis* he has been able to observe a deep brownish-red coloration. The colouring matter found in marine Rhizopods is ordinarily converted into green under the action of alcohol.

**New Condition of Reticular Rhizopods.***—M. de Folin has noticed among the naked Rhizopods forms provided with ramified

* Comptes Rendus, ci. (1885) pp. 327-8.

tubes which so intercross as to give the appearance of an irregular plexus. These he calls *Pseudarkys*. They are frequently to be found in the cavities which are afforded by old perforated tests. One and the same species was found in various retreats in a number of the 'Travailleur' dredgings; among those of the 'Talisman' there was an example which showed a remarkable alteration in its mode of hiding itself; instead of penetrating into a retreat already made, it surrounded itself with corpuscles, and especially with Globigerinæ, In another case the covering was made of grains of sand, and of small tests of Mollusca or their débris. In yet other cases the organism covers itself with a composition of secretion and sarcode, quite analogous to that which forms the tests of the porcellanous Foraminifera. For such forms the author proposes to establish the genus *Lithozoa*, which will, he expects, be found to contain several species.

**Amœba infesting Sheep.***—Sheep in New South Wales are affected by a disease which appears to be very similar to epithelial cancer, and is met with on the feet behind the hoofs and also on the lips and nostrils and the gums of lambs. The epithelium in these places grows with pathological rapidity, the horny layer produced soon attains a thickness of 3–5 mm., the wool drops out in the diseased parts and below the thick outer layer a festering process sets in. After some time a new epithelium makes its appearance below the festering layer. Then, provided the lamb does not die, the thick horny layer is thrown off like scurf, and the epithelium below attains new wool and replaces the old skin.

In studying the circumstances in which these sheep live, Dr. R. v. Lendenfeld found that they were invariably exposed to being wounded in those places which eventually developed the disease, blistered by standing on rocks heated by the sun after they had been standing in water for several hours, or pricked by the spines of the variegated thistle, and it was found by a process of artificial breeding in an aquarium that the disease is produced by an *Amœba* (*A. parasilica* n. sp.), which enters the wounds and multiplies rapidly in the epithelium, causing very strong irritation. The organism is found between the layers of horny substance. It does not differ morphologically from the well-known *A. princeps* of Ehrenberg.

Dr. Lendenfeld adds, "It is well known that several fungi in certain stages of their life appear very similar to *Amœbæ*, and so it is not impossible that my *Amœba* is in some connection with them. I do not consider this probable, however, as I made no observation which might lead one to suppose that the *Amœba* ever divided into a multitude of swarming spores."

**Critical Notes on Amœbæ.**†—Dr. G. C. Wallich, after some critical notes on the recent contributions to our knowledge of the *Amœbæ* made by Dr. Gruber and quotations from his own and other papers, observes that, in his experience the number of nuclei may vary almost

* Proc. Linn. Soc. N. S. Wales, x. (1885) pp. 35–8 (1 pl.).
† Ann. and Mag. Nat. Hist., xvi. (1885) pp. 215–27.

to any moderate extent, and that it is not a legitimate conclusion to regard as distinct species forms which differ only by having multiple nuclei. As to the effects of pressure, it seems certain that "no pressure of any ordinary kind could actually compress a fluid or semifluid substance like sarcode, even in the slightest degree." Even if pressure acts, as Gruber thinks, by extracting water, the explanation would not account for the collapse as well as the inflation with fluid of the contractile vesicle; further, the pressure referred to by Dr. Gruber is exercised at the posterior aspect of the *Amœba*, and as the contractile vesicle almost always discharges itself in that region, it would be doing so in the teeth of the force which is, at the very same time, exerting itself in projecting pseudopodia in the opposite direction.

**Pseudocyclosis in Amœba.***—Dr. G. C. Wallich calls attention to the fact that in 1863 † he explained the quasi-circulatory movement of particles in the body-substance of *Amœba* on the same basis as that recently advanced by Mr. S. Lockwood, ‡ and which he considers to be the only rational explanation of the phenomena which is compatible with the readily observable facts of the case.

## BOTANY.

### A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

#### *a.* Anatomy.§

**Various Degrees of Resistance in Protoplasm.‖**—Dr. O. Loew distinguishes between sensitive and resisting protoplasm, all intermediate grades occurring, however, between the extremes. A remarkable sensitiveness is shown, for example, by *Sphæroplea*, the cell-protoplasm dying with the slightest mechanical impact; while in *Vaucheria* the protoplasm which has been pressed out remains long in a living state. A similar difference is exhibited in the effect of chemical reagents. While a 1 per cent. solution of ammonium chloride kills *Spirogyra* in a very short time, it is completely unchanged in a solution of 0·01 per cent. until the sixth or eighth day, when a separation of granules takes place in the colourless protoplasm which reduces neutral silver-solutions. In contrast to *Spirogyra*, *Torula* is very resistent to a 1 per cent. solution of ammonium chloride, and will even live in a 10 per cent. solution at 40° C. for some time.

* Amer. Mon. Micr. Journ., vi. (1885) pp. 190–3.

† Ann. and Mag. Nat. Hist., xi. (1863) p. 365, xii. (1863) pp. 111, 329, and 448. Also Mon. Micr. Journ., i. (1869) p. 233.

‡ Amer. Mon. Micr. Journ., vi. (1885) pp. 46–7.

§ This subdivision contains (1) Cell-structure and Protoplasm (including the Nucleus and Cell-division); (2) Other Cell-contents (including the Cell-sap and Chlorophyll); (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‖ Pflüger's Arch. f. Gesammt. Physiol., xxxv. (1885) pp. 509–16.

*Torula* is even but very slightly sensitive to hydrocyanic acid; and the alcoholic fermentation of grape-sugar goes on unaffected even by a 2 per cent. solution of chinolin.

Even in the same organism, the resistance to external agents often varies greatly. Both the Saccharomycetes and Schizomycetes endure a higher temperature than most algæ, but die more quickly in an alkaline silver-solution. As a general rule, the resistance decreases with a rise of temperature; while a lower temperature retards the vital movements, and thus increases the power of resistance.

**Peculiar Structure of Protoplasm in the Paratracheal Parenchyma.***—Dr. E. Giltay describes a peculiar structure of the protoplasm in the layer of small, often very irregular and lignified, parenchymatous cells which surround the large vessels with bordered pits in the stem of *Bryonia dioica*. It consists in a differentiation of the outer layer of the protoplasm of these cells into closely packed rods, very difficult to detect without staining, but rendered very evident by the deep staining from hæmatoxylin. Other reagents produce no effect on them. The author suggests that their function may be connected with the conduction of water.

**Tannin and Lignin in Galls.†**—According to Herr C. Hartwich, the starch which is found in abundance in the nutritive layer of *Infectoria*-galls is not used directly for the nutrition of the larva, but undergoes in the first place transformation into other substances. Among these are round or irregular bright brown-red balls of tannin, not exceeding 30 $\mu$ in diameter; and among them, but not so common, peculiar colourless or yellowish bodies, usually of an ovoid form, which he has determined to consist chiefly of lignin.

**Conditions of the Development and of the Activity of Chlorophyll.‡**—Dr. J. H. Gilbert gives an account of some experiments made in conjunction with Dr. W. J. Russell, which show a close connection to exist between the formation of chlorophyll and the amount of nitrogen assimilated by plants; the amount of carbon assimilated is not, however, in proportion to the chlorophyll formed, unless a sufficiency of mineral substances, required by the plants, is available. In cases where both nitrogenous and mineral manures were applied, a lower proportion was observed of nitrogen assimilated and chlorophyll formed over a given area, which is no doubt due to the greater assimilation of carbon and consequent greater formation of non-nitrogenous substances, although the amounts of nitrogen assimilated and chlorophyll formed were as great, if not greater.

**Sieve-tubes in the Leaves of Dicotyledons.§**—Dr. A. Fischer gives the following as the results of a number of observations.

The width of the sieve-tubes, and of their accompanying cells, decreases with the diameter of the veins of the leaves; but the sieve-tubes decrease in width much more rapidly than the accompanying

* Nederl. Kruidk. Arch., 1884, p. 187. See Bot. Centralbl., xxii. (1885) p. 199.

† Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 146–50 (1 pl.).

‡ Nature, xxxii. (1885) p. 539. (Paper read before the British Association, Section B.)

§ Ber. Verhandl. K. Sächs. Gesell. Wiss., 1885, pp. 245–90 (2 pls.).

cells. In the finest ramifications the latter are at least as wide as, and in most cases wider than, the sieve-tubes. In many dicotyledons, especially those with bicollateral vascular bundles, the accompanying cells of the finest ramifications of the veins have even a larger diameter than in the leaf-stalk and stem. Koch's peripheral cells—the transitional cells of Fischer—are these broad accompanying cells. In all collateral and bicollateral dicotyledons, with the sole exception of the Cucurbitaceæ, the finest ramifications of the bundles have a collateral structure. In the sieve-portion which lies beneath the vascular portion, imperfect sieve-tubes always occur along with the broad accompanying cells, and the cambiform which is sometimes scarcely distinguishable from them. These imperfect sieve-tubes are very narrow, and have no distinct sieve-discs; they contain little or no protoplasm, and no nucleus, but sometimes mucilage; frequently they are filled only with a watery fluid.

The blind ends of the veins in the lamina of the leaf are of two kinds, principal and secondary. The secondary ends never contain sieve-tubes, and in all collateral dicotyledons consist only of tracheids. Among bicollateral dicotyledons, only the Cucurbitaceæ have bicollateral secondary ends to the veins; the lower sieve-portion is in these represented by a row of broad accompanying cells, the upper sieve-portion by elongated cells containing but little protoplasm and no nucleus. All other bicollateral dicotyledons agree with the collateral in the structure of the secondary ends of the veins. The principal ends of all collateral and bicollateral dictyledons have always a lower complete sieve-portion, of the same composition as in the finest ramifications; and this always ceases before or along with the tracheids, never after them. In all the principal ends are also the blind ends of imperfect sieve-tubes.

The author disputes the statement of Areschoug that in *Ilex*, *Tilia*, and *Buxus*, the blind ends of sieve-tubes penetrate between the cells of the loose parenchyma, independently of the veins; the observation arises from a confusion with sclerenchymatous fibres. In *Buxus* the blind ends consist only of sclerenchymatous fibres, which have here assumed the function of tracheids, and must apparently be regarded as elements for the conduction of water. In *Buxus*, *Quercus*, *Juglans*, and *Aristolochia*, there are no blind ends of sieve-tubes in the lamina of the leaf, and no principal ends.

The sieve-portions of all dicotyledons examined always contain sieve-tubes, accompanying cells, and cambiform. The cambiform, in which the accompanying cells were formerly included, takes no part, or only a subsidiary one, in the conduction of albuminoids; its chief function is probably to furnish the materials for the production of albuminoids. The accompanying cells are the special seat of the formation of albuminoids, as is shown by their increase in size in the ultimate ramifications of the veins in the leaf. Fully formed sieve-tubes take no part in the production of albuminoids, but are the special organs for their conduction.

A list of sixty-two species is appended, to all of which these remarks apply, with the limitations named.

"**Sclerotioids" of Potato.***—Mr. A. S. Wilson finds in the leaves of diseased potatoes sclerotium-like bodies composed partly of protoplasm and partly of calcium oxalate, which he believes to be connected with the disease, the protoplasm not being found within the cells, but in the intercellular spaces through which the mycelium of the *Phytophthora* passes, consisting, therefore, probably of the remains of the fungus. Mr. G. Murray, on the contrary, maintains that they are merely mechanical concretions of the protoplasm of the cells of the leaf with calcium oxalate.

**Laticiferous Vessels.**†—Prof. S. Schwendener has investigated the laticiferous vessels of a number of plants, with the view specially of determining the following points:—the special conditions which cause the occasional very considerable thickening of their walls; the physical properties of their walls; and the cause of the movements in the latex.

The thickness of the walls was not found to be proportional to the age of the vessels; nor is there any simple arithmetical relationship between the thickness of the walls and the diameter of the tubes. The thick-walled tubes frequently bound intercellular spaces full of air, while those with thin walls permeate the parenchyma which is without interstices. The object of the thickness appears to be to present a resistance to the pressure of the contents, which may amount to several atmospheres. This is shown by the fact that if drops of desiccated latex, which are frequently found in the tubes, are dissolved in ether, the diameter of the tubes diminishes 4 or 5 per cent., while their walls increase 50 per cent. or more in thickness. It follows also from this observation that the inner lamellæ of the walls undergo greater tension from the contents than the outer lamellæ; the former show remarkable tenacity and elasticity, and can be stretched at least 10 or 15 per cent. in the direction of their length.

This elastic tension of the walls may obviously occasion movements in the contents of the tubes; such a movement towards the points of least pressure can be observed in the latex of seedlings of *Chelidonium majus;* for example, in the apex of the tap-root. Variations of pressure are brought about in the living plant by the elongation of the laticiferous tubes in the apical growth of the organ, and by changes in the composition of the latex. The author was able also to demonstrate a mass-movement of the latex by observation of the form and distribution of the solid substances found in it, especially starch-grains. Even unseptated laticiferous tubes may become closed by the pressure of the adjacent parenchyma, or by the formation of walls within the tubes.

With regard to substances excreted in the latex, it was found to be considerably more watery in withered or half-withered fig-leaves, in mulberry-shoots in the hibernating state, in roots of *Tragopogon* from which the leaves had been removed, in specimens of *Lactuca*

* Proc. R. Hort. Soc., 1885, March 10. See Journ. of Bot., xxiii. (1885) p. 74.
† SB. K. Preuss. Akad. Wiss., 1885, pp. 323-36 (1 pl.).

and *Chelidonium* grown in the dark, than under normal conditions. Whether this is caused by the resorption of the solid particles contained in the latex, the author was unable to determine. These solid particles, consisting of resin, caoutchouc, &c., he believes to be actual products of excretion, of no further use to the plant. They probably perform a purely mechanical function.

**Spiral Cells of Nepenthes.***—Herren L. Kny and A. Zimmermann have investigated the structure and functions of the elongated spiral cells which are found in the pith and cortex of the stem and in all parts of the leaves of *Nepenthes phyllamphora*. With regard to function, they conclude that the purpose of these structures is the storing up, and possibly the uniform distribution, of water through the assimilating tissue. They appear to have no mechanical function of supporting the tissues in which they are found.

**Fibrovascular Bundles of Cycadeæ.†**—MM. J. Costantin and L. Morot have determined the previously unsolved question of the origin of the supernumerary fibrovascular bundles in Cycadeæ, taking as their example *Cycas siamensis*. They find their origin to be in the pericycle, like those of *Dracæna* and of the Chenopodiaceæ. The successive layers formed by these bundles are not independent of one another; the first is connected with the normal fibrovascular circle by a certain number of anastomoses; and the following layers are united in the same way with one another, so as to present a network of larger or smaller meshes. These bundles, like those of Monocotyledons, appear at a very early period at the base of the stem, in connection with the adventitious roots. This was observed also in *Encephalartos Altensteinii* and *Ceratozamia mexicana*.

**Relation of Annual Rings of Exogens to Age.‡**—Prof. D. P. Penhallow, while hardly feeling justified in drawing decisive conclusions from his observations on this subject, considers that they furnish certain indications which it may be well to state as a guide to future and confirmatory observations. They are as follows:—

1. The formation of rings of growth is chiefly determined by whatever operates to produce alternating periods of physiological activity. In temperate climates, where the seasons are sharply defined, these periods are determined by the seasons themselves, but in tropical and sub-tropical latitudes other influences, recurring at less regular periods, operate to determine them;—therefore

2. In cold climates, rings of growth are an approximately correct index of age, but in warm climates they are of little or no value in this respect.

3. Even in cold climates there is not an absolute correspondence between number of rings formed and years of growth.

4. In warm climates the tendency is to obliteration of rings and homogeneity of structure.

5. The distinction of rings is essentially due to structural modifi-

* Ber. Deutsch. Bot. Gesell., iii. (1885) pp. 123-8 (1 fig.).
† Bull. Soc. Bot. France, vii. (1885) pp. 173-5.
‡ Canadian Record of Science, i. (1885) pp. 162-75.

cations sometimes aided by local deposit of pigment or resin, and this modification of structure is due in part to pressure of the external structure upon the formative tissues, and in part to physiological peculiarities of the plant itself independently of such pressure.

These indications are thus seen to be essentially in accord with the views generally held at the present time.

6. The influence of meteorological conditions in determining the growth of each season is most important, particularly with reference to rainfall.

7. Periodicity in rainfall corresponds with periodicity in growth.

**Anatomy of Pitcher-plants.***—MM. E. Heckel and J. Chareyre report the results of an anatomical investigation of various pitcher-plants belonging to the genera *Sarracenia*, *Darlingtonia*, and *Nepenthes*.

In the pitcher of *Sarracenia* they distinguish (1) the *lid* region, of which the upper (exterior) epidermis presents the ordinary leaf surface, while the lower surface is formed from cells with sinuous walls, and is furnished with very long, rigid, transparent, downward directed hairs. (2) The cells of the very short *throat* region are rectangular, elongated in the direction of the greatest dimension of the leaf. The cell-walls are thick, and on the external wall there is developed an extremely short, shining, downward directed hair-process. (3) The *median* region occupies two-thirds or the upper half of the pitcher. It has an epidermis of large cells with sinuous walls and abundant protoplasmic contents, and between its cells there occur numerous glands of eight cells, four triangular central, and four much larger peripheral. (4) The foot of the pitcher is alone assimilative; it is lined by small epidermic cells with rectilinear walls, some inclosing colouring matter, and all provided with abundant protoplasm. The hairs are very numerous, rigid, coloured, and directed downwards. The cavities of *Darlingtonia californica*, the only species of that genus examined, are anatomically wholly comparable with this fourth region.

In *Nepenthes* (1) the epidermis of both surfaces of the lid has sinuous cells with almost sessile glands, of which the base is formed of a single short cell, and the head of four or five reddish cells, forming a rosette. Delicate multicellular reddish hairs also occur. The other characters are those of the leaf. (2) The throat region forms the upper half of the pitcher below the collar, and is provided with an epidermis of sinuous cells, with abundant protoplasm and distinct nucleus. Many of the cells exhibit a swallow's-nest-shaped cavity, with greyish granular contents, and downward directed opening. The mesophyll layer of this and of the next region exhibits numerous cells with crystals of oxalate of lime, while others more numerous possess a very large nucleus and abundant colourless granules, with active Brownian movement. (3) The epidermal cells of the foot of the pitcher have very thick walls, and the glands are formed from a mass of small somewhat thick-walled cells, with abundant protoplasm and bright red colour. The glands are contained in a nest formed

* Comptes Rendus, ci. (1885) pp. 579–82.

of several cells, and the opening is directed downwards. The base of the pitcher always contains fewer animal remains than *Sarracenia*.

**Vegetative Organs of Monotropa.***—M. F. Kamienski describes in detail the structure of *Monotropa hypopitys*. The most important point of his observations refers to the root, which he finds to be covered externally by the mycelium of a fungus, which branches abundantly and forms a pseudo-parenchymatous envelope, often two or three times the thickness of the epidermis itself, being especially well developed at the apex of the root. It is entirely superficial, not penetrating into the living cells, though occasionally between the epidermal cells. The species of this fungus M. Kamienski was unable to determine, but considers it to be probably identical with that found on the roots of conifers and other trees.†

With regard to the mode of nutrition of *Monotropa*, M. Kamienski decides that it is not a parasite; the most careful examination failed in detecting any haustoria or other parasitic union with the root of any "host." He regards it as deriving its nutriment from the soil through the medium of the fungus-mycelium by which the roots are invested; the only parts of the root which are in actual contact with the soil are composed of lifeless cells with no power of deriving nutriment from it. The connection of the fungus with the roots of the *Monotropa* is not one of parasitism, but of true symbiosis, each of the two organisms deriving support and nutriment from the other.

**Protection of Leaves from excessive Transpiration.‡**—Herr E. Fleischer describes the various modes in which plants are protected against too great a loss of water through their leaves in respect of (1) the size, form, and position of the leaves; (2) the number, size, and structure of the stomata; (3) the size and form of the intercellular spaces; (4) the thickness of the outer epidermal walls, including formation of cuticle, coating of wax, or covering of hairs; (5) nature of the cell-contents; and (6) vital functions of the protoplasm. Those plants which are best protected against desiccation have a feeble energy of growth from the small quantity of carbonic acid which they absorb, and also from their small absorption of water in consequence of the diminished transpiration. Such plants are unable to maintain themselves in moist situations, and confine themselves to dry localities, while their leaves usually persist through two periods of vegetation; in the temperate zone they are mostly evergreen trees and shrubs.

**Heterophylly of Eucalyptus globulus.§**—Sig. G. Briozi suggests the following history of the dimorphism of the leaves of this tree. He supposes the original form and position of the leaves to have been broad and horizontal, and that the tree is probably descended from ancestors adapted to totally different climatic conditions. The vertical

* Mem. Soc. Nation. Sci. Nat. Cherbourg, xxiv. (1884) pp. 5-40 (3 pls.).

† See this Journal, *ante*, p. 844.

‡ Fleischer, E., 'Die Schutzeinrichtungen der Pflanzenblätter gegen Vertrocknung' (1 pl.), Döbeln, 1885. See Bot. Centralbl., xxii. (1885) p. 356.

§ Mem. Accad. Lincei, xiv. (1883) pp. 136-42. See Naturforscher, xviii. (1885) p. 296.

position and various form of the leaves in the upper part of older trees is an attempt to adapt themselves to new conditions, when the intensity of the sun's rays is above the optimum for the species, by greatly diminishing the surface of leaf exposed to the direct action of sunlight.

**Cecidomyia-galls on Poa.***—Herr W. Beyerinck has examined the structure of the remarkable galls produced on the internodes of the stem of *Poa nemoralis* by the attacks of *Cecidomyia Poœ*. While, under normal conditions, grasses are able to produce roots only from the nodes, these galls are clothed with a thick matting of roots produced from the pericambial layer of the internodes. When first formed these roots differ in no respect from ordinary underground roots, being provided with a root-cap, and a central vascular cylinder with a few pitted vessels, but with no root-hairs. In the course of development they assume more and more the character of aerial roots, and lose their root-cap.

**Opening of the Flowers of Desmodium sessilifolium.†**—Prof. C. E. Bessey describes the opening of the flowers of *Desmodium sessilifolium;* the principal phenomenon connected with this being that the resistance offered by the sepals is such as to cause the wings and keel, with their inclosed stamens and pistil, to be strongly deflexed. The stamens and pistil are thus drawn downward as one might draw down the end of a stiff spring. On pushing the standard gently back by a touch with a pencil point near the vicinity of the two bright yellowish-white eye-like spots on its dark-coloured base, the stamens and pistil are freed with a violent jerk. The object of this mechanism is obviously to cause the pollen to be thrown forcibly against the body of any insect hovering over the flower or resting upon its wings and keel.

**Inflorescence of Cuscuta glomerata.‡**—In his studies of this degraded member of the Convolvulaceæ, Prof. C. E. Bessey has found that the dodder produces its flowers upon short, adventitious branches, which themselves repeatedly branch, and are closely covered with scales. A further examination shows that this is the universal rule with the species, no normal inflorescence developing. The adventitious inflorescence always bears a definite relation to the position of the parasitic roots; that portion of the stem which produces roots always produces flowers; and the greater the number of the former, the larger is the number of the latter. The stem proper dies away soon, not only between the inflorescences, but also in the flower-clusters themselves. The flowering branches establish direct structural connection with the host-plant. When this is accomplished, the scales upon the branches often contain considerable quantities of chlorophyll.

**Relation of Ovary and Perianth in the development of Dicotyledons.§**—Prof. J. M. Coulter describes a simple and important

* Bot. Ztg., xliii. (1885) pp. 305–15, 321–32 (1 pl.).
† Amer. Natural., xix. (1885) pp. 711–3 (4 figs.).
‡ Science, vi. (1885) pp. 225–6. (Proc. Sect. of Biology, Amer. Assoc. Adv. Sci.)
§ Bot. Gazette, x. (1885) pp. 360–3.

character of systematic value observed in the study of the embryology of the dandelion. On comparing the same rudimentary stages of a large number of families, it was found that the character of superior or inferior ovary was the first to manifest itself. In the case of an inferior ovary, the protuberance which is to develope into the flower is arrested in its axial development, grows into a collar (the nascent floral envelopes); and there soon appears an external constriction separating the floral envelopes above from the ovary below. In the case of a superior ovary, the axial development is continued, and there is no external constriction. On such a basis the Compositæ stand at the head of the list, then Umbelliferæ, Rubiaceæ, &c. The second group, that with a superior ovary, includes Leguminosæ, Scrophulariaceæ, Labiatæ, &c.

**Elasticity in the Fruit of Cactaceæ.***—Mr. T. Meehan remarks on the elastic characters exhibited by the fruit of *Mamillaria Heyderi* and other species. This *Mamillaria*, under cultivation, flowers in April or May, and, after flowering, there is no sign of any development in the fruit. The ovary is, indeed, buried between the closely appressed walls of the bases of the mammæ. Here the fruits, which are two inches in length, remain undiscernible till just before the next flowering season, when they suddenly emerge, and in a single night apparently stretch out to their full length. The same sudden appearance of the fruit has been noticed in *Mamillaria Nuttalliana* and some allied Mexican species. That the sudden development is the result of an elastic projection and not of a proper growth, is manifest from the fact that the fruit is mature from its first appearance.

**Use of Spines in Cactuses.**†—Mr. T. Meehan considers that one of the uses of these spines is to break the full force of the sun on the plant. Plant-lovers set out their treasures in summer under "arbors" of fish-netting or galvanized wire, and those who have no experience would be surprised to find how the moving shadows of the twine or wire lower the temperature. A mass of spines on a cactus must certainly have the same effect. A cactus does not need much light on its epidermis to keep it healthy. Mr. Meehan adds, "I do not suppose I have yet reached the final purpose of spines in a cactus any more than we have the final purpose in the existence of the cactus itself, but that one use of cactus spines is to furnish a partial shade I feel to be beyond a doubt."

### *β.* Physiology.‡

**Theory of Descent.**§—Prof. E. Strasburger regards the act of reproduction in flowering plants as consisting in the union of the

* Proc. Acad. Nat. Sci. Philad., 1885, pp. 117-9.

† Bull. Torrey Bot. Club, xii. (1885) pp. 60-1.

‡ This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

§ Strasburger, E., 'Neue Unters. üb. den Befructungsvorgang für eine Theorie der Zeugung,' Jena, 1884. See Naturforscher, xviii. (1885) p. 326.

nucleus of the sperm-cell with the nucleus of the germ-cell, and as being therefore of the nature of a process of nutrition. The course of this union and the part taken in it by each constituent portion of the nucleus is described in detail. The elements of the nuclei which are not morphologically differentiated actually coalesce; the nuclear threads, on the contrary, of the two nuclei, do not coalesce, but simply lay themselves in apposition one to another, and actually coalesce in the daughter-nucleus only after the complete division of the germinal nucleus. The segments then unite by their ends into a single thread, which consists, therefore, half of segments derived from the father and half of segments derived from the mother, and hence, in inverse ratio, of portions derived from their more remote ancestors. This is, according to Strasburger, the morphological explanation of the inheritance of characters by descent. No morphological facts support the hypothesis of a difference in function of the two portions of the nucleus in conjugation; there are no special male or female elements which unite in the process. The influences of the male or female parent on the offspring are the result of special characteristics inherited by them from their ancestors.

**Hybridization and Cross-breeding of Plants.***—Dr. E. L. Sturtevant details his observations on crossed beans, maize, barley, peppers, tomatoes, squash, lettuce, and peas, from the results of which he concludes that in our domesticated vegetables cross-fertilization shows its effects at once in the reproduction of the form-species and varieties which are involved in the parentage of the crossed seed, and that when "pure seed" is crossed, intermediate forms rarely occur, but the original parents in variable proportions.

**Fertilization of the Wild Onion.†**—Mr. A. E. Foerste describes the fertilization of the (American) wild onion (*Allium cernuum*). The flowers are arranged in dense umbels, and there are six stamens, which arrive at maturity one after the other, the outer row developing first. The style remains short, maturing after the anthers have burst. The last stamen has shed its pollen before the stigma matures. The stamens composing the outer row are partly enfolded by the inner perianth-whorl, to which they are attached at their base. This tube serves as a guide to the nectary, which lies just in front of the base of the inner perianth-whorl. The nectary itself consists of three organs placed so as to cover the ovary, being adnate to it, and bilobed above in such a manner that the contiguous lobes approach each other, and serve as a cover to the three nectary glands just beneath their place of meeting. The lobes afterwards appear as six teeth cresting the maturing ovary. Cross-fertilization is necessary in these plants, and is effected by bees of various sizes. Self-fertilization is apparently impossible.

**Fertilization in Campanula americana.‡**—Prof. Charles R. Barnes finds that in this strongly proterandrous species, the pollen is scraped

* Amer. Natural., xix. (1885) pp. 1040–4. See also p. 995.
† Ibid., pp. 601–2 (4 figs.).
‡ Bot. Gazette, x. (1885) pp. 349–54 (1 pl.). See also *infra*, p. 1085.

out of the anthers by the hairy style at a period anterior to the maturation of the stigmas; before the occurrence of which the pollen has disappeared from the style. In this manner cross-fertilization is rendered certain. The pollen developes normally. The stigmas are held together until mature by interlocking papillæ. The hairs on the style become partially introverted, and thus free the pollen.

The pollen-grain contains two nuclei, the larger of which, the vegetative nucleus, becomes disorganized shortly after entering the pollen-tube, while the smaller spindle-shaped generative nucleus persists. The embryo-sac is cylindrical, with a gradual enlargement near the micropylar end, where is located the egg-apparatus, and an abrupt enlargement at the chalazal end, in which lie the antipodal cells. The embryo-sac has usually two nuclei. The pollen-tubes enter the style between the bases of the papillæ of the stigma, pass down in the strands of the conducting tissue, and not through the central canal around which this tissue is arranged.

**Influence of Want of Moisture on the Growth of the Chinese Yam.***—M. P. Duchartre has made a series of experiments on the effects of different degrees of moisture on the growth and structure of *Dioscorea Batatas*. The results are given in considerable detail, with the general conclusion that, at all events as regards this particular species, water, as an alimentary substance, promotes essentially the formation of parenchyma, without, in an appreciable degree, affecting the strengthening anatomical elements.

**Mechanical Injury to Trees by Cold.**†—Prof. T. J. Burrill deals with two mechanical effects of cold upon trees: the radial splitting of wood and bark, and the separation of bark or wood layers in a concentric way.

The first is explained by water freezing in plates parallel to the surface of an organ, and then, additions being made to the base, crystals perpendicular to the surface will be formed. Thus the wood contracting, and the ice expanding tangentially and longitudinally (chiefly the former), radial bursting is the result. The south side of a tree is the weakest, as more water exists there, and ice is first formed. Direct observation shows that the specific gravity of sap is greater on the north side of a tree.

Concentric splitting is explained by minute ice-crystals forming with their axes perpendicular to the wood-cylinder, thus causing radial tension. Want of ripeness of tissue, in the sense of the relation of water to other constituents, is the chief predisposing cause.

**Essential Food of Plants.**‡—Whilst no doubt exists as to the essential character of the elements of carbon, hydrogen, oxygen, and nitrogen as constituents of the food of plants, the evidence in support

* Bull. Soc. Bot. France, vii. (1885) pp. 156–67.

† Bot. Gazette, x. (1885) pp. 331–5.

‡ Nature, xxxii. (1885) p. 538. (Paper read before the British Association, Section B.)

of the elements phosphorus, potassium, magnesium, calcium, sulphur, iron, and chlorine to be regarded in this light cannot, Mr. T. Jamieson thinks, be considered conclusive.

A little consideration shows that the two elements iron and chlorine have but little claim to be considered as essential to the food of plants; and the experiments, of which an account is given, were made by the author with the view of vindicating the right of the five remaining elements to be so considered. These investigations were conducted at an experimental station in Sussex and also at one in Aberdeenshire, the nature of the soil in both cases being specially favourable. The method adopted consisted in observing the effect on plants grown in similar soil and under similar conditions when supplied with manures containing all these elements, and comparing the results with those obtained when one or other of these elements was withheld. The experiments seem to provide proof that sulphur must be discarded from the list of essentials, while some doubt is thrown on even lime and magnesia. At the same time striking confirmation is afforded of the essential characters of both phosphorus and potassium.

**Digestion of Proteids in Plants.***—Of proteolytic ferments occurring in plants two kinds have been described—one acting like animal pepsin, and occurring in carnivorous plants, in the seeds of vetches, hemp, flax, barley, and malt, and the fruit of the fig, *Ficus carica;* the other acting like animal trypsin (pancreatin), and occurring in the juice of the green fruit of *Carica Papaya* (the papaw tree). The use of these ferments in the plant economy has also been surmised by testing their action on animal proteids, from which they form peptones. It is a question whether they form peptones from the proteid occurring in the individual, and from two considerations. It is doubtful whether a true peptone exists in plants, i.e. a proteid soluble in water, and not precipitated by boiling, nitric acid, or acetic acid and potassic ferrocyanide. Vines concludes that the body called vegetable peptone is hemialbumose (Meissner's *a*-peptone). It is also evident that the action of these ferments on the proteids will be slow in comparison to the action of animal proteolytic ferments; thus there might appear the proteids intermediate between albumen and peptone, which Kühne and Chittenden call *albumoses.*

These questions Dr. S. Martin attempted to settle in the case of the papaw juice. He first of all extracted the proteids, which consisted of a *globulin*, corresponding to animal paraglobulin; two albumoses, which he proposes to call *α*- and *β-phytalbumose.* The *β* form is precipitated; the *α* form is not thrown down by boiling; a vegetable *albumen* corresponding to egg-albumen. The effect of pure papain (the proteolytic ferment of the papaw juice) was tested on each of these bodies, but from none of them was a true peptone formed; only a body corresponding to Meissner's *b*-peptone. The very slow proteolysis explains the limitation of the formation of the final products of proteid change. Leucin and tyroin were formed.

* Nature, xxxii. (1885) p. 563. (Paper read before the British Association.)

**Ferments and Enzyma.***—Dr. A. Hansen has experimented on the products of digestion resulting from the action on fibrin of the secretion of the pitchers of *Nepenthes*. The fibrin was first heated with hydrochloric acid, and then subjected to the action of the *Nepenthes*-secretion, neutralized by soda-lye, and boiled with a 5 per cent. solution of sodium chloride. The solution gave the reaction of hemialbumose, while the filtrate separated from the albumoses contains the peptone. The ferment of the *Nepenthes*-secretion may therefore be termed a vegetable pepsin, though its definite properties as regards resistance to acids and to temperature have not yet been determined.

The latex of the fig, *Ficus carica*, contains a substance with enzymatic properties, causing a peptone-reaction in both acid and alkaline solutions, coagulation of milk, an inverting diastatic action on starch and glycogen, and a precipitation of casein.

The latex of *Carica Papaya* was found also to contain a peptonizing enzyma, while substances of this kind appeared to be entirely wanting in a large number of laticiferous plants, e. g. *Euphorbia Myrsinites* and other Euphorbiaceæ, *Ficus elastica*, *Papaver somniferum*, *Chelidonium majus*, *Scorzonera*, and *Taraxacum*.

The author confirms the observation of Krukenberg with regard to the presence of a peptonizing ferment in *Æthalium septicum*, but not those of Gorup-Besanez and Will with regard to a similar phenomenon in the seeds of barley, vetches, and flax.

**Ascent of Sap.**†—M. J. Vesque further explains his theory of the cause and the course of the movements of water through the solid parts of plants. The vessels he regards, from this point of view, as elements for the purpose of carrying large quantities of water to great distances, and also as reservoirs of water when the fluid which they contain is rendered immobile by Jamin's chains, and to convey the small pressure of the inclosed air to a distance. The ascent of sap takes place in the following way.

The transpiring cells remove water from the fibres in the upper part of the plant, and the pressure of the air contained in these fibres consequently decreases, and they absorb water from fibres below them. The distribution of the air and water in each fibre depends on capillary attraction; each change in the volume of water corresponds to a new arrangement of the gaseous and liquid fluids, causing water to be carried to the upper part of the cell along its walls, the cell itself having previously contained water in its lower part only. This is brought about by capillarity only; the layer of water which covers the inside of the wall of the fibre and separates it from the air-bubble does not press by its weight on the fluid column, but on the skeleton of the tree; in consequence of which the pressure of water on the base of the tree is not greater than that of the sum of the indices of water which vary in the body of the tree; and these cannot exceed

* Arbeit. Bot. Inst. Würzburg, iii. (1885) pp. 253-88.

† Ann. Agronomiques, xi. (1885) p. 214. See Naturforscher, xviii. (1885) p. 300. Cf. this Journal, iv. (1884) p. 85.

10 m., at least when the pressure of the air which surrounds the wood of the roots is not greater than the atmospheric pressure. It is possible that columns of water may be formed which are interrupted only by saturated walls; but these, if they are long enough, will soon become immobile, and will play the part of the columns found in the vessels. They are besides of small constancy, because the active absorption of water by the surrounding elements breaks them up, or because they are themselves displaced by sinking.

**Galvanotropism.***—Herr L. Rischawi gives a *résumé* of all the previous observations on this subject; and has repeated the experiments on seedlings of *Vicia Faba* by means of Du Bois Reymond's apparatus. A positive curvature is easily obtained, which he explains in this way, that, under the influence of a galvanic current, the water in the root moves in the direction of the current. In consequence of this the turgidity of the cells increases on the side facing the cathode, which therefore elongates and causes a positive curvature. Negative and S-shaped curvatures stated to occur with a very weak current, the author found it very difficult to obtain; and, when obtained, they very soon became obliterated, and gave place to positive curvatures. They may be explained by assuming that with a weak current a slight diffusion is at first caused of the external fluid into the cells, especially on the side facing the anode, in consequence of which this side elongates, causing a negative curvature.

**Transpiration-currents.**†—Dr. A. Hansen describes experiments on living plants which tend to confirm his previous theory that transpiration-currents are due to imbibition. All the experiments negative the possibility of root-pressure taking any part in the phenomenon; the plants experimented on remained fresh for days, and absorbed considerable quantities of water through dead roots. They are equally opposed to Godlewski's hypothesis that osmose performs an essential part in causing the transpiration-currents.

**Absorption by the Plant of Non-nutrient Substances.**‡—Herr W. Knop describes a series of experiments for the purpose of determining the effect on plants of supplying to the soil in which they grow dilute solutions of various mineral salts. The degree is stated in which each ingredient was absorbed, and in which it produced a poisonous effect on the plant.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Bursting of the Sporangium of Ferns and the Anther of Flowering Plants.**§—Herr J. Schrodt reviews the existing literature of this subject, and gives the results of his own observations made with the assistance of the camera. In the case of *Scolopendrium vulgare*, the movements of the annulus, resulting from alternations of dryness and

* Bot. Centralbl., xxii. (1885) pp. 121–6.
† Arbeit. Bot. Inst. Würzburg, iii. (1885) pp. 305–14.
‡ Ber. Verhandl. K. Sächs. Gesell. Wiss., 1885, pp. 39–54.
§ Flora, lxviii. (1885) pp. 455–67, 471–99 (1 pl.).

moisture, are best explained by the assumption of unequal contractions of the unequally thickened parts of the cell-walls; a thin semicylindrical cell-wall contracting more strongly than the thickened inner wall of the same cells. The thickened radial walls act as arms of a lever.

The bursting of anthers was investigated chiefly in Berberideæ (*Mahonia intermedia* and *Epimedium alpinum*), Laurineæ (*Laurus canariensis*), Hamamelideæ (*Trichocladus crinitus*), and Ranunculaceæ (*Adonis autumnalis*). No contraction was shown in any direction by the epidermis. The cause of the unrolling of the wall of the anther must be sought in tensions of the inner fibrous layer of cells, of such a nature that the wall of the loculi, which is nearly uniform in thickness, exhibits considerably less power of contraction than the radial walls, the contraction of which causes the rupture of the anther, the thickenings contained in them acting as arms of a lever.

**Root-organs of Nephrolepis.***—In pursuing his examination of the underground stems and roots of ferns,† M. P. Lachmann has paid special attention to organs produced from the stem of *Nephrolepis*, below the base of the leaves, which have been regarded by some authors as cauline, by others as radicular. He finds that when the main stem has produced a dense rosette of leaves, it puts out from beneath each leaf a stolon, which sometimes developes into an aerial flagelliform organ, which branches only slightly or not at all, and sometimes buries itself in the soil, and branches like a root. Sometimes both these organs are found beneath a leaf, and each has then its characteristic fibro-vascular structure. The diameter of the stolons is usually about 2 mm., while that of the roots rarely exceeds 0·5 mm.

**Apex of the Root in Osmunda and Todea.‡**—Prof. F. O. Bower regards the leaf of Osmundaceæ as exhibiting an intermediate condition between that of the leptosporangiate ferns and the Marattiaceæ; the structure of the meristem of the root showing also a similar transition; this is best shown in transverse sections. In this way three distinct types may be determined, viz. (1) a single three-sided apical cell; in the Equisetaceæ and Polypodiaceæ; (2) a single four-sided apical cell; (3) a group of three equivalent initial cells. Intermediate conditions are found; but not the group of four initial cells, which Strasburger describes in the Marattiaceæ. The three-sided apical cell is always pyramidal, and the group of three have also always a truncate-pyramidal form. There does not appear to be the same regularity in the succession and position of the dividing-walls as in the Equisetaceæ and in many ferns. A similar variety is apparent in the development of the lateral roots.

In *Todea barbara* the author observed as a rule a group of four initial cells, which are either pyramidal or truncate-pyramidal; but with irregularities both in the origin of the lateral roots and in the

* Comptes Rendus, ci. (1885) pp. 603–5.

† See this Journal, iv. (1884) p. 592; *ante*, p. 839.

‡ Quart. Journ. Micr. Sci., xxv. (1885) pp. 75–103 (2 pls.). See this Journal, iv. (1884) p. 923.

apex of the mature root. In *Angiopteris evecta* the lateral roots also originate in a group of four initial cells.

The transition from the growing point of true ferns to that of the Marattiaceæ and flowering plants is accompanied by a lowering of the centre of formation. Both in this respect and in the partial filling up of the apical cell-cavity by radial walls, the Osmundaceæ occupy an intermediate position between typical Filices and Marattiaceæ. The co-axial structure, which first makes its appearance in the Osmundaceæ, is strongly developed in the Marattiaceæ, and indicates an approach to the structure of Gymnosperms.

In the development of the sporangium *Todea* also exhibits a transition to the Eusporangiatæ.

**Structure and Classification of Ophioglossaceæ.***—Following up his division of *Ophioglossum* into the three subgenera Euophioglossum, Ophioderma, and Cheiroglossa, Dr. K. Prantl uses, for further diagnosis of the species belonging to the first subgenus, the venation of the sterile branch, the length of the leaf-stalk, and the structure of the exospore.

The venation Dr. Prantl classes under two types, paraneural and ptiloneural. In the first, the median vein does not branch, while the lateral nerves which spring directly from the leaf-stalk dichotomize; the result being an arrangement similar to that of the leaves of monocotyledons. In the second type the median vein, which reaches the apex of the leaf, sends off alternately secondary branches on each side; and the lateral nerves which spring from the leaf-stalk are very subordinate. The leaf-stalk is either hypogæan or epigæan. The exospore is always thickened in a reticulate manner, but exhibits differences in the width of the meshes and the height of the ridges. Of less importance from a systematic point of view are the form of the epidermal cells of the stomata, the consistence of the leaf, the number of leaves developed at the same time, the structure of the stem and roots, and the presence or absence of adventitious shoots. Under the subgenus Euophioglossum are arranged twenty-seven species; Ophioderma and Cheiroglossa contain only one each, viz. *O. pendulum* and *palmatum*.

The fifteen species of *Botrychium* are arranged under the two subgenera Eubotrychium and Phyllotrichium already described.

**Morphology of Phylloglossum Drummondii.**†—Prof. F. O. Bower reports some of the results of a successful cultivation of this little known Cryptogam. From the smaller tubers, only vegetative organs arise, in the form of a successive whorl of rounded leaves springing as outgrowths from the broad apex. The apex of the axis, which is at first central, becomes depressed and overarched, and forms the apex of the new tuber. By peculiar localization of growth this is inverted, and comes to project laterally from the parent plant, while on the opposite side of the axis below the insertion of the oldest leaf the first root

* Jahrb. K. Bot. Gart. Berlin, iii. (1884) (2 pls.). See Bot. Centralbl., xxii. (1885) p. 135. Cf. this Journal, iv. (1884) p. 92.

† Proc. Roy. Soc., xxxviii. (1885) pp. 445-7.

arises *exogenously*, as in the embryo of *Isoetes*. Where the tuber is relatively large, sporangia are borne on the elongated axis of the parent tuber, and in such cases the new tuber originates adventitiously as a depression at the base of the sporangium stalk.

From the striking resemblance between *Phylloglossum* and the young plants of *Lycopodium cernuum*, recently described by Treub,* Bower proposes to regard *Phylloglossum* as a permanently embryonic form of a lycopodiaceous plant; but this awaits verification from the study of the as yet unobserved oophore generation.

### Muscineæ.

**Exudation of Water from the Female Receptacle of Corsinia.**†— Dr. H. Leitgeb points out the great importance to the Archegoniatæ (Vascular Cryptogams and Muscineæ) of the mouth of the archegonium being kept perfectly moist during the period of impregnation; otherwise air-bubbles enter the neck and prevent the passage of the antherozoids down the canal. This is in most cases insured by contrivances for conducting drops of rain or dew to the archegonium and retaining them there; as, for example, the dorsal furrows in *Riccia*, the lobes and appendages of the archegonial receptacle in the Marchantieæ, &c. In *Corsinia marchantioides* the same end is attained in a totally different way. The female receptacles here stand in the central line of the foliar organ, in depressions from which the necks of the archegonia project free into the air, each pit containing usually several receptacles in different stages of development. These are kept moist by a drop of water exuded from the tissue of the *Corsinia* itself into the depression, and found only in those near the apex of the shoot where the archegonia are in a receptive condition. The drop of water is found during the three or four days over which the impregnation of the various receptacles extends, and then disappears. The author was unable to detect the nature of the tissue by which it is exuded. He observed also in these depressions a funnel-shaped mass of protoplasm somewhat similar to that in the macrospores of *Marsilea*.

**Peristome of Bryaceæ.**‡ — M. Philibert considers that in the Diplolepideæ the internal row of teeth is formed by the detachment of a second thin membrane, of more complicated network, separated from the ordinary thick double membrane by empty cell-cavities. By such a separation would be formed a series of sixteen free processes such as are found in *Funaria*. That this is the true origin of the internal peristome is confirmed by the fact that in some species of *Bryum* it remains attached for a certain portion of its extent to the outer teeth. In *Funaria* this adherence is less common, but occurs in the rare *F. æquidens*.

This interpretation becomes clearer when compared with analogous structures in the Bryaceæ, especially in *Bryum* (*Ptychostomum*)

* See this Journal, *ante*, p. 277. † Flora, lxviii. (1885) pp. 327–30.
‡ Rev. Bryologique, xii. (1885) pp. 67–77. See this Journal, *ante*, p. 100.

*pendulum*, belonging to the section *Cladodium*, and its allies. The peristome here is of a very beautiful appearance and structure. We find a multiplication of cells in the layer which separates the two peristomes, explained, no doubt, by the influence of the internal peristome, the network of which is always more complicated, while the external peristome exhibits a tendency to be reduced, on its ventral side, to five rows of simple plates.

The structure of the peristome is described in detail in several other species of *Bryum*.

**Spores of Pottia.*** —Dr. G. Venturi insists on the importance of the characters of the spores, hitherto too much neglected, in determining the species and genera of Musci and Hepaticæ; the important characters relating chiefly to the form of the spores, and to the nature of their outer coat.

By using these characters, the moss hitherto described as *Pottia minutula* var. *conica* is clearly seen to be a totally distinct species; the spores being strongly tuberculated, instead of covered with minute hairs or spines, as in *P. minutula*, in addition to other differences in the capsule. The spores of *P. minutula* var. *conica* are those of *P. Starkei*, a species distinguished by the peculiarity that it presents every possible gradation between a perfect peristome and the complete absence of a peristome. Using the same test, *P. minutula* var. *oblonga* remains as a variety of the typical species; while *P. minutula* var. *mutica* and *P. lanceolata* var. *leucodonta* display an unquestionable affinity with *P. Starkei*.

**Stomata of Marchantia.†**—Prof. C. R. Barnes calls attention to the erroneous figures of the stomata of *Marchantia* in all English works on botany. They are shown with six cells in circumference, whereas they have only four. The shapes of the innermost cells, the true guard-cells, and of the outermost cells of the chimney-like stoma, are not correctly drawn.

**Pleuroweisia, a new genus of Mosses.‡**—Herr K. Schliephacke describes under this name a new genus of Musci from Switzerland with the following characters:—Perennial slender rooting densely cæspitose mosses. Stem erect, slender, usually dichotomous above, uniformly leafy. Network of the leaves oblong-rectangular below pellucid, minutely quadrate above, very minutely papillose. Inflorescence dicœcious; reproductive organs of both kinds lateral. Capsule gymnostomous, seated on a slender seta, exannulate; operculum with an oblique and very long beak. Calyptra cylindrical, slit on the side, covering the operculum, often falling off along with it. The type-species *P. Schliephackei* was found in a glacier-stream near Pontresina.

**Mosses of Terra-del-Fuego.§**—Herr C. Müller has examined a large collection of mosses from this district, including a considerable number of new species, which he describes. The total number of species now known from Terra-del-Fuego is 152, and the moss-flora

* Rev. Bryologique, xii. (1885) pp. 51–5.
† Bot. Gazette, x. (1885) p. 340.
‡ Flora, lxviii. (1885) pp. 359–64 (1 pl.).
§ Ibid., pp. 391–429.

presents several interesting peculiarities. Although reaching to over 50° S. lat., it includes tropical types belonging to the genera *Hypopterygium*, *Muiadelphus*, and *Hookeria*. The flora which presents the nearest relationship to that of Terra-del-Fuego is that of Kerguelen's Land; but here the tropical types are entirely wanting.

## Algæ.

**Polymorphism of Algæ.***—Dr. A. Hansgirg gives an historical *résumé* of the facts known with regard to the polymorphism of algæ, and then lays down the following propositions:—

1. Most, if not all, of the Schizophyceæ or Cyanophyceæ are polymorphic algæ, which occur in nature in different stages of their development, whether unicellular or multicellular, and may, under certain conditions, maintain themselves through many generations at any particular stage; their genetic connection can be proved by observation of the history of their development.

2. Most, if not all, of the algæ hitherto included in the family Chroococcaceæ, belonging to the genera *Chroococcus*, *Glœocapsa*, *Aphanocapsa*, *Synechococcus*, *Glœothece*. *Aphanothece*, *Chroodactylon*, *Glaucocystis*, *Clathrocystis*, *Polycystis*, *Cœlosphærium*, *Gomphosphæria*, *Merismopedium*, *Chroothece*, and *Rhodococcus*, are connected genetically with other more highly developed algæ; that is, they are descended, by retrogressive metamorphosis, from various filamentous Schizophyceæ, which pass into the unicellular condition by their filaments breaking up into separate cells.

3. In the genera *Leptothrix*, *Hypheothrix*, *Spirulina*, *Oscillaria*, *Phormidium*, *Chthonoblastus*, *Lyngbya*, *Hydrocoleum*, *Symploca*, and *Schizothrix*, belonging to the family Oscillariaceæ, are numerous forms most, if not all, of which are connected genetically, not only with one another as younger and older stages, and with various Nostochaceæ and Chroococcaceæ, by retrogressive metamorphosis, but also with others belonging to the families Rivulariaceæ, Scytonemaceæ, and Sirosiphonaceæ, as higher developments.

4. The genera *Nostoc*, *Anabæna*, *Cylindrospermum*, and *Sphærozyga*, belonging to the family Nostochaceæ, include many heterogenous forms, which, like the Chroococcaceæ, must be regarded as stages of development, analogous to certain zooglœa-conditions of the Schizomycetes, of different species belonging to the groups Oscillariaceæ, Rivulariaceæ, and Scytonemaceæ.

5. In the genera *Calothrix*, *Masticothrix*, *Mastigonema*, *Schizosiphon*, belonging to Rivulariaceæ, and in *Diplocolon*, *Scytonema*, *Arthrosiphon*, *Tolypothrix*, *Plectonema*, and *Glaucothrix*, belonging to the Scytonemaceæ, are included the highest developments of various algæ hitherto mostly placed among Oscillariaceæ.

6. Just as the more highly developed Rivulariaceæ and Scytonemaceæ may develope from various Oscillariaceæ, so also from *Glaucothrix*, *Tolypothrix*, and *Scytonema* may arise the corresponding forms

* Bot. Centralbl., xxii. (1885) pp. 246–51, 277–85, 308–10, 343–52, 373–83, 385–406; xxiii. (1885) pp. 229–33 (2 pls.).

in the genera *Hapalosiphon*, *Mastigocladus*, *Sirosiphon*, *Stigonema*, *Fischera*, and *Phragmonema*, placed under Sirosiphonaceæ.

7. Some Chlorophycaceæ are, like most Schizophyceæ, also polymorphic algæ. Most of the filamentous chlorophyll-green algæ which are placed in the genera *Glœotila*, *Microspora*, *Conferva*, *Psichohormium*, *Rhizoclonium*, *Hormiscia*, *Ulothrix*, *Hormidium*, *Schizomeris*, and *Schizogonium*, are connected genetically with other more highly developed algæ belonging to the families Chætophoraceæ, Siphonocladaceæ, and Ulvaceæ. By the swelling and separation of the cell-walls, and by continuous division, there arise from the last-named and other families of the higher algæ, various unicellular algæ in the broader sense of the term, which are placed under the genera *Protococcus*, *Palmella*, *Pleurococcus*, *Chlorococcus*, *Glœocystis*, *Inoderma*, *Stichococcus*, *Dactylothece*, *Palmoglœa*, *Schizochlamys*, *Oocystis*, *Nephrocytium*, *Palmodactylon*, *Dictyosphærium*, *Geminella*, *Hormospora*, *Apiocystis*, *Acanthococcus*, *Polyedrium*, *Characium*, and *Hydrianum*.

The author describes the mode in which the various forms of algæ here named may develope one out of another; and regards also the Schizophyceæ and Schizomycetes as connected with one another by insensible gradations. Thus we may have one and the same alga occurring in its fully developed form, and in its *Stigonema*, *Lyngbya*, unicellular, *Nostoc*, *Ulothrix*, and a variety of other forms. Of this a number of examples are given.

The various species of *Euglena*, hitherto included under Flagellata, especially *E. viridis*, have been discovered by Dr. Hansgirg to be genetically connected with the Phycochromaceæ or Oscillariaceæ.

Finally, a further analogy between the Schizomycetes and Schizophyceæ is established by the discovery in the latter of a hitherto unobserved swarming condition. This condition would appear to be extremely rare; but under the name *Chroomonas Nordstedtii*, Dr. Hansgirg describes a unicellular biciliated organism with blue-green endochrome, which he regards as the swarm-cell condition of a phycochromaceous alga which occurs normally in the filamentous form, probably *Oscillaria tenuis* or *Frölichii*.

**Chlorophyll-green of Fucaceæ.*** — Dr. A. Hansen details the method by which he extracts pure chlorophyll from *Fucus vesiculosus*, and describes the peculiarities of its spectrum, showing that it differs in no essential point from that of the higher plants. The spectrum of living *Fucus* shows four absorption-bands of the chlorophyll, one of the brown pigment, while the bands of the chlorophyll-yellow are not seen, being concealed by the strong absorption in the blue.

**Bisexuality of the Zygnemaceæ.†**—Prof. C. E. Bessey considers that these organisms do not possess true bisexuality. All the observed facts of the conjugation of these algæ tend to prove that sexuality is in its beginning, but as yet there is no differentiation into male and female elements; so that we cannot speak of a bisexuality,

* Arbeit. Bot. Inst. Würzburg, iii. (1885) pp. 289–304 (1 pl.).

† Science, vi. (1885) pp. 224–5. (Proc. Sect. of Biology, Amer. Assoc. Adv. Sci.)

although there is a union of two distinct bodies of protoplasm. One fact not sufficiently taken account of by Bennett* is that of the formation of a resting spore by union of the protoplasm of two adjacent cells of the same filament. The position of the Zygnemaceæ he puts as being among the lower Thallophytes, but little above the Protophytes.

**Problematic Organisms of the Ancient Sea.**†—Count G. de Saporta enters into an elaborate reply to the theory of Nathorst that the supposed organic remains of a very early geological period are in reality the petrified impressions of the footsteps of animals. He maintains that a minute examination of their structure entirely contradicts this view; and that even those about which Nathorst expresses the greatest doubt may be petrifications of algæ in half-relief.

**Algal-flora of the Arctic Ocean.**‡—Dr. F. R. Kjellman describes in great detail the algæ collected by the 'Vega' expedition in different parts of the Arctic Sea, and discusses the causes which have brought about its special characteristics. The total number of species described is 174, viz. 135 in the Spitzbergen, 27 in the Siberian, 117 in the American region. These include a considerable number of new species, and two new genera, *Hæmescharia* and *Diploderma*, both belonging to the Lithodermatieæ. 63 of the species (belonging to 34 genera and 22 families) are not found south of the Arctic Sea; while one-third belong exclusively to the portion not filled with ice.

The families to which the greater part of the algæ belong are the Laminariaceæ, Fucaceæ, and Corallineæ, all the others being but sparsely represented. The Fucaceæ give the prevalent character only to the sub-arctic region, being very scarce or altogether absent elsewhere. The Corallineæ occupy large extents of the sub-littoral region; cushions of *Lithothamnion glaciale* cover in places areas of four to five square miles. By far the largest portion of the algal vegetation of the Arctic Sea is composed of Laminariaceæ, extending, on the west coast of Norway and Greenland, from low-water mark to a depth of ten fathoms; in other parts they are found only at a depth of three to ten fathoms.

**Laminariaceæ of Norway.**§—In describing the Laminariaceæ of the Norwegian coast, Herr M. Foslie points out a frequent source of error in the description of species from the use of dried instead of fresh specimens. He further describes three different forms of haptera or attachment-organs found in the Norwegian species.

**Morphology and Classification of Black Sea Algæ.**‖—Prof. L. Reinhardt contributes an elaborate paper, the first of a series, on this

* See this Journal, iv. (1884) p. 434.

† Bull. Soc. Geol. France, xiii. p. 179. See Naturforscher, xviii. (1885) p. 267.

‡ Vega-Expeditionens Vetens. Jakttagelser, iii. pp. 1–430 (31 pls.), Stockholm, 1883. See Bot. Centralbl., xxii. (1885) p. 65.

§ Christiania Videns.-Selks. Forhandl., 1884, 112 pp. (10 pls.). See Bot. Centralbl, xxii. (1885) p. 193.

‖ Mem. Novorossian Soc. Naturalists, ix. (1885) pp. 201–512 (11 pls.). Cf. Nature, xxxii. (1885) p. 579.

subject. Following the example of Bornet and Thuret in their 'Notes Algologiques,' the author publishes his observations on separate species without awaiting the time when he will be enabled to publish a more complete work.

In the morphological part of his paper Prof. Reinhardt discusses the development of a few Chlorophyceæ, and enters into more details with regard to some of the Cyanophyceæ, and especially the Phæosporeæ (the conjugation of *Ectocarpus siliculosus* and the growth of *Sphacelaria*). As to the Rhodophyceæ, only short remarks are given, more particularly as to pores in their external covering. The chief attention has been devoted to the Bacillariaceæ, and the paper contains a good deal of new observations on the structure of gelatinous colonies, the structure of the cell and its protoplasmic parts, and the auxospores. The systematic parts will appear in a subsequent issue.

**Movement and Formation of Mucilage by the Desmidieæ.***—Herr G. Klebs describes four kinds of movement in the desmids, viz. (1) A forward motion on the surface, one end of the cell touching the bottom, while the other end is more or less elevated, and oscillates backwards and forwards during the movement; this is especially well seen in *Closterium acerosum*. (2) An elevation in a vertical direction from the substratum, the free end making wide circular movements; well seen in *Closterium didymotocum*. (3) A similar motion followed by a sinking of the free end, and an elevation of the other end, and so on alternately, characteristic of *Closterium moniliferum*. (4) An oblique elevation, so that both ends touch the bottom, lateral movements in this position, then an elevation and circular motion of one end, and a sinking again to an oblique or horizontal position, seen best in strongly curved species of *Closterium*, as *C. Dianæ* and *Archerianum*. These movements are none of them peculiar to particular species; several of them are often combined in one. A free swimming on the surface was never observed.

The two first of these kinds of movement depend on the formation, during the motion, of a filament of mucilage by which the desmid is attached to the bottom, and by the gradual lengthening of which, from the formation of fresh mucilage, it rises. This filament is best detected (e. g. in *C. didymotocum*) by tinging by a weak solution of methyl-violet, which does not kill the desmid; fuchsin also answers, and cyanin, though not so well; other pigments fail in staining it. Many species of *Euastrum*, *Cosmarium*, *Pleurotænium*, and *Staurastrum* exhibit the same phenomenon. The rapidity of the movement and of the formation of the filament vary with the conditions and with the species, many species exhibiting no trace of the former; the most rapid motion observed in *C. acerosum* was 112 $\mu$ in thirty seconds. It is subject also to periodic variations, with alternations of complete rest. The greatest length of filament measured was 3 mm.

Light exercises an influence on the direction of the movement of desmids similar to that of zoospores; but the power of motion itself appears to be very little affected by light. The elevation above the substratum appears to be independent of the direction of gravitation.

* Biol. Centralbl., v. (1885) pp. 353–67.

The author regards the cause of the motion to be the exudation of mucilage, which does not take place uniformly and simultaneously from the whole surface of the desmid. This is not, however, here, as it is elsewhere, a result of the disintegration of the cell-wall itself; it is derived directly from the cytoplasm, and passes through the cell-wall without the latter undergoing any change. Many species are completely surrounded by a gelatinous envelope, while others are comparatively free.

**Internal Spore-formation in Diatoms.***—Count Ab. F. Castracane describes a remarkable appearance in a deposit of marine diatoms of pliocene date from the Apennines. In a specimen of *Coscinodiscus punctulatus* he observed that the lower part of the valve, minutely punctuated in a radial disposition, showed small round uniform stalked bodies; the drawing under the camera lucida exhibiting clearly the circular figure. No other interpretation seems possible of these minute round bodies, always found in the interior of the frustule, except that they constitute a nest of embryonal diatoms on the point of escaping from the mother-cell. This is in accord with previous observations of the author on similar round bodies seen on the point of escaping from a *Podosphenia*, and with observations of Rabenhorst and O'Meara. The fact that the diatoms in which these bodies were observed had previously been treated with boiling sulphuric acid with addition of potassium chlorate, shows conclusively that the round corpuscles seen to escape from living diatoms are not Infusoria or other organisms fortuitously collected round them, and demonstrates at the same time that, from the first moment of their existence, diatoms must be provided with a siliceous coating, though it may be of extreme tenuity.

It would seem then that a diatom may assume the function of a sporangium, producing in its interior embryonal forms by which the species is reproduced, and which ultimately acquire the form and approximately the size of the mother-frustule.

**Mysterious Appearance of a Diatom.**†—Mr. F. Kitton finding on carafes of water a film composed entirely of frustules of *Achnanthes linearis*, and having never found it on the filter papers used in filtering the water, filtered 8 oz. of the water into a glass-stoppered bottle, using a filter paper 1 in. in diameter and a very small glass funnel. When the bottle was filled the paper was boiled in sulphuric acid and decarbonized, the residuum giving no indications of diatomaceous remains. In the course of a few days the film began to appear on the bottle, and was found to consist of the above-named diatom unmixed with any other form. As this is a very minute species (0·0004 in. in length and less than 0·0002 in. in breadth), he thought it just possible that some of the frustules might have passed through the paper, but on filtering some emery-powder which had remained in suspension six or seven hours, and the particles of which were less than 0·00005 in. in size, these were found not to pass through the

* Accad. Pontif. de' Nuov. Linc., xxxviii. (1885) Sess. May 17, pp. 7–8.
† Journ. Quek. Micr. Club, ii. (1885) pp. 178–9 and 206.

filter. The microspores must therefore be sufficiently minute to pass through the paper.

**Navicula Durrandii n. sp. F. K.**—Mr. F. Kitton gives the following specific description of this new diatom. "Valve elliptical-lanceolate, apices produced, median blank space linear-elliptical with two narrow lines of puncta one each side of the raphe, markings composed of longitudinal lines (about 8 in ·001 in.) of puncta 24–28 in ·001 in. Length, ·0116–·0200 in.; breadth, ·0038–·0040 in. Habitat, Island of Rea, near Singapore. I am indebted te Mr. A. Durrand for this beautiful species; it occurs sparingly in a dredging recently made by him in the above-mentioned locality, and from which he has permitted me to make some preparations. Although apparently a robust species, it is really not so, as the somewhat numerous fragments of valves unfortunately testify. In almost every case the fracture occurs between the longitudinal lines. An examination with a power of 750 diameters shows that these lines are dentate elevations, and the spaces between them concave grooves. Under a lower power (40 diameters) the valve is slightly iridescent, but the lines are visible. I have named this fine form after Mr. Durrand."

**Fossil Marine Diatoms.***—Prof. P. T. Cleve describes the fossil diatoms found recently in the marine deposits of Moravia, known as Tegel (marl or clay) belonging to the miocene and pliocene divisions of the tertiary formation.

The new species are *Campylodiscus obsoletus*, *Triceratium turgidum*, *Aulacodiscus Grunowii*, *Auliscus pulvinatus*, *Podosira antediluviana*, *Syringidium* sp., *Melosira Omma*, *Coscinodiscus Thumii*, and *Aulacodiscus* sp. (found by Mr. F. Kitton). A new family, Thaumatodisci, is established to include some very remarkable forms, the valves of which have prominent central processes. Prof. Cleve places in this family *Thaumatonema* Greville, *Strangulonema* Greville, and *Pyrgodiscus* n. gen., *P. armatus* n. sp.

Some eighty species have been found in the Tegel, with two exceptions all marine. Only a comparatively few appear to be extinct, and of these a remarkable number have been detected in the Moron deposit said to be found near Seville. Of the recent species many forms are now living in the seas of Japan, California, West Indies, &c., proving that the Tegel was a deposit in a tropical or subtropical sea. It is of interest to compare these fossil forms with recent specimens, and to note how little their characteristics have been altered during the long period since the later tertiary.

### Lichenes.

**Müller's 'Contributions to Lichenology.'†**—Dr. J. Müller concludes his 'Lichenologische Beiträge,' which have been going through twenty-one numbers of 'Flora,' with some general remarks.

* Journ. Quek. Micr. Club, ii. (1885) pp. 165–77 (2 pls.).
† Flora, lxviii. (1885) pp. 345–56.

In two species of *Strigula* from Cuba and Caracas, Dr. Müller found stylospores of a very peculiar form, with a number of transverse divisions, amounting to even eight, instead of the ordinary bicellular condition, with a power of growing to more than ten times their original length. These facts lead to the hypothesis that spermogonia and spermatia are possibly connected genetically with pycnidia and stylospores; that spermatia are, in fact, nothing but young stylospores, and spermogonia nothing but young conditions of pycnidia.

The ordinary view that the spermatia of lichens are male sexual organs which have lost their function, is combated on the following grounds:—The spermatia spring from basidia, and have therefore a totally different origin from antherozoids. They are not naked nucleated masses of protoplasm, but are provided with a cell-wall, like spores and ordinary vegetative cells. They are not organs of special nature, but have the structure of an ordinary unicellular spore. There is no organ in lichens which can be regarded as an oogonium. The sexual reproduction observed by Stahl is not essential to lichens, for Fünfstück has shown * that in *Peltigera* fructification and ascospores are produced without the agency of spermatia; the swelling of the ascogonium taking place vegetatively without the co-operation of a trichogyne. The author contends that in lichens no true process of sexual reproduction has been observed, but at the most a doubtful "copulation" in the older sense of the term.

Dr. Müller supports the older view of the autonomy of lichens, against the newer theory of "symbiosis." He complains of de Bary's recently published 'Anatomie u. Physiologie der Pilze,' that in summing up the arguments in favour of Schwendener's hypothesis, he omits all reference to Minks's and his own work on Microgonidia, and incorrectly uses the terms "conidia" and "gonidia" as convertible. Dr. Müller considers this theory as completely demolished by the discovery of Minks † that the gonidia of lichens exist from the first in the hyphæ or hypha-like organs, in the form of minute very light-green microgonidia, some of which develope, when the hyphal membrane becomes converted into mucilage, into gonidia. These facts he claims to have confirmed by independent observation.

**Anatomy and Development of Lecanora granatina.**‡—Dr. K. B. J. Forssell has carefully studied the structure and development of this lichen, the peculiarities of which have caused it to be placed by different authorities in several different groups. The crustaceous thallus contains both yellow-green (palmella) and blue-green (gloeocapsa) gonidia, inclosed in a reddish gelatinous envelope; and these different parts of the thallus may be either quite dissociated or closely united together; the two kinds of gonidium becoming sometimes completely intermingled in the course of development of the lichen. Between the different parts of the thallus are also free gloeocapsa-colonies, and others into which the hyphæ are beginning to penetrate. Those parts of the thallus which contain these colonies are especially

* See this Journal, *ante*, p. 499.
† See this Journal, ii. (1879) p. 311.
‡ Bot. Centralbl., xxii. (1885) pp. 54-8, 85-9.

strongly developed; while those parts which contain the palmella-gonidia are much less luxuriant; they usually have gonidia in their middle, but no distinctly differentiated cortical layer. It is, however, only these portions of the thallus which produce apothecia; but no spermogonia were detected in them. In the parts which contain the glœocapsa-gonidia, spermogonia were occasionally observed of the same structure as those of *Pyrenopsis*. In the same crustaceous grain, and sometimes at the same time, may be found an apothecium in the part which contains palmella-gonidia, and a spermogonium in the part which contains glœocapsa-gonidia.

From analogy with the development of *L. hypnorum*, the author concludes that the portions of the thallus which contain glœocapsa-cells, and which are united in growth with grains which contain palmella-gonidia, are true cephalodia, while those parts which are somewhat more free develope into pseudo-cephalodia. In both these species of *Lecanora* the thallus consists of two different parts, one containing normal gonidia, the other a foreign alga; in both parts the foreign alga comes into contact with hyphæ which envelope it, branch in the algal colony, and form a hyphal system inclosing gonidia, in other words a cephalodium. As compared with *L. hypnorum* the glœocapsa-gonidia have, in *L. granatina*, attained a much fuller development in comparison with the normal gonidia. The disc of the apothecia is even sometimes to a great extent covered by glœocapsa-colonies.

*Lecanora granatina* may therefore be regarded as a lichen which developes from a form with yellow-green gonidia (archilichen) to one with blue-green gonidia (glœolichen), or rather to a species of *Pyrenopsis*, the only distinction from *P. pulvinata* consisting in the presence of an excipulum thallodes containing yellow-green gonidia.

No previous instance has been observed of spermogonia occurring in cephalodia; but trichogynes and ascogenous hyphæ have not yet been detected in them. It is, however, clearly demonstrated that from hyphæ which come into contact with free algal colonies, a hyphal system containing spermogonia may be developed.

### Fungi.

**Hydrocarbon Reserve-products of Mushrooms.***—Dr. L. Errera has demonstrated the similarity of the reserve nutritive products in Phanerogams and Fungi. M. Errera has shown that just as in the Phanerogams the reserve food-material is found in starchy, oily, or cellulose form, so it is in the mushrooms, where, however, glycogen replaces starch. The sclerotia of the fungi were especially examined, and during germination the glycogen of the sclerotium of e. g. *Coprinus niveus* was seen to diminish and to migrate into the young fungus. In the oily sclerotia (e. g. *Claviceps purpurea*) he has proved the passage of oily material into glycogen. Just as Sachs long since demonstrated the change of oily material into starch in the germinating seed, so M. Errera has shown in oily sclerotia (e. g. *Claviceps purpurea*)

* Comptes Rendus, ci. (1885) pp. 391–3.

a similar passage into glycogen. It is interesting to note that in the young *Claviceps* there is a special accumulation of glycogen at the points where the organs of fructification afterwards appear, especially in the cells which occupy the central region of the cavity of each future perithecium, whence it disappears as the spores reach maturity. Many spores inclose oil formed at the expense of the glycogen, and during germination this changes into the transitory glycogen found in the germinating filaments. An interesting physiological parallel between phanerogamic and cryptogamic germination is thus indicated.

**Helicobasidium, a new Genus of Hymenomycetes.*** — M. N. Patouillard describes a fungus parasitic on *Asarum europæum* under the name *Helicobasidium purpureum*, which he regards as the type of a new genus. It is characterized by a peculiar twisting of the basidia, each of which is surmounted by two sterigmata. The basidia are arranged like those of *Corticium;* the spores are colourless, and kidney-shaped.

**Puccinia Thlaspidis.†** — M. P. Vuillemin finds this fungus parasitic on *Thlaspi alpestre*, at various altitudes in the southern Vosges. It is characterized by the absence of the heteromorphy which is so characteristic of the genus, occurring only as teleutospores without any uredo- or æcidio-form. The germination of the spores is preceded by a gelatinization of the membrane. The teleutospores appear to have lost their ordinary property of hibernating, and the fungus persists through the winter by means of its mycelium.

**Mould-fungi as Ferments.‡**—Prof. F. Cohn describes the mode of fermentation of the Japanese saké or rice-wine. The material used is grains of "Tane Kosi," i.e. of rice coated with the mycelium, conidiophores, and greenish-yellow chains of conidia of *Aspergillus Oryzæ*. The fermentation is caused by the mycelium of this fungus before the development of the fructification. The rice is first exposed to moist air so as to change the starch into paste, and then mixed with grains of "Tane Kosi." The whole mass of rice is shortly permeated by the soft white shining mycelium, which imparts to it an odour of apple or pine-apple. To prevent the production of fructification, freshly moistened rice is constantly added for two or three days, and then exposed to alcoholic fermentation from the *Saccharomyces* which is always present in the rice, but which has nothing to do with the *Aspergillus*. After two or three weeks the fermentation is completed, and the golden-yellow sherry-like saké poured off. A sample manufactured in the laboratory contained 13·9 per cent. of alcohol. Chemical investigation showed that the *Aspergillus*-mycelium transforms the starch into glucose, and thus plays the part of a diastase.

Another substance produced from the *Aspergillus*-rice is the soja-sauce. The soja-beans, which contain little starch but a great deal of oil and casein, are boiled, mixed with roasted barley, and then with the greenish-yellow conidia-powder of the *Aspergillus*. After the myce-

* Bull. Soc. Bot. France, vii. (1885) pp. 171–3. † Ibid., pp. 184–5.

‡ JB. Schles. Gesell. Vaterl. Cultur, lxi. (1884). See Biol. Centralbl., v. (1885) p. 417.

lium has fructified the mass is treated with a solution of sodium chloride, which kills the *Aspergillus;* another fungus, a *Chalara,* appearing in its place, similar to that produced in the fermentation of "sauerkraut." The dark-brown soja-sauce then separates.

**Penicillium-Ferment in Pharmaceutical Extracts.*** — M. E. Cocardas describes and figures the forms of *Penicillium*-ferment grown on various pharmaceutical extracts, and arrives at the conclusion that the ferment causes in the extract changes comparable to those effected by heat, viz. the absorption of oxygen and disengagement of carbonic acid, with formation of water, causing in consequence dilution of the extract. The exact changes are, however, complex, and vary with each special extract. The *Penicillium* itself is subject to a series of variations, but these are all varieties in the evolution of a single form.

**Rhodomyces, a new Human Parasite.†**—Dr. R. v. Wettstein has found a fungus in the gastric juice of patients suffering from pyrosis, which he describes as a new species and genus under the name *Rhodomyces Kochii.* It was always observed outside the organism, but appears to be connected with the saliva, but only in certain individuals. It then shows itself as a dense delicate pink mould, the structure of which is obscured by the enormous quantity of conidia. Its morphological character can, therefore, only be determined by culture. The author considers *Rhodomyces* to have the closest affinity to several forms of *Oidium,* but is distinguished by the appearance of the conidiophores, by the mode of formation of the conidia, and especially by its unseptated hyphal branches. Its habit resembles that of *Trichothecium roseum* and several other moulds.

**Fungus-disease in Daphnia.‡**—Under the name *Monospoza bicuspidata* Professor A. Guillebeau describes a parasitic fungus which attacks the great water-flea, *Daphnia magna.* It appears in the form of chains of conidia which reproduce themselves by budding in such quantities that the cavity of the body is completely filled by them. Under certain conditions a needle-shaped spore is formed within the interior of the cells, surrounded by a sac derived from the cell itself, which sac is not soluble either in water or various nutrient fluids, but very soluble in the gastric juice of the *Daphnia.* As soon as these spores lose their envelope, they penetrate into the cavity of the body of the host, and there develope fresh conidia. The increase of the parasite is impeded, and sometimes entirely prevented, by the blood-cells which surround the spores, and which exercise a digestive effect upon them.

### Protophyta.

**Beggiatoa alba.§**—Prof. J. B. Schnetzler has observed this organism forming gelatinous greyish floating masses in the effluent water from

* Bull. Soc. Bot. France, vii. (1885) pp. 146–9 (1 pl.).

† SB. K. K. Akad. Wiss. Wien, xci. (1885) pp. 33–58 (1 pl.). See Oester. Bot. Zeitschr., xxxv. (1885) p. 287.

‡ SB. Naturf. Gesell. Bern, 1884, pp. 9–11.

§ Bull. Soc. Vaud. Sci. Nat., xxi. (1885) pp. 68–70.

a brewery. He confirms the statement of previous observers,* of its power of separating free sulphur from the sulphates contained in the water in which it is found, in the form of refringent globules found within its cells. M. Schnetzler has observed the segments divide themselves into little discs, and these again divide into zoogloea-masses. Sometimes the cells elongate into a bacillus-form, or twist into a vibrio-form, and it is from these cells that the filaments of *Beggiatoa* are developed. He regards the organism as a degraded *Oscillaria*, which has retained its power of oscillation, but has lost its capacity for forming chlorophyll, and also the mucilaginous sheath which originally surrounded it.

**Algæ of Thermal Waters.**†—M. J. Thore has published a monograph of the algæ found in the warm springs of Dax, at a temperature of 64° C., which form a green, brown, or greenish-brown deposit on any object brought into contact with the waters or their vapour. These algæ are of very simple organization and minute size, and do not resemble those of fresh or salt water. He divides them into five groups, viz:—(1) Globular forms containing protoplasm which is first yellow and then green, and which gives birth to organisms resembling the Palmellaceæ, *Merismopedia*, &c., or dividing in one direction only and passing into moniliform algæ of group (2), presenting the appearance of Nostochineæ, with here and there larger cells or heterocysts. (3) Tubular algæ, with forms intermediate between these and group (2). (4) Filamentous cylindrical algæ, of a blue-green colour and endowed with rotatory and oscillatory motions, Oscillarieæ, including *Oscillaria niger*. (5) Minute organisms belonging to the Bacteriaceæ. The author states that these organisms are formed directly from the glarous protoplasm by condensation and inclosure within an envelope. He distinguishes two modes of genesis from this glarous protoplasm, spherical and tubular. The forms included in the second and third groups belong exclusively to the thermal flora, and M. Thore suggests that they may possibly be the last surviving representatives of the ancient flora of the warm seas of the Laurentian and Silurian epochs.

**Cystitis and Nephritis produced by Micrococcus ureæ.**‡—MM. R. Lépine and G. Roux find that cystitis and nephritis may be produced in the healthy animal by the introduction of *Micrococcus urcæ* into the ureter. Experiments made on guinea-pigs showed that the mucous membrane of the bladder was inflamed, and that if the animal was killed soon after the experiment the kidneys were congested. Sections revealed the presence of micrococci in the epithelial cells, and a fragment of the central portion of the kidney gave a pure cultivation of *Micrococcus ureæ*. Corresponding results were obtained with dogs, even though the urine is there acid.

**Effect of Sunlight on Micrococcus.**§—M. E. Duclaux follows up his researches on the influences of the environment on microbes by an

* See this Journal, iv. (1884) p. 937.
† Bull. Soc. de Borda, 1885. See Journ. de Microgr., ix. (1885) p. 320.
‡ Journ. des Soc. Scientifiques, i. (1885) p. 369.
§ Comptes Rendus, ci. (1885) pp. 395-8.

interesting study as to the effect of sunlight on the vitality of micrococci. He experimented on six species, more or less distinct, discovered in various cases of disease (clou de Biskra, pemphigus, rheumatic nodosities, impetigo contagiosa, &c.). The influence of the sunlight varied with the age of the microbes, with the absence or presence of cultivating fluid, and with the season. He did not discriminate between the influence of the light and of the heat of the sun, except in so far that he did not subject the micrococci to temperatures exceeding those most suitable to their development (i. e. between 30° and 40° C.). In ordinary circumstances, where the sun's heat is frequently much greater, the vitality of the microbes will be consequently much less. (1) Young micrococci in decoction of veal, living on an average more than a year when not subjected to sunlight, were killed by forty days' exposure to the feeble and intermittent light of the spring sun of May and June, while in July a few days sufficed to render them innocuous, and fifteen days to kill them. (2) When the micrococci were allowed to dry, protected only by the thin residue of the evaporation of a drop of the cultivating fluid, they were killed by eight days' exposure, between May 26th and June 3rd, while in July, two or three days were enough, even in a window with only four hours' sun, and with a temperature never above 39°. The apparent absence of spores is probably largely the explanation why the limits of vitality are more restricted than in the case of bacilli. Since a few hours' exposure is enough to kill the micrococci, we have an interesting explanation of the abundant dead germs in the air, of the restricted area of their fatal potency, except when conveyed by media where they are protected from sunlight. In a word, as he says, sunlight is the most universal, potent, and economic antagonist of these our most subtle enemies.

**Decomposition and Fermentation of Milk.***—In continuation of previous investigations on this subject,† Dr. F. Hüppe describes distinct organisms which he finds to be invariable accompaniments of lactic fermentation. One of these he isolated on nutrient gelatin, in the form of white shining flat minute beads. This organism transforms milk-sugar and other saccharoses into lactic acid, with evolution of carbonic acid gas. It is rarely found in the saliva or dental mucilage. In them are two micrococci, which cause the production of lactic acid, which manifest differences in their development on cultivation. There were also two pigment-forming bacteria, the *Micrococcus prodigiosus*, which produces intense red spots, and the yellow micrococcus of osteomyelitis. These five bacteria are so different and so constant in their properties, that they must be regarded as distinct species. In addition to these, there is in milk an organism resembling *Mycoderma aceti* which transforms milk-sugar into gluconic acid.

**Systematic Position of the Bacteriaceæ.**‡—M. J. Künstler discusses this subject in detail, and argues that the Schizomycetes

* Deutsch. Medicin. Wochenschrift, 1884. See Bot. Centralbl., xxii. (1885) p. 237.

† See this Journal, iv. (1884) p. 786.

‡ Journ. de Microgr., ix. (1885) pp. 248–58, 295–307 (1 pl.).

occupy an intermediate position between the animal and vegetable kingdoms, partaking of the character of both. He believes them to be of animal origin, but to have acquired, in certain instances, characters which are purely vegetable. They show no indication, as some have believed, of degradation from a higher type; their characters are those of evolution. They are organisms altogether devoid of differentiation; they have no nucleus, and their protoplasm presents everywhere a homogeneous structure.

The author has observed in the intestines of a *Nepa* an organism which he describes under the name *Trypanosoma Berti*. It is a cylindrical filiform body, sometimes somewhat curved, about 18 $\mu$ long, slightly swollen in the middle, and bearing at its anterior end a flagellum of nearly uniform thickness. The adult individuals are usually twisted in a spiral manner, and then closely resemble a *Spirillum*. He regards it as a monadiform organism in a permanent spirillum-condition, and endowed with motility throughout its existence. Between *Spirodomonas* and *Spirillum* there is scarcely any appreciable difference, the latter differing from the former only in the body being more or less cylindrical. The genera *Spirodomonas*, *Trypanosoma*, and *Hæmatomonas* are included in the family Proteromonadeæ, intermediate between the animal Bacteria and the Flagellata, characterized by their elongated or spiral form, the absence of nucleus, and the great density of their protoplasm.

*Bacterioïdomonas* can scarcely be separated from the Bacteriaceæ except by its larger size, its continuous motion, and the presence of a nucleus, and yet is unquestionably of animal nature. The nucleus is but slightly differentiated, and resembles the nucleoli of ordinary nuclei. The group of Bacterioïdomonadeæ may be regarded as exhibiting an approach to the nucleated Protozoa.

On the whole the Bacteriaceæ must be regarded as presenting the closest affinity to the astomous Flagellata.

**Pleomorphy of Pathogenic Bacteria.***—Herr G. Hauser has extended the observations on the pleomorphy of other bacteria to those which are active in causing disease, especially septicæmia. He states that the three species of *Proteus*, *P. vulgaris*, *mirabilis*, and *Zenkeri*, go through in the course of their life-history a wide cycle of development, resulting in the formation of coccus-like organisms, as well as bacterium-, bacillus-, leptothrix-, vibrio-, spirillum-, spirulina-, and spirochæte-forms. This variation is greatly influenced by changes in the constitution of the nutrient substance; when this, for example, is acid, only the coccus- and bacterium-forms are developed. The different species of the genus *Proteus* enter, under favourable conditions of nutrition, a swarming condition, in which they display great motility both on the surface and in the interior of stiffened gelatin. They belong, among bacteria, to the active anaerobes. All the species are pathogenous, *P. vulgaris* and *mirabilis* being especially active in this way. The putrefaction caused by species of *Proteus* does not

* Hauser, G., 'Ueb. Fäulnissbacterien u. deren Beziehungen zur Septicaemie' (15 pls.), Leipzig, 1885. See Biol. Centralbl., v. (1885) p. 321.

result in the production of any unorganized ferment; the decomposition of albuminoids which they bring about must, therefore, be regarded as the direct work of the bacteria.

**Influence of the Sun on the Growth and Activity of Bacillus anthracis.***—M. S. Arloing finds that the "vegetability" or power possessed by the sporulated mycelium or the free spores to give rise to a fresh mycelium of *Bacillus anthracis* is rapidly suppressed by the rays of a July sun, when the culture is fresh; if the sun's rays exert their influence for less than two hours vegetability is simply suspended; the rays of influence seem to be those that are luminous, and these are effective in proportion to their intensity. These results corroborate generally those that were gained by experiments with artificial light. The author points out that the sun is destructive to pathogenic germs, and suggests that the spores are not as resistant as we have been lately led to believe.

In a second communication † the author reports that the solar rays are not as destructive of cultivations already set in progress; at the same time he believes himself warranted in concluding that solar light can attenuate the virulence of cultivations of this bacillus, and convert them, as surely as heat, into a series of vaccine-cultures. It still remains to be discovered whether the attenuation is or is not inherited. At least, it is certain that light is a very potent biological agent with minute organisms.

**Cholera Bacillus.‡**—Drs. Finkler and Prior have recently published the results of some further investigations made by them on the comma bacilli of cholera asiatica and of cholera nostras, and while no longer maintaining their identity, they refute the notion that gelatin cultivations of these two bacilli at the same age show marked differences in appearance. They consider that both these comma bacilli are vibrios which form genuine spirilla. The two vibrios are similar in all stages, and their behaviour under cultivation almost identical; the difference chiefly consisting in the greater energy of growth and vitality of the vibrio of cholera nostras. The vibrios show marked resistance to drying and variation of temperature, and very probably have a resting-stage similar to that of other micro-organisms. Both vibrios are pathogenic, but this property is greater for the vibrio of Koch than for that of Finkler and Prior. All animals are not affected by these bacilli, which are pathogenic only under certain conditions. The susceptible animals and the conditions for producing positive results are the same for both vibrios. Though the symptoms have a great similarity to those of Asiatic cholera in man, they cannot be said to be specific, as other infectious materials and chemical poisons produce the same symptoms.

The causal connection between these two bacilli and the two diseases in which they occur is rendered probable by their constant presence, but is not made certain by inoculation experiments. Both

* Comptes Rendus, ci. (1885) pp. 511–3. † Ibid., pp. 535–7.
‡ Ergänzungshefte z. Centralbl. f. Allgemein. Gesundheitspflege, 1885.

vibrios may pass into the blood after infection into the intestine, and may be excreted in the urine.

M. A. G. Pouchet reports * that from the bouillon used in the culture of the cholera-bacillus he has extracted an alkaloid which has all the external characters (smell, chemical instability, toxic effect on animals) of a substance found in choleraic dejections.

**Morphology of the Comma Bacillus.**†—Herr J. Ferran records some remarkable observations on the morphology of *Spirillum Choleræ asiaticæ*. When cultivated in a particular way there are formed, he states, within the spirillum-like filaments one or more globular bodies, composed of undifferentiated protoplasm of the same refractive power as the rest of the plant. They surround themselves with a periplasm or hyaline envelope, within which the protoplasm contracts, the largest attaining the size of 6–12 $\mu$. These bodies the author regards as antheridia. He has also observed true spores proceeding from the filiform or curved thallus. Under special conditions of culture they grow to a considerable size, 6–12 $\mu$ in diameter, and when they have attained the size of a blood-corpuscle, they assume a spiny character; and in this condition, described as the "mulberry-condition," the author regards them as ova or oospheres. At a certain period they put out a long slender thread of protoplasm, about 0·25–0·5 $\mu$ in thickness, and extremely transparent. The end of this filament rapidly assumes a spiral character, and then reproduces itself by division, then going through the same cycle again. Actual conjugation or sexual union is not stated to have been observed; but in consequence of these phenomena, Herr Ferran removes the cholera-fungus from the Schizomycetes, and places it among the Peronosporeæ, with the name *Peronospora Barcinonæ*.

**Attenuation of the Choleraic Virus.** ‡ — MM. W. Nicati and Rietsch find that cultivations, which, being inoculated last October into the digestive tract of guinea-pigs, produced diarrhœa and death, did not in the succeeding May produce either diarrhœa or death. Similar facts recorded by other observers tend to the belief that the choleraic virus is attenuated by cultivation in nutrient gelatin at a temperature of from 20°–25° C. Large quantities of the poison, even when quite fresh, may be subcutaneously injected into small animals, and especially guinea-pigs, without producing any ill effects.

**Passage of Pathogenic Microbes from the Mother to the Fœtus.** —M. Koubassoff has put to himself the following questions § :—

1. What is the influence of the time which elapses between the inoculation of the gravid female and its death on the passage of the microbes of anthrax from the mother to the fœtus? He finds that the longer the time, the larger the number of microbes in the fœtus.

2. Is there any difference between the passage of the bacilli of the vaccine of anthrax and those of the virulent culture? There are fewer microbes when the mother is inoculated with the attenuated

* Comptes Rendus, ci. (1885) pp. 510–1.
† Zeitschr. f. Klin. Medicin, ix. (1885). See Biol. Centralbl., v. (1885) p. 323.
‡ Comptes Rendus, ci. (1885) pp. 186–7. § Ibid., pp. 101–4.

virus, and that, though there is a longer time between inoculation and death.

3. When the fœtus and placenta are unhealthy, there is a very much more extensive passage of microbes than under healthy conditions.

4. The author has made experiments to test the views of some who object that the passage is a post-mortem effect, and he believes that there is no basis for this objection. When the inoculation is too strong the fœtus nearly always dies; the fœtus cannot be completely vaccinated through its mother.

M. Koubassoff has also examined * the passages of the microbes of septicæmia, pig-cholera, and tuberculosis, and he comes to the conclusion that the bacilli of these maladies do pass from the mother to the fœtus.

**Passage of Microbes by means of Milk.**†—M. Koubassoff also finds that splenic fever, pig-cholera, and tubercular bacilli pass by the milk of the mother; that when they once appear in the milk they remain till the end of lactation or the death of the female, but the young are not infected. During fœtal life poisoning is probably effected by the direct communications between the vessels of the mother and child in the placenta.

**Microbe of Typhoid Fever in Man.**‡—M. Tayon by experiments made on himself, finds that subcutaneous inoculation of the typhic microbe is not mortal, but he is unable to solve the question as to whether an organism which has been subjected to two injections is refractory to the typhic microbe.

**New Chromogenous Bacillus—B. luteus suis.** §—Drs. D. E. Salmon and T. Smith describe this non-pathogenic form which was found in the pericardial and peritoneal fluids in swine killed for the purpose of studying the swine fever. When grown in a meat infusion, the liquid becomes pale straw colour, then orange with a greenish tint, soon changing to a wine red. The pigment when obtained pure is insoluble in alcohol or ether. An aqueous solution is decolorized by adding an excess of strong nitric or hydrochloric acid, but reappears on neutralizing with potassium hydrate or ammonia.

**Bacilli of Malaria.**‖—Herr v. Schlen found in the blood of a malaria patient in an early stage of the fever, both in the red corpuscles and lying free in the blood among them, round blue granules from 0·5 to 1 $\mu$ in size, and ring-shaped bodies of about double this size, with intermediate stages between them, but no bacilli. From the blood of chronic malaria patients there was obtained by culture on the third day a whitish bacterial growth consisting entirely of micrococci about 1 $\mu$ in diameter.

In the soil and water of malarial regions there were found, besides various moulds and micrococci, the following three forms of

* Comptes Rendus, ci. (1885) pp. 451–3. † Ibid., pp. 508–10.
‡ Ibid., pp. 450–1.
§ Science, vi. (1885) p. 226. (Proc. Sect. of Biology, Amer. Assoc. Adv. Sci.)
‖ Fortschritte der Medicin, ii. (1884) pp. 585–91. See Bot. Centralbl., xxii. (1885) p. 234.

bacillus:—(1) A delicate bacillus, 3 $\mu$ long by 0·75 $\mu$ broad, the cells sometimes united into short threads, but usually single and motile. (2) Thicker bacilli, 4 $\mu$ by 1·5 $\mu$, growing into gelatinous colonies and without motility. (3) A very delicate bacillus, 2 $\mu$ long and 0·25 $\mu$ broad, which takes only a slight stain with anilin dyes. In addition to these there were invariably found micrococci from 0·5 to 1 $\mu$ in diameter; and the author regards it as probable, though not yet demonstrable, that these micrococci are the cause of malaria.

**Gummosis of Figs.***—Sig. C. Comes attributes an epidemic disease of the fig-tree, which consists in the suppression and death of the young shoots and the final drying up of the older branches, to a "gummosis" or transformation of starch and of the young tissues through the action of a specifically distinct organism which he calls *Bacterium gummis*. Sig. Comes identifies this organism with that which causes gummosis in the Amygdaleæ and Aurantiaceæ, and the "mal nero" of the vine, and even with the "Cornalia's corpuscles" in the blood of silkworms.

**Bacillus of the Vine.**†—M. L. A. Corvo contends that the destruction of vines ascribed to the *Phylloxera* is really due to a tubercular disease occasioned by a special bacillus. This disease can be communicated to other plants by inoculation in the entire absence of the *Phylloxera*. The insect merely spreads the evil of inoculation.

**Pear Blight.**‡—In proof that bacteria are the direct cause of the disease known as pear blight, Mr. J. C. Arthur shows by the results of his experiments that, (1) sap from an infected tree when inoculated into a healthy tree invariably produced the blight. (2) When cultures to the sixth generation of organisms were made with all precaution to prevent error, and healthy trees were inoculated with the pure culture of this sixth generation, the tree is stricken with blight, starting from the point of inoculation, and gradually extending over the whole plant. (3) That wherever there is a blight not produced by freezing, bacteria of this species are invariably present. The crucial experiment was made by filtering a watery solution containing the bacteria, and then inoculating with the bacteria on the one hand and the filtration on the other, resulting in blight in the former and none at all in the latter case.

**Action of Ozonized Air upon Micro-organisms and Albumen in Solution.**§—Mr. J. J. Coleman describes a number of experiments conducted by him in conjunction with Prof. M'Kendrick, being supplementary to their joint investigation upon the influence of cold on microphytes.‖

Air artificially impregnated with ozone by means of a Ruhmkorff

* Atti R. Ist. d'Incoraggiamento di Napoli, iii. (1884). See Bot. Centralbl., xxii. (1885) p. 270.

† Comptes Rendus, ci. (1885) pp. 528–30.

‡ Bot. Gazette, x. (1885) pp. 343–5.

§ Nature, xxxii. (1885) pp. 561–2. (Paper read before British Association.)

‖ See this Journal, *ante*, p. 619.

coil, so as to contain a much larger percentage of ozone than any natural atmospheric air, was passed continuously through a 1 per cent. solution of white of egg placed in a glass flask, the inlet and outlet tubes of which were carefully plugged with cotton-wool previously to commencing the experiment. It was found that a stream of air, containing an amount of ozone equal in weight to the albumen in solution, passed through 100 c.c. of the liquid for thirty hours, failed in producing the slightest trace of oxidation, and that the ozonized air passed through the liquid quite unaltered. During the course of the experiment and for six days following, the development of micro-organisms ceased, but at the end of that time, and notwithstanding the cotton-wool plugs, the liquid became slightly turbid from the presence of organisms. As dilute hydrogen peroxide is without action upon albumen, the conclusion seems inevitable that albumen is practically indestructible by any atmospheric agency without previous splitting up by micro-organisms, and further, that whilst micro-organisms cannot develope and are probably killed in an ozonized atmosphere, their spores are not easily destroyed by its agency. These results confirm the surmise of the late Dr. Angus Smith, that putrefaction is a necessary preliminary to oxidation in all cases of *natural* river purification.

## MICROSCOPY.

### *a.* Instruments, Accessories, &c.*

**D'Arsonval's Water Microscope.**—Our justification for noticing this instrument (fig. 229) is that it has been suggested by a leading member of the Société de Biologie of Paris, M. D'Arsonval, who presided at a meeting of the Société in May last. The suggestion is, moreover, evidently a serious one, as the Société devoted two pages of their Proceedings † to a description of it.

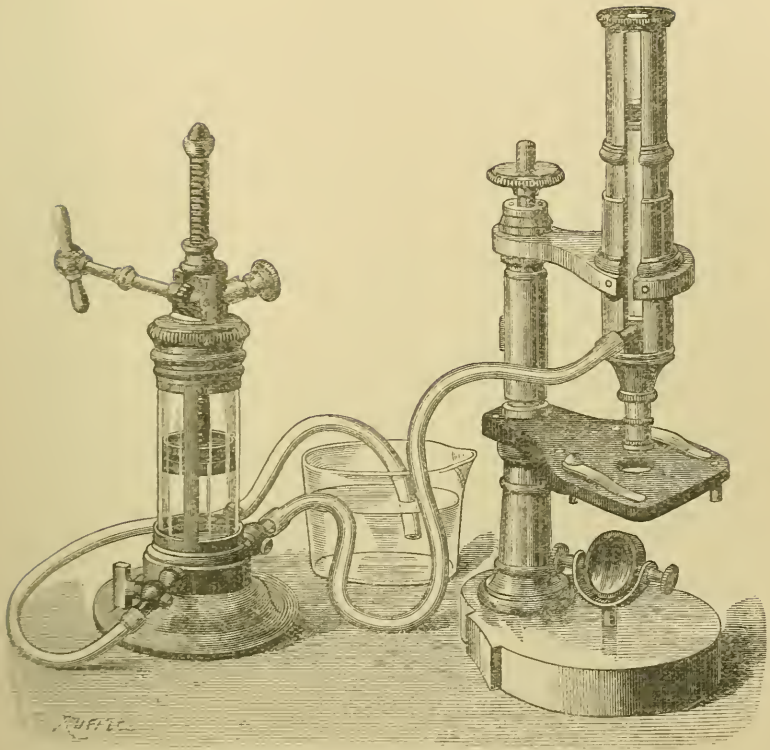
The principle of the instrument depends upon the fact that if an object is viewed through a parallel plate of glass it will appear the nearer as the plate is thicker. The interposition between the objective and the eye-piece of a greater or less quantity of water will act in the same way, and thus (in theory) a very sensitive method of focusing is obtained, the focus varying according to the thickness of the stratum of water.

The construction of the instrument is as follows:—A glass cylinder (fig. 230), open at the top and closed at the bottom by a plane glass disc, is inserted into the body-tube, which is split to allow the contents of the cylinder to be observed without removing it. An orifice at the lower end communicates by an indiarubber tube with a

* This subdivision is arranged in the following order:—(1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

† See this Journal, ii. (1879) p. 767.

FIG. 229.



syringe (the Lacaze-Duthiers vertical injecting syringe is the most convenient for this purpose). By working the syringe water can be forced into the tube or withdrawn from it, and, as before stated, the focus of the Microscope is varied. A cover (fig. 231) can be used to exclude the light from entering the body-tube through the slit.

FIG. 230.

FIG. 231.

We will assume that by this means the variation in the focus can be made with much more sensitiveness than with the best mechanical means, though the latter has now reached a great pitch of perfection. Is this (assumed) increased sensitiveness obtained at the sacrifice of other indispensable qualities? There can be no doubt that it is. The arrangement is of course of no use except with high powers—for low powers the existing focusing arrangements leave nothing to be desired as a practical

question. With high powers, however, the interposed water would seriously interfere with the corrections. The objectives are constructed to work with air, and if the rays have to pass through water there is a considerable disturbance of their action both as regards aplanatism and achromatism. The same result follows from capillarity, by the action of which the upper surface of the water is distinctly curved.

We are obliged therefore to come to the conclusion that M. D'Arsonval's idea, though a not uninteresting contribution to the history of suggestions on the construction of the Microscope, cannot be realized in practice.

Another advantage claimed by the inventor was the power of using thick cover-glasses; also coloured solutions for monochromatic light for photography.

In this connection it may be interesting to note an idea which occurred to Hooke,* in regard to the use of water between the lenses. "I provided me a Tube of Brass . . . ; into the smaller end of this I fixt with Wax a good plano convex Object Glass, with the convex side towards the Object, and into the bigger end I fixt also with wax a pretty large plano Convex Glass, with the convex side towards my eye, then by means of the small hole by the side, I fill'd the intermediate space between these two Glasses with very clear water, and with a Screw stopped it in; then putting on a Cell for the Eye, I could perceive an Object more bright than I could when the intermediate space was only fill'd with Air, but this, for other inconveniences, I made but little use of."

**Direct Vision Microscopes.**†—Mr. T. E. Amyot, observing that many of the old faults and deficiencies of these instruments remain uncorrected and unsupplied, describes the alterations which he has made in one, which have rendered it "perfectly available for many purposes for which it was previously inapplicable, and in fact," as far as his own requirements go, "a very useful instead of a nearly useless instrument."

The faults of all the instruments of this class with which he is acquainted are the following:—

1. The object examined is rendered indistinct by the amount of side light which falls upon it in its exposed position.

2. The stage arrangements are so imperfect that it is impossible to examine any but the central portion of the slide, or at best such a portion as has been previously arranged for examination.

To correct the first fault nothing more is required than 1/3 in. of metal tube blackened internally, the size of, and projecting beyond, the stage aperture; this too would easily carry a polarizing prism or a spot-lens if desired.

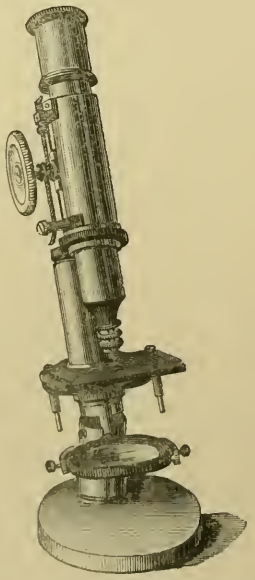
To remedy the second fault (the instrument operated on being Dr. Beale's Class Microscope) the bell-shaped end is removed and in its place is fixed a brass cylinder, with a gap in front for the use of

* Hooke, R., 'Micrographia,' 1667, preface.

† Sci.-Gossip, 1885, pp. 201–2 (1 fig.).

reflected light when required, as in the original arrangement. It is 3/4 in. long and 2 in. wide, and to it is attached by a strong bar a stout brass disc or stage, with a central aperture of 3/4 in. diameter, the interval between it and the cylinder being 1/4 in. A thinner brass disc of rather smaller circumference and similar central aperture, but having its edge bordered by a projecting rim both above and below, is kept in close apposition to the first by a coil of wire-spring soldered to it and to the base of the internal circumference of the brass cylinder. It is between these two discs that the slide is lightly but firmly held, it being easy to move it without jerk or unevenness in any direction. The shallower projecting rim, which is deficient in front, should be about the depth of the thickness of an ordinary slide, and is intended to prevent the possible pressure of cemented objects between the discs when searching far from their centre. The deficiency of the rim in front secures the cover-glasses from injury. The other rim should be much deeper, its use being to keep the disc central, and working within the cylinder when drawn down. Its border is arched, and the points between the arches are bent outwards; the centre one forming a convenient catch for the thumb of the left hand when depressing the disc to introduce the object, and the others steadying the movement in the inside of the cylinder. There is also a small pin attached to this rim, which works in a tube fixed to the cylinder, securing perfect steadiness.

Fig. 232.



**Microscope with Catgut Focusing Adjustment.** — In 1881 * Herr J. Ulmer suggested the use of a silk thread for obtaining a simple adjustment of the focus of a Microscope, working very easily and without "loss of time." The principle was apparently adopted several years earlier in the form shown in fig. 232.

A piece of catgut is attached by its two ends to the top and bottom of the fixed sheath in which the body-tube moves, and is wound once round a spindle with milled head, which is screwed to the body-tube and passes through a slot in the sheath. On rotating the milled head the catgut winds on the spindle, thus carrying the body-tube up or down as desired. The spindle travelling in the slot prevents any rotation of the body-tube. For the purpose of tightening the catgut the upper end is passed through a hollow screw working in a fixed socket. The axle of the spindle is milled to prevent the catgut slipping.

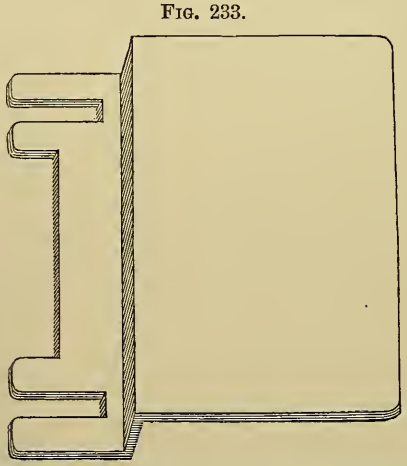
* See this Journal, ii. (1882) p. 406.

**Inostranzeff's Double Microscope.***—M. Inostranzeff "proposes to use the tint and lustre of non-transparent minerals as a means of comparison, by adapting a double Microscope, so that the objectives receive separately the rays proceeding from the minerals studied. The rays are inflected by prisms, so that they reach a single eye-piece, and form two halves of the field of view divided by a fine line. With identical minerals a uniform image is obtained, but the slightest change of shade in any one object causes the line of division and two distinct parts to appear."

**Microscopes with Accessory Stages.**—The cutting of series of sections now so much in use necessitates, as mentioned *ante* p. 153, a considerable increase in the size of the slides on which they are to be mounted, some of those in use at Cambridge being 6 in. × 2 in. with cover-glasses 5 in. × 1½ in., and containing it may be 500 sections.

This of course renders it desirable that the stage of the Microscope should be much wider than ordinarily made, so as to support the slides when the sections at either end are examined. For broad as well as long sections such as brain, the arrangements devised by Schieck and Giacomini and shown *ante*, p. 515, are very suitable. The extensible

Fig. 233.



arms of Schieck's form will not however accommodate the narrow slides used for series of sections, and the supports of Giacomini's are more especially intended for broad and not for long and narrow slides. The increase in the size of the fixed stage is moreover undesirable, what is wanted being some simple and readily adapted addition to a stage which will allow it to be again restored to its normal size when required.

This want may be supplied by an adaptation of the device used many years since by Andrew Pritchard and Powell, and applied in more modern times for the attachment of the hand-rests used with German dissecting Microscopes.

* Illus. Sci. Monthly, iv. (1885) p. 27.

It consists of a brass angle-plate with slots, which slide on suitably arranged milled-head screws beneath the stage. When the plate is in position the screws are tightened, and it is firmly clamped to the stage, forming a continuation on either or both sides at the same level.

Riddell's Binocular Compound Microscope.—Prof. J. L. Riddell, of New Orleans, Louisiana, was the original inventor of the Binocular Compound Microscope with one objective. A description of his form of prisms was published in 1854,* but the instrument itself has not been figured complete, either here or abroad. Prof. Riddell's own instrument is the property of the United States Government, but by the courtesy of the Surgeon-General of the United States Army (acting through Dr. John S. Billings, Curator of the Army Medical Museum, Washington) it was placed in the hands of Mr. J. Grunow, of New York (brother of the original constructor), by whom a duplicate was made and sent to this country, and is reproduced in fig. 234. The arrangement of the binocular prisms is shown in section in fig. 235, as drawn in the original paper.

The pencil of rays emerging from the objective *l* is divided in two, each half passing respectively into the right and left prisms. The path of the rays is *a*, *b*, *c*, *d* (the object is at *o*). In the prisms figured Prof. Riddell remarked that the equal angles at the long face are 45°, consequently the rays suffer a slight chromatic dispersion at *c*, but he found no attendant practical disadvantage, unless eye-pieces of unusually high power were used. By making the equal angles of the prisms 85° or 86°, so that the immergence and emergence would be at right angles to the glass planes, the dispersion would be avoided; but then another difficulty would arise by the transmission of direct rays (without reflection from the binocular prisms) from the object, which would destroy the binocular image.

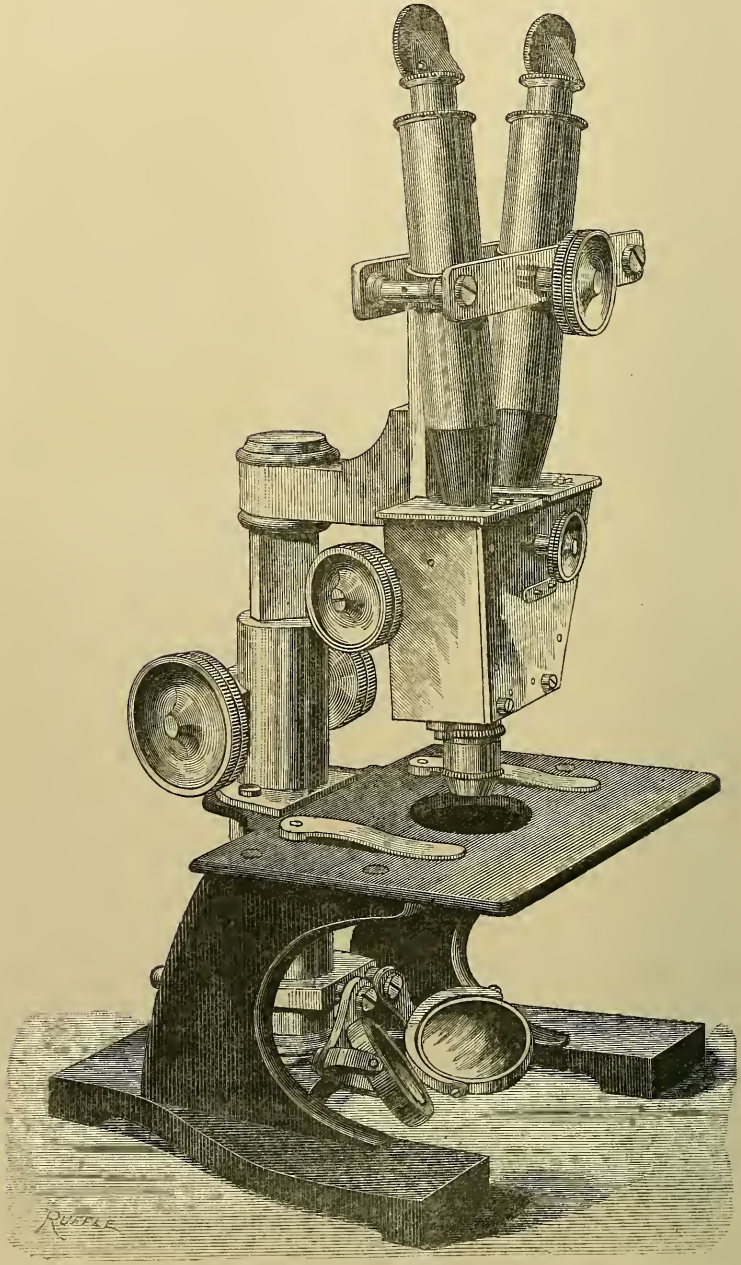
To facilitate the perfect coalescence of the images in the field of view for every width of eyes, Prof. Riddell provided (1) a means of regulating the inclination of the prisms by mounting them in hinged frames, so that while their lower terminal edges remain always in parallel contact the inclination of the internal reflecting faces can be varied by the action of a milled head in front of the prism box; (2) the lower ends of the binocular tubes are connected by travelling sockets, moving on one and the same axis on which are cut corresponding right- and left-handed screws, so that the width of the tubes may correspond with that of the prisms; and (3) the upper ends of the tubes are connected by racks, one acting above and the other below the same pinion, so that right- and left-handed movements are communicated by turning the pinion.

Prof. Riddell found that in many cases it was advantageous to employ two small concave mirrors rather than one large one, so as to equalize the illumination in both fields.

To obviate the inconvenience of using the instrument always in the vertical position, small rectangular equilateral prisms are so mounted in brass caps as to be slipped at pleasure over the eye-pieces.

* Quart. Journ. Micr. Sci., ii. (1854) pp. 18–24 (4 figs.).

FIG. 234.




RIDDELL'S BINOCULAR MICROSCOPE.

These prisms are adjustable so that the image may be viewed at any inclination between the vertical and the horizontal. The combination of the binocular prisms with the eye-piece prisms inverts the image in both planes, so that the movement upon the stage is seen through the instrument to be natural or erect—"a condition essential to the convenient manipulation or dissection of a microscopic object."

Fig. 235.


In the original description Professor Riddell states that the instrument, with its firm stand, broad stage [6 by 4 in.], and erect images, is pre-eminently adapted for use in prosecuting minute dissections, or the unravelling of minute structures of any kind. Opaque objects may be illuminated by the bull's-eye condenser, and transparent objects by one or two concave mirrors, aided perhaps by two diaphragms or screens. At night two candles may be used conveniently with one mirror. To illuminate for the higher powers a single achromatic condenser suffices.

**Megaloscopy.***—Under this heading M. Boisseau du Rocher writes as follows:—

"I will first indicate the optical principle that has guided me in the construction of a series of instruments for the inspection of cavities, notably the stomach, bladder, and rectum (*μέγας*, large, *εἰκών*, image, *σκοπεῖν*, to see).

The problem was to pass through a tube 7 mm. in diameter and 50 cm. long, the image of a very near object of the dimensions of 20 cm. To accomplish this I reduced the image of the object to microscopical dimensions by means of a suitably placed objective. This image, visible in the lower part of the instrument, is then examined with a telescope, which I call a megaloscopic telescope. It will be understood that with lenses of suitable focal length the reduced image of the object can be magnified, and consequently observed with the normal dimensions of the object.

The application of the principle is as follows:—The instrument is in the form of a tube or probe, terminated at its extreme end by a lantern in which is fixed an incandescent lamp. Above it is the optical arrangement which reduces to microscopical dimensions the image of the mucous membrane to be observed. This is composed of a right-angle prism; above are two plano-convex lenses with their convex surfaces facing each other, which have given the best results, whether in regard to the diminution of the image and of the field of view, or to distortion which is thus absent. At the other end of the

* Comptes Rendus, ci. (1885) pp. 329-30.

tube is the megaloscopic telescope consisting of an objective and an eye-piece of suitable power.

The advantages of this arrangement are first, that the adjustment for the eye of each observer is made externally by the eye-piece, and therefore all internal mechanism is suppressed. This allows, moreover, a second eye-piece of much greater power to be substituted for the first eye-piece; the mucous membrane and its lesions are then observed as with a magnifier. Second, adjustment for focus, properly so called, is nil. This proposition which is not theoretically exact, is so, however, practically. The reduced image formed in space, being displaced by a very small quantity only in proportion to the greater or less distance of the object, the focal adjustment may be neglected; the eye of the observer itself makes *unconsciously* its proper adjustment for focus, and the different parts of the mucous membrane situated at different planes are thus seen in their entirety with the same clearness—a point of first importance.

For the bladder and the rectum the tubes are straight. For the stomach there is a double tube; one with an elbow has a prism 7 cm. long, placed between the reduced image and the telescope; the other is straight and passes into the former, and its movements of elevation, depression, or rotation are governed by exterior mechanism.

A further improvement, which is in contemplation, is the photographic reproduction of the megaloscopic image.

Finally, this instrument shows that the result obtained is and will always be the same, however long may be the tube at the extremity of which the reduced image is formed, or whatever may be the distance of this image from the telescope and the eye of the observer."

The apparatus of M. du Rocher appears to be identical with that described * by Herr J. Leiter, but there is no acknowledgment of his priority in the matter.

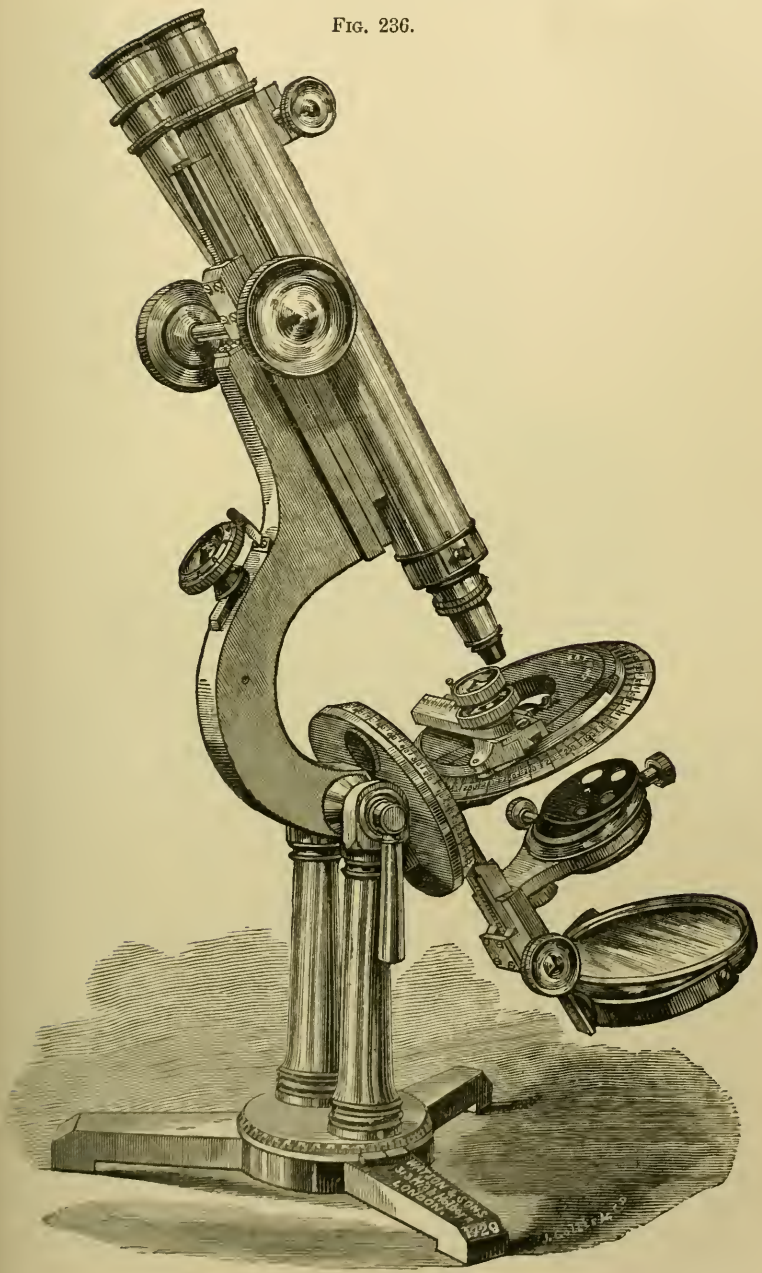
**Watson's Swinging Substage Microscope.**—Messrs. W. Watson and Sons have modified their large stand † which now has the form shown in fig. 236. It has a rotating base plate, mirror arranged to swing either above or below the stage (with graduated circle), and patent concentric rotating stage.

The fine adjustment is upon the Zentmayer principle, in which the coarse adjustment slide is carried by the fine adjustment slide, and the whole moved together by a lever acted on by a micrometer screw. The peculiarity of Messrs. Watson's construction is in the application of adjustable slide bearings to the original form of arrangement. For this purpose they have made the fine adjustment slide much broader than usual, thus increasing its stability; the prism bars also not only slide in grooves on the main surfaces of contact of the bearings, as in Bulloch's and other forms, but the bearings are carried round the outer prismatic edges of the whole length of the main slides, and adjustable screws are applied by which the friction on these edges can be regulated.

* See this Journal, iii. (1883) p. 421.

† For the original form see Engl. Mech., xxxii. (1881) pp. 487-8 (1 fig.).

Fig. 236.

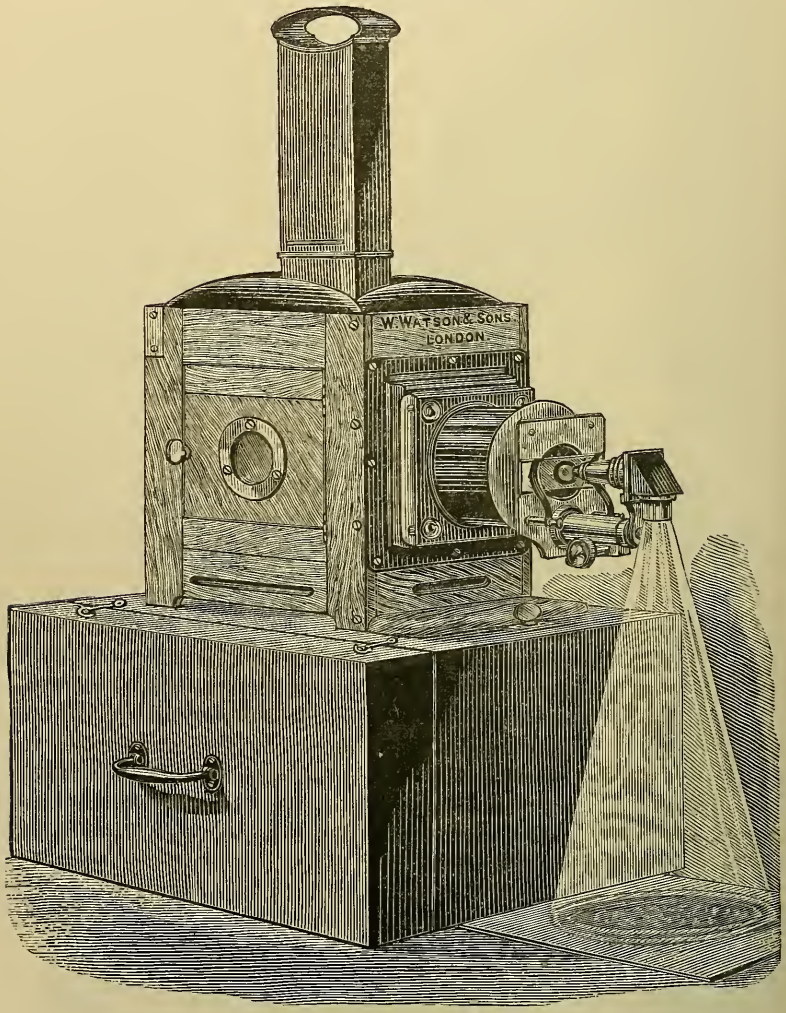



Watson's Swinging Substage Microscope.

3 z 2

**Watson's Camera or Lantern Microscope.**—This (fig. 237), also designed by Messrs. W. Watson and Sons, is a very convenient arrangement either for drawing microscopic objects, or for exhibiting

Fig. 237.




them to a class, as a number of students can examine the object at the same time, and have its special features pointed out to them.

It consists of a four-wick paraffin lamp in a lantern body, with compound condensing lenses 4 in. in diameter. In front of the latter

is a tube of length corresponding to the focus of the condenser, and to this is screwed a frame consisting of a stage for the objects, and a fitting with Society screw to take the ordinary objectives. There is a rack and pinion for focusing. The image from the objective is received by a right-angled prism and is thrown through an amplifying lens on a sheet of paper placed below to receive it. As has been before pointed out, a microscopic object can thus be more easily and correctly traced or drawn, than by any other method. The instrument can be used as an ordinary magic lantern by removing the Microscope attachment and substituting an achromatic front lens.

**Leckenby's Microscope Pencil-case.***—Mr. A. B. Leckenby has devised a combination of a pencil-case and a Microscope for the use of school children in the study of botany. "It consists of a thin tube of brass to hold the pencils, at the end of which is a lens mounted in such a way that when drawn out of the tube it is a simple Microscope well adapted for studying seeds and parts of plants, insects, &c. In addition to the Microscope pencil-case Mr. Leckenby has prepared sets of fifty slides of seeds neatly mounted on stiff paper to accompany it. The case and sets of seeds will be a source of pleasure and instruction to children, and also to persons more advanced in life, for this little Microscope can reveal a world of beauty."

**Adjusting the Eye-pieces of Binoculars to eyes of unequal focal length.**†— Colonel Malcolm thus describes an arrangement for binocular field-glasses which might we think be well applied to the Microscope, having regard to the number of observers whose eyes differ in focal length.

"One tube is left untouched; the eye-piece of the other is so arranged that it can be moved through a small range in and out, with reference to the eye-piece of the untouched tube, by turning round a milled ring. An index arrangement is provided.

The unaltered tube is used with one eye and brought to the most perfect focus possible in the ordinary way; then the other tube is used with the other eye, and by means of the adjustment its definition is made as perfect as may be, the ordinary adjustment not being interfered with. The two eyes are then used together; and the process of adjustment had better be gone over again, as certainly the two eyes do help each other.

The final position of the index mark is noted; and that holds good for all ranges, as far as I have tried.

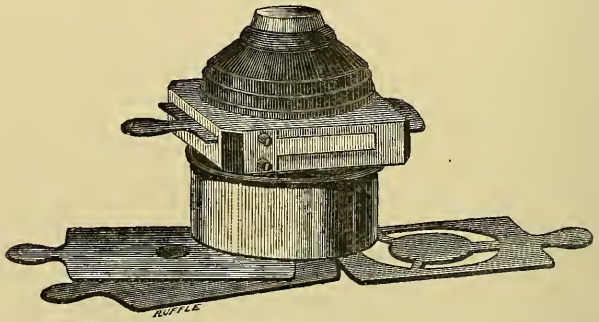
Having noted this, you may lend your glasses to your friend, who may alter them to his sight, and yet have them in perfect order for yourself by bringing the index to your own mark."

**Abbe Condenser.**—This condenser, the use of which is extending very largely both on the Continent and in America, is made in a great variety of forms, nearly all concurring, however, in a very considerable curtailment of the original dimensions which rendered it

* Amer. Mon. Micr. Journ., vi. (1885) p. 200.
† Proc. Phys. Soc. Lond., vii. (1885) pp. 80-1.

very heavy and unsuitable for use with Microscopes to which it was not specially adapted. The latest modification of form is that of Mr. J. Grunow, shown in fig. 238.*

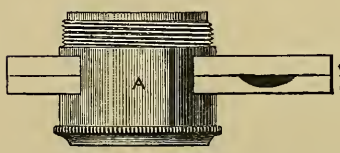
Fig. 238.



**Device for Testing Refractive Index.**†—A new device for testing the refractive index of immersion media, and indicating how near an approach to homogeneity with crown glass can be made, was described at the recent meeting of the American Society of Microscopists by Prof. H. L. Smith, who claims for this simple device superiority, both as to ease of manipulation and accuracy of indication, over the well-known wedge and bottle furnished by Herr Zeiss. In testing any medium for immersion purposes, but little more than a drop of the liquid is required, and the slightest variations of refractive index are indicated by a considerable latitude of motion, when, in the ordinary use of the wedge, these variations would be inappreciable.

The instrument is used upon the Microscope, and a reference to fig. 239 will make its application plain. A is an adapter about 3/4 in. in length, with the Society screw outside and inside. This is attached to the Microscope, and carries a 1 in. objective. *a* and *b* are two slips of crown glass, as near the refractive index of the cover-glass as possible, 2 in. long and 1/2 in. wide, each about 1/40 in. in thickness. In one of these, *b*, near the end, a concave is ground to a depth of about one-third or more of the thickness of the glass, and polished.

Fig. 239.




To test whether a medium has the same refractive index as the glass, and also the dispersion, a drop of it is put into the concave, and the two slips of glass are placed together and inserted into an opening

* See Amer. Mon. Micr. Journ., vi. (1885) p. 183 (1 fig.).
† Ibid., pp. 181–2 (1 fig.).

cut in the adapter-tube, as shown in the figure. A thin stratum of the medium will flow between the two slips. The whole being now in the position shown in the figure, the 1 in. objective is screwed on below, and the Microscope is focused on some well-defined object on the stage. Looking through the two slips in this way, the focus will be found not to differ appreciably from what it would be if the glass plates were removed. When the object is clearly defined the plates are pushed in, bringing the concave, filled with the liquid, directly over the back of the objective; if the medium be optically homogeneous with the glass slips, there will be neither spherical nor chromatic aberrations produced, and the definition and focus remain unchanged. As none of the immersion media now known are strictly homogeneous in this sense, but may, nevertheless, have the same mean refractive index as the crown glass, clear vision with these will be obtained with the general focus unchanged, but an excess of colour will fringe the outlines of the object.

If the focus has been obtained by means of the rack and pinion, the fine adjustment always remaining the same, one can readily ascertain the refractive indices of various media proposed for use with immersion objectives in this way. Let a mark be made on the rack-bar or sliding tube, as the case may be, when the focus is obtained with the plates in the position shown in the figure; this mark will indicate, for example, a refractive index of 1·52. Filling the concave now with cinnamon oil, and focusing again (using the same object, objective, and eye-piece), we get another position for a mark indicating a refractive index of 1·6. Using water, we get still another, 1·33, and with glycerin 1·41, the extremes will be about 1/2 in. apart, as measured on the bar or tube, and, by interpolating, we can thus get pretty nearly the refractive index of any fluid medium. Prof. Smith has found the so-called homogeneous media sold in the shops to differ very greatly, fully 1/4 in. out of the way in many cases. A specimen of cedar oil from Zeiss caused a change of focus only about 1/20 in., which was less than was required by any other samples tried.

When one has a fine objective, and with a given immersion medium has obtained certain positions of the screw collar for the best work on certain tests, the exact refractive index of the medium can be ascertained, and afterwards always secured. A non-adjustable immersion objective, an 1/8 by Spencer, which performed most admirably, both with oblique and direct light with the medium furnished by the maker, showed but indifferently well with another medium, which, on being tested with the little apparatus above described, required an alteration of focus necessary to obtain distinct vision, or rather the most distinct vision, of fully 1/4 in. On diluting the second medium to bring it to the same index as that sent out by the maker, the performance was entirely satisfactory. It will be understood that there should be a diaphragm in the adapter of such size as will prevent any light passing through when the concave is put over the objective with the immersion fluid to be tested in it, except what actually passes through the fluid.

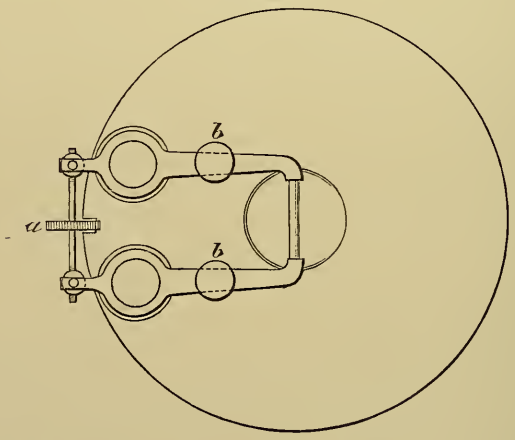
**Table of Colour-corrections.***—Mr. J. W. Queen gives the following table of the colour-corrections of objectives :—

| | Within Focus. | Without Focus. |
|---|---|---|
| Under-correction .. .. .. .. .. | Brick red | Greenish blue |
| Slightly under—but a large number of the finest lenses have this colour .. | Claret | Light green |
| Nearly colourless—shows the secondary spectrum .. .. .. .. .. .. | Lilac | Paler green |
| Over-correction .. .. .. .. .. .. | Blue | Yellow |

**Joly's Meldometer.**†—The apparatus which Mr. J. Joly calls by this name ($\mu\epsilon\lambda\delta\omega$, to melt) consists of an adjunct to the mineralogical Microscope, whereby the melting-points of minerals may be compared or approximately determined, and their behaviour watched at high temperatures, either alone or in the presence of reagents (figs. 240–1).

As now used, it consists of a narrow ribbon of platinum (2 mm. wide) arranged to traverse the field of the Microscope. The ribbon, clamped in two brass clamps so as to be readily renewable, passes bridgewise over a little scooped-out hollow in a disc of ebony (4 cm.

Fig. 240.




diam.). The clamps also take wires from a battery (3 Grove's cells), and an adjustable resistance being placed in circuit, the strip can be thus raised in temperature up to the melting-point of platinum.

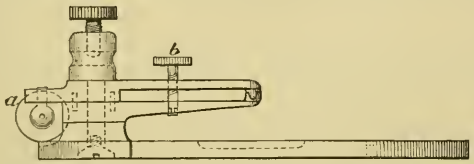
The disc being placed on the stage of the Microscope, the platinum strip is brought into the field of a 1 in. objective, protected by a glass slip from the radiant heat. The observer is sheltered from the intense light at high temperatures by a wedge of tinted glass, which further can be used in photometrically estimating the temperature by using

* Queen's Micr. Bull., ii. (1885) p. 38. † Nature, xxxiii. (1885) pp. 15–16.

it to obtain extinction of the field. Once for all approximate estimations of the temperature of the field might be made in terms of the resistance of the platinum strip, the variation of such resistance with rise of temperature being known. Such observations being made on a suitably protected strip might be compared with the wedge readings, the latter being then used for ready determination.

The mineral to be experimented on is placed in small fragments near the centre of the platinum ribbon, and closely watched while the current is increased, till the melting-point of the substance is apparent. Up to the present Mr. Joly has only used it comparatively, laying fragments of different fusibilities near the specimen. In this way he

Fig. 241.




has melted beryl, orthoclase, and quartz. Mr. Joly has been using the apparatus for nearly a month, and in its earliest days it led him right in the diagnosis of a microscopical mineral, iolite, not before found in Irish granite. The unlooked-for characters of the mineral, coupled with the extreme minuteness of the crystals, led him previously astray, until the meldometer fixed its fusibility as far above the suspected bodies.

A form of the apparatus has been adapted, at Professor Fitzgerald's suggestion, to fit into the lantern for projection on the screen. In this form the heated conductor passes both below and above the specimen, which is regarded from a horizontal direction.

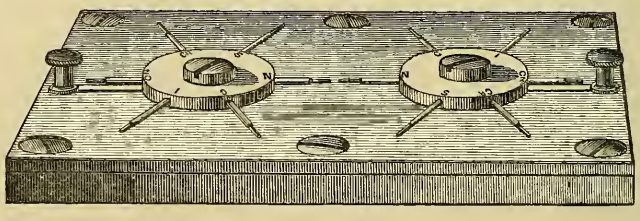
Mr. Joly writes us:—"The figs. represent the improved form of the meldometer; in which the clamps of the stage can be used to hold it firm against the drag of the wires connecting it with the battery. The platinum strip is held by two forceps bound to the hearth of the meldometer by the binding screws, taking the leads but free to turn round the shafts of these screws, so that, on rotating the little adjusting screw shown at *a*, the forceps are brought nearer or further apart. The object of this is to take up the sag of the platinum strip, which becomes very considerable at high temperature. The forceps are opened when inserting the platinum by turning the little screws *b b*. In the figure the jaws of these forceps are shown so shaped as to tend to impress a trough or channel form on the strip, which is advantageous both for the purpose of keeping the specimen from falling off and also as further insuring its being at the temperature of the strip."

**Stokes-Watson Electric Spark Apparatus.**—Messrs. Watson have modified this apparatus as shown in fig. 242, substituting for the single electrode of the original form * a second disc of six electrodes.

* See this Journal, iv. (1884) p. 964.

By this arrangement any given metal can be used, not merely in conjunction with platinum only, as before, but also with any other metal.

Fig. 242.



A simpler and cheaper form is also supplied, in which the discs are replaced by two supports, each carrying a single arm for the electrodes.

**Optical Arrangements for Photo-micrography, and Remarks on Magnification.***—Mr. R. Hitchcock discusses the relative merits of the two methods of obtaining amplification in photographing microscopic objects: viz. by regulating the distance of the sensitive plate, or by the interposition of an eye-piece, or a supplementary lens, usually an achromatic concave, between the objective and the sensitive plate. The following are his conclusions:—

"Summing up this matter, we are personally inclined to favour the use of large plates, 8 by 10 in. for example, using the lens with an amplifier instead of an eye-piece, for the reason that large pictures highly magnified can thus be obtained of exquisite definition. These will bear further enlarging with the solar camera. There remains, however, the consideration of expense, and the inconvenience of using such a large apparatus under ordinary circumstances. It is, unquestionably, more convenient in most cases, to use smaller plates and to work with an eye-piece. Still better, to use an amplifier in place of the ocular, for then it is possible to attach the amplifier to the camera in such a position that when the object is focused with the eye-piece it is also in focus on the ground glass of the camera when the latter is attached. With such an arrangement, a quarter-plate camera can be used with perfect satisfaction, giving negatives equal to any that can be made.

The same cannot be said when the ocular is used, although there is no doubt thoroughly satisfactory results can be obtained with the ocular on small plates."

**Actinic and Visual Foci in Photo-micrography with High Powers.†**—It is very commonly said that whilst the difference between the visual and the actinic focus is considerable when making photo-micrographs with low powers, it is not appreciable when using high

* Amer. Mon. Micr. Journ., vi. (1885) pp. 168–70.

† Ibid., pp. 193–5. (Paper read before the American Society of Microscopists.)

powers. Dr. J. D. Cox's experience does not accord with this statement, and he makes the following remarks on the subject:—

"If the statement had been that a sharp picture may be taken when the object is exactly in focus with a high power I should not take exception to it, and I incline to think that this is what has been meant. But a sharp picture may be either a positive or a negative of the visual image seen in the Microscope, and in my own work so many examples have turned out to be positives when I expected them to be negatives, that I have been led to make an investigation of the subject, in which the evidence tends strongly to show that with our best high-power lenses the image fixed upon the sensitive plate is a positive instead of being a negative, and consequently the paper prints from this are negatives and not positives.

It would be very easy to overlook this difference in a large class of photo-micrographs, because, in an alternation of dark and light lines, or dark and light spaces, it often matters little which of a pair is light or dark; the picture may be equally clear and satisfactory either way. In the case of a large majority of the microscopic objects photographed, either the positive or negative image would be good enough for the purpose intended; so good that a close examination of the point I am now suggesting would hardly occur to one. This, in fact, was my own experience until, in efforts to get a good picture of the broken edge of fragments of the finer diatoms, my attention was arrested by the fact that the appearances seen by the eye were often reversed in the print from the supposed negative which I had taken. As, in dealing with minute areolæ, this often amounted to showing a projection where I had seen an apparent depression, and *vice versâ*, it became in effect a failure to photograph what I had seen, and challenged my best efforts to overcome the difficulty. If the illumination of such transparent objects as diatoms were always by a perfectly central beam of parallel rays of light, there would be no practical difference whether they showed light upon a dark ground or the reverse. But we rarely get such exactly central illumination, even after our best efforts to do so. For example, plate No. 23 of my broken shell series was thus taken with light intended to be strictly central, a diaphragm being behind the achromatic condenser, which had a small circular hole in it, limiting the illuminating rays to the small central portion of the condenser. Yet in one position the central areolæ of the *Coscinodiscus* which it represents, appear as deep cups, whilst, if it be turned round so as to change places of top and bottom, they appear as projecting bosses.

No. 51 of the same series was the first in which I distinctly marked in my note-book the fact that the dots in that diatom, *Mastogloia angulata*, appeared dark in the instrument, but light in the photograph print. The difference of effect was least important in shells which have an even, smooth film of comparatively little thickness, and the greatest in those in which the diatom seems to have strongly marked bars separating the lines of areolæ, as in *Pleurosigma balticum*.

In a number of cases in which the plates were originally taken

with a sharp focus upon the view of the shell which I desired, I have taken transparencies from them by contact, and using these last as negatives from which to print the paper prints, I have found that these last are, according to my notes, what the former should have been if there were no difference between the visual and the actinic focus. A few of these have been prepared for exhibition to the Society. The prints taken from the second plates are marked 'positives' of the originals, and are in fact the true representation of the object as I saw it when taking the original photograph. They are—

No. 66. *Navicula serians* Kütz., taken with a Spencer 1/16 in. balsam angle 125°, with No. 118 as the positive from it.

No. 60. *Pleurosigma formosum* W. Sm., taken with a Spencer 1/10 in. balsam angle 108°, with No. 122 as the positive from it.

No. 83. *Pleurosigma formosum* W. Sm., taken with a Wales 1/15 in. balsam angle 82°, with No. 119 as the positive from it.

No. 110. *Pleurosigma balticum* W. Sm., taken with a Zeiss 1/18 in. balsam angle 116°, with No. 113 as the positive from it.

The objectives are all of the first class, and it is safe to assume that what holds true with them will be found true with any of our best glasses. In taking the original photographs, I used a plain plate of glass instead of the usual ground-glass screen in the camera, and focused by the aid of a Dorlot focusing glass.

The examples to which I have referred would seem to warrant the conclusion that in using high-power objectives, the difference between the visual and the actinic focus is the equivalent of that between a positive and negative image of the object, when the details have passed a certain limit in fineness. But some experiments, made for the purpose of finding how far the tube of the Microscope must be moved to secure the proper actinic focus upon the sensitive plate, have had such unsatisfactory results as make me unwilling to venture any positive conclusion, but content myself with stating the facts above given, until further investigations which I am making shall be completed.

In the course of the experiments referred to, I noticed that the image taken on the plate was apparently of a lower plane in the object, than the visual one which I was seeking to get. This was shown in the diatoms with a convex surface, by the sharper image, in the print or plate, of areolæ nearer the margin of the object than those upon which I had focused. It showed also that the difference seemed to be the same in kind as in the use of low-power objectives, with which it is necessary to raise (withdraw) the tube after getting a sharp visual image of the object. Acting upon this, I tried in several instances the gradual raising of the tube, taking pictures at slightly varying departures from the visual focus, until the image was quite spoiled and blurred to the eye. I made some series of as many as five or six plates thus progressively varying, but without satisfactorily establishing any point (different from the visual focus) at which the objective should be placed to secure in the photographic image the true characters of the visual one. I was surprised to find at what a distance from the visual focus a sharp image could be

taken, but it was not the image for which I was in search. Examples of this sort are among the prints which I will exhibit to the Society.

I design to add to my experiments on the subject, the examination of the effect of changing the focus of the focusing glass to correspond with the difference between the visual image of a diatom, showing little dots or areolæ and that which shows dark ones. Everybody has noticed that a slight change of focus with a high power produces this change of appearance, and if the focusing glass were adjusted for the image which is complementary to the one desired, and then the focusing done in the usual way, the result might be that which is sought. It has at least seemed worth the experiment, but a press of other work has prevented my making a satisfactory test of it before the time of our meeting."

**Images in the Binocular Microscope.***—Mr. E. M. Nelson writes, "Binoculars give less critical pictures than monoculars, for the very good reason that half an objective will not perform so well as a whole one. All prisms are defective; therefore the image in the left tube is worse than that in the right. The image in the binocular, therefore, consists of an indifferent picture in the right-hand tube, and a worse one in the left. Observers put up with this for the sake of the stereoscopic effect, which is gained at the cost of a critical image. . . .

Opticians know very well that the eye will accommodate itself, and combine almost anything; therefore little or no pains are taken to send out binoculars in perfect adjustment. I will mention a fault which is frequently seen in binoculars exhibited at the Societies.

1. The axis of the left-hand tube does not make the proper inclination with the other; this causes the field of the left-hand tube not to coincide laterally with that of the right hand (fig. 243).

2. If the axes of the eye-pieces are not in the same plane, the field of one tube will be either above or below the other (fig. 244).

Fig. 245 shows what is often found, viz. Nos. 1 and 2 combined.

3. The focus of each tube should be carefully adjusted, either by the tube or by the eye-piece. I have my own done by collars round the eye-pieces; but the tube-length method is preferred by some, and is just as efficient.

4. The eye-pieces should be matched in power.

5. The position of the prism in its carrier should be correctly adjusted. One would think that a very trifling movement in the prism would make a very great difference in the position of the image of the field, but such is not the case. The plane of the base of the prism should be at right angles to the axis of the objective; if, however, this is tilted through an angle of 20°, one will be surprised at the small difference it makes. Any twist in the prism would make a very serious fault; in other words, the planes of the reflecting surfaces of the prism must be at right angles to the plane of the axes of the tubes. See fig. 246, which shows that when the prism is out of adjustment an object will not occupy the same position in each

* Engl. Mech., xlii. (1885) p. 202 (6 figs.).

field. (In making this test it is as well to use the same eye-piece on each tube.)

6. When the carrier of the prism is pushed home, the edge of the prism should exactly bisect the back of the objective. Fig. 247 shows the picture in the left-hand tube when the prism is not pushed in far enough. When the prism is pushed in too far the dark patch would be seen on the opposite side of the right-hand tube.

7. The diaphragms in the eye-pieces should be of the same size (fig. 248).

Fig. 243.

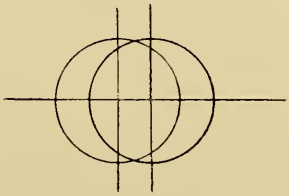


Fig. 244.

Fig. 245.

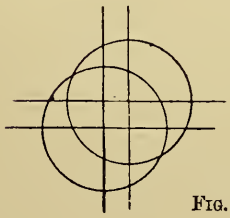


Fig. 246.

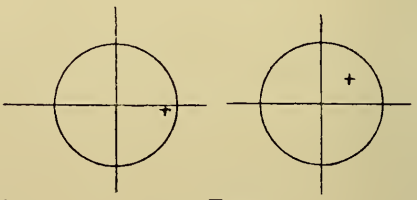


Fig. 247.

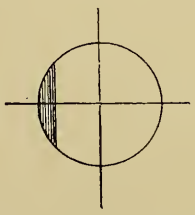


Fig. 248.

The best way to find out if the fields are exactly superimposed is to blink or wink rapidly with each eye alternately." (Mr. Nelson's remarks apply to the Wenham Binocular only.)

**Position of Objects with the Binocular.**—Mr. E. M. Nelson, considering that the binocular Microscope does not give images so good as the monocular, has endeavoured to find out the cause and to remedy it if possible.*

He obtained a Wenham prism of good quality and had it properly

* Journ. Quek. Micr. Club, ii. (1885) pp. 198-200.

fitted; then, finding that the left tube was rather longer than the right, he had the eye-pieces differently focused to suit, having them so marked as to be able to tell the one from the other. Having done this he found that matters were improved, but that there was still something more which required a remedy. To test it he took one of the fine bristles from the maxillary palpi of a blow-fly, but he found that no kind of illumination would make it appear sharp if it were placed on the stage in a vertical position, but if it were placed horizontally across the prism, it was perfectly shown.

Another experiment was in regard to the stereoscopic effects obtained when the object was in different positions, and the object selected for this purpose was the central pseudo-trachea of the proboscis of the blow-fly. On examining this he found that when it was placed in a vertical position, there was no difference between the stereoscopic effect with and without the prism, except as regarded the marginal portions of the field where the eyes were to a certain extent deceived, but when the object was placed horizontally a strongly stereoscopic effect was produced. On the central membrane of the trachea there were a number of small spines which formed excellent test-objects, and if these were placed vertically they appeared foggy, and nothing could be clearly made out about them; but when seen in the horizontal position their appearance was so changed that it was hardly possible to recognize them as the same objects. In his specimen there was a slight dip or depression in one part of the membrane, which could not be perceived under any illumination with the monocular, but under the binocular in a horizontal position it was perfectly well seen, though the same instrument failed entirely to show it when the major axis of the lips was in a vertical position. He also tried diatoms, and found the difference in the stereoscopic effects surprisingly marked, especially in the case of *Heliopelta*.

In a later communication * Mr. Nelson deals more fully with the case of the proboscis of the blow-fly as follows:—

"I wish that every possessor of a binocular would try the following experiment.

Place the proboscis of the blow-fly, squeezed flat in balsam, in a vertical position, and examine it binocularly with, say, a 2/3 in. objective, and let the attention be concentrated solely on the two main vertical cut suctorial pipes. Now let the observer carefully examine those with a view to determine the amount of stereoscopic effect the binocular gives to them. Let me warn him against letting his eye cheat him by giving those suctorial pipes a stereoscopic effect which they do not possess, derived by contrast with other parts of the field. He must, to make this experiment correctly, resolutely shut his eyes to everything else in the field except those suctorial pipes. I feel sure that no candid observer correctly performing this experiment will be able to detect any more stereoscopic effect on that object than if it were examined monocularly. Of course, there will be stereoscopic effect to a certain degree, as there will be also in the

* Eng. Mech., xlii. (1885) pp. 202-3.

monocular, for it must be admitted that the monocular gives a decided idea of solidity. For myself, I cannot see any difference in the stereoscopic effect between the binocular and monocular on that object when it is placed in the position I have pointed out, although I have repeatedly gone over the experiment with great care, and with a perfectly unbiassed mind.

Now turn the object round, so that the cut suctorial pipes lie in a horizontal or east and west position; the stereoscopic effect is so marked that you might easily fancy you could crawl along the pipes. When the object is in a vertical position, I would call the attention of the observer to the loss of definition of all fine details which lie in a vertical position. I allude to the minute hairs on the delicate membrane which is stretched across the two cut suctorial pipes. When the object is turned round, notice how sharp they become.

To sum up, every exhibitor should be careful to *place his object so as to secure the largest amount of stereoscopic effect.* It is, of course, immaterial which way some objects are placed, such as a *Coscinodiscus;* but *Isthmia*, *Pleurosigma*, *Navicula*, &c., should be placed with their major axes east and west, as well as objects such as scales on butterflies' wings, and many others."

Mr. Nelson further expressed "the hope that some one might be "able to find out the cause of the difference, and to suggest a remedy."

It may be that we underrate the difficulty which Mr. Nelson feels on this matter, but we should have thought it almost unnecessary to point out that the maximum of stereoscopic effect is obtained, *ex necessitate rei*, only when the object lies in a "horizontal" position. In that position there is necessarily the maximum of displacement of the images observed by the two eyes; in the "vertical" position this displacement is at its minimum, and the stereoscopic effect is in great part lost.*

Another and quite different point to be noted in explanation of Mr. Nelson's difficulty is the reduction of aperture that takes place *in one direction* with the Binocular, which we have already pointed out in this Journal.† This necessitates for the resolution of the markings on diatoms, for instance, that the *particular markings to be resolved* should be placed "east and west," but not necessarily the major axis of the object, as directed by Mr. Nelson, a direction which we fear will mislead some microscopists.

Whilst pointing out that the explanation of Mr. Nelson's problem is one that has been long recognized by microscopists, and presents no such difficulty from a theoretical point of view as supposed, we quite agree with him that it is but rarely that any practical effect is given to the matter by exhibitors.

**Microscopes at the Inventions Exhibition.**—The following Jury awards have been made in respect of the Microscopes and Microscopic Apparatus exhibited at the International Inventions Exhibition.

To Messrs. R. & J. Beck a Gold Medal for "Microscopic and other

* See further on this subject, this Journal, i. (1881) p. 203, and iv. (1884) p. 20.

† See this Journal, iii. (1880) p. 874.

optical apparatus." To Messrs. Ross & Co. a Gold Medal for "Progress and excellence of work in the manufacture of lenses since the early days of photography, also microscopic and other optical apparatus." To Mr. H. Crouch a Silver Medal for "Improvements in microscopic apparatus." And to Mr. C. Baker a Bronze Medal for "Students' microscopic apparatus."*

**Photo-micrograph of Tongue of Blow-fly.**—The Photographic Society of Great Britain awarded a medal to Mr. Mansell J. Swift for a photo-micrograph of this object shown at their recent exhibition. There were 805 exhibits, and 20 medals were awarded.†

**Pen-and-Ink Drawings of Microscopic Objects.**‡—A very valuable addition has recently been made to the science collections now displayed in the western galleries at the South Kensington Museum of Science and Art. Mr. Rochefort Connor, of the Inland Revenue Department, has prepared a number of exquisitely finished pen-and-ink drawings of objects viewed with the Microscope, often by the aid of very high powers.

The collection, which covers two large screens in the rooms devoted to biology and geology, includes drawings of insects and other minute forms of animals and of various anatomical preparations from them, of curiosities of pond-life and of the skeletons of many organisms both recent and fossil. Amongst these last Mr. Connor's highly finished representation of some of the more complicated forms of the Diatomaceæ, such as *Heliopelta* and *Coscinodiscus*, are especially worthy of admiration, though some of his drawings of Foraminifera, Pryozoa, and sponge-spicules are scarcely inferior to these in delicacy of execution. These drawings represent, we understand, the leisure hours of a busy lifetime, and their author is now engaged in a series of microscopic drawings illustrating the characters of food products and their adulterants. A few of these are now exhibited as samples, and the series, when complete, cannot fail to be of great use to public analysts and others.

**Supposed increase of the Aperture of an Objective by using highly refractive Media.**—A very important misapprehension appears to have arisen on this subject amongst some of our colonial brethren, it being supposed that by using a mounting medium of high refractive index an objective of small aperture can be made equal in effect to one of large aperture. This is recorded in the Journal of the Royal Society of New South Wales,§ from which we make the following extracts.

"Dr. Morris exhibited a new mounting medium, having a refractive angle of 2·6, the highest known, and comparing favourably with the celebrated one of Prof. Smith, of Geneva, New York. Sulphur is melted on the slide, and the cover to which the diatoms are attached is dropped upon and pressed down upon the sulphur; the refractive index of sulphur is 2. Also selenium and sulphur ground and mixed

* Supplement to the 'London Gazette' of 11th August, 1885, No. 25,500.
† Cf. Journ. and Trans. Phot. Soc., x. (1885) p. 13.
‡ Nature, xxxii. (1885) p. 633.
§ Journ. and Proc. Roy. Soc. N. S. Wales, xviii. (1884) pp. 178–9.

together, and the slide prepared as above—refractive index about 2·3. Also selenium by itself—refractive index 2·6.

With all the above media *A. pellucida* was splendidly resolved. These experiments by Dr. Morris were undertaken with a view of enabling objectives of the older constructions and of less angular aperture to resolve the highest test diatoms as easily as the new wide-angled homogeneous lenses."

"Mr. Hirst exhibited *A. pellucida* resolved by Zeiss's 1/8 water-immersion objective, in a manner scarcely to be surpassed by the new oil-immersion objectives. The diatom was mounted in sulphur—this proving Dr. Morris's theory that a highly refractive mounting medium enables low-angled objectives to compete in resolution with the new oil-immersions."

We do not quite understand how such a notion could have arisen, unless it was from misapplying a little the principle which requires the use of a mounting medium of at least equal refractive index to the aperture of the objective, in order to fully utilize such aperture. It need hardly be pointed out here that if an objective has an aperture of say 0·75 only, nothing that can be done with the mounting medium can possibly increase the aperture or resolving power of the objective. The advantages of highly refracting media are limited (as shown by Mr. Stephenson in his original paper *) to intensifying the images. An appropriate medium will enable the full effect of a given aperture to be utilized, but cannot increase it or make an objective of low aperture "resolve the highest test diatoms as easily as a wide-angled homogeneous lens." We propose to return to this subject when we can find space for a few diagrams, which will, we hope, prevent such an idea as that above quoted being again put forward.

**American Society of Microscopists.**—[Conclusion of Report of Cleveland Meeting. Also a serio-comic account of the working of the Session and Soirée, from the 'Plain Dealer,' containing such comments as the following: "Having looked at the wriggling worms [in printers' paste] that made the mass literally alive, they could understand why it is that newspaper paste so seldom sticks. The insects literally walk off with the pasted clipping on their backs."]

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 195–9.

See also *Queen's Micr. Bull.*, II. (1885) pp. 33, 34–5.

BANKS, C. W.—**[Electricity under the Microscope.]**

[Exhibition of "Stokes's Spark Apparatus," and "Moore's Geissler tube." "Mr. Banks also showed the peculiar effects produced by the passage of the electric spark through various substances—such as oil, filings of metals, films of soot, finely powdered plumbago, &c. These displays were in nearly every case vivid and beautiful. The oil imparted an intensely green colour to the spark; while the course of the latter through the filings of metals produced entirely different, though not less striking effects. A peculiar appearance was produced by the passage of the calorific spark through a mixture of small globules of mercury and gold-filings. The current was thereby interrupted in such a manner that instead of continuous streams of light, these were broken up into dots and dashes, very strikingly resembling a luminous Morse alphabet. The entire exhibition was attractive by reason of its novelty as well as its beauty."]

*Proc. San Francisco Micr. Soc.*, 1885, Sept. 23rd.

---

* See this Journal, ii. (1882) p. 163.

*Behrens, W.*—**Winkel's Mikrometerocular mit vertical beweglichem Mikrometer.** —(Winkel's Micrometer-eyepiece, with vertically movable Micrometer.)

[Abstract of article in Zeitschr. f. Wiss. Mikr., II. (1885) p. 41. With comments. *Post.*]

*Zeitschr. f. Instrumentenk.*, V. (1885) p. 326.

*Bert, P.*—**First Year of Scientific Knowledge.** Transl. by Mdme. P. Bert.

[Sec. 131, Lens, pp. 168-9, 176 (2 figs.). Sec. 132, Compound Magnifying-glasses and Microscopes, pp. 169–70, 176 (1 fig.). "Great magnifying power may be obtained by a Microscope. Things appear 100 times, 200, and even 1000 times larger than they really are." "Had we time, how many astonishing and marvellous things might I not show with its help! Thousands of living beings in a drop of stagnant water, *millions of tiny red bodies in a drop of blood*, and I cannot tell what besides."]

344 pp. (figs.), 8vo, London and Paris, 1885.

**Blacking Brass Diaphragms, &c.**

[Dissolve 1/4 oz. sulphate of copper and half its weight of hyposulphite of soda in a little more than a pint of water. Well clean the diaphragm; place it in the solution and heat it. More hyposulphite will give a darker tint; more sulphate, a lighter steel-grey colour.]

*Amer. Mon. Micr. Journ.*, VI. (1885) p. 178, from *Brit. Journ. Phot.*

Burrill, T. J.—**Photo-micrography work with high powers.**

[Title only of paper read at Ann Arbor meeting of the Amer. Assoc. Adv. Sci., 1885.]

*Amer. Journ. Sci.*, XXX. (1885) p. 327.

Carpenter, W. B.—**The President's Address to the Quekett Microscopical Club, 24th June, 1885.**

[Remarks on Mr. Buffham's paper on the conjugation of *Rhabdonema*, *ante*, p. 842. Expression of regret at the tone of Prof. E. R. Lankester's criticism of Mr. B. T. Lowne's views of the eyes of insects. Recommending the study of the question whether the Bacteria have permanent specific forms and distinctive potencies, or are capable of being modified by culture or natural influences so as to change their potency. Nitrification.]

*Journ. Quek. Micr. Club*, II. (1885) pp. 180–8.

Chadwick, W. I.—**The Magic Lantern Manual.**

[The Microscope, pp. 131–5.]

2nd edition, 154 pp. and 107 figs., 8vo, London, n.d. (Preface 1885).

Cox, J. D.—**The Actinic and Visual Focus in Photo-micrography with High Powers.** [*Supra*, p. 1070.] *Amer. Mon. Micr. Journ.*, VI. (1885) pp. 193–5.

Czapski, S.—**[Abbe's Optical Thories.]**

[Brief general summary in a review of Dippel's 'Grundzüge der Allgemeinen Mikroskopie.'] (*In part.*)

*Zeitschr. f. Instrumentenk.*, V. (1885) pp. 367–9.

*Ellis, A. J.*—See Helmholtz, H. L. F.

Fleischl, E. v.—**C. Reichert's neuer beweglicher Objecttisch.** (C. Reichert's new movable stage.) [*Post.*]

*Zeitschr. f. Wiss. Mikr.*, ii. (1885) pp. 289–95 (2 figs.).

Friederich, K.—**Instrument zur Messen und Theilen von Linien.** (Instrument for measuring and dividing lines.)

German Patent Kl. No. 31,878, June 4th, 1884, and No. 32,805, March 10th, 1885.

G., E. P.—**Binocular Microscope.**—See Nelson, E. M.

**Gray's (S.) Water Microscopes.**

[Description (by "the ghost of Stephen Gray") of his water, fluid reflecting, and isinglass Microscopes—from Phil. Trans., XIII. (1696–7).]

*Engl. Mech.*, XLII. (1885) pp. 99–100 (2 figs.).

**Grunow's (J.) Abbe Illuminator.** [*Supra*, p. 1065.]

*Amer. Mon. Micr. Journ.*, VI. (1885) p. 183 (1 fig.).

*Helmholtz, H. L. F.*—**On the Sensations of Tone** as a physiological basis for the theory of music. 2nd Engl. ed. transl. from the 4th German ed. by A. J. Ellis, with additional notes and appendix.

[Contains a description of the "Vibration Microscope." *Post.*]

xix. and 567 pp. (70 figs.), 8vo, London, 1885.

HEURCK, H. VAN.—**Le Microscope à l'Exposition Universelle d'Anvers.** (The Microscope at the Antwerp Universal Exhibition. *In part.*)
*Journ. de Microgr.*, IX. (1885) pp. 364–75 (6 figs.).

HIRST, G. D.—[**Dr. Morris's theory as to highly refractive mounting media.**]
[*Supra*, p. 1078.]
*Journ. and Proc. Royal Soc. N. S. Wales*, XVII. (1884) p. 179.

[HITCHCOCK, R.]—**Postal Club Boxes.**
[Contents of Box F.] *Amer. Mon. Micr. Journ.*, VI. (1885) pp. 199–200.

HOGG, J.—**The Microscope**; its history, construction, and application.
[New title-page only.]
11th ed., xx. and 770 pp., 8 pls. and 356 figs., 8vo, London, 1885.

HYDE, H. C.—**The Electric Light in Microscopy.**
[Exhibition of lamps of 1 and 3 candle power. He "agreed with the conclusions arrived at by other observers, that while the light itself is eminently adapted to microscopical purposes, its general adoption will have to be deferred until marked improvements are made at the battery end. He doubted whether any of the fluid batteries could be modified so as to answer the purpose, and was disposed to think that in some form of storage battery the necessary qualities would ultimately be found. To that end he was experimenting." ]
*Proc. San Francisco Micr. Soc.*., 1885, *August 26th.*

INOSTRANZEFF.—[**Double Microscope for non-transparent Minerals.**]
[*Supra*, p. 1058.] *Illus. Sci. Monthly*, IV. (1885) p. 27.

*Jadanza, N.*—**Zur Theorie der Fernrohre. Ueber die zusammengesetzten dioptrischen Systeme.** (Theory of the Telescope. On compound dioptric systems.)
*Centr.-Ztg. f. Optik u. Mech.*, VI. (1885) pp. 193–5, 205–8 (2 figs.).
Transl. from *Atti R. Accad. Sci. Tor.*, XIX. (1883).

[JAUBERT, L.]—**Les Instruments de l'Observatoire Populaire.** (The Instruments of the 'Popular Observatory.')
[Microscopes *post.*] *Les Sciences*, I. (1883) pp. 53–7 (4 figs.).
Cf. also pp. 9 and 11, 31, 46, 62–3, 78, 109.

JOLY, J.—**The Meldometer.**
[*Supra*, p. 1068.] *Nature*, XXXIII. (1885) pp. 15–6.

LANKESTER, E.—**Half Hours with the Microscope.** A popular guide to the use of the Microscope as a means of amusement and instruction.
[New title-page only.]
16th ed., xx. and 130 pp. (30 figs. and 9 pls.), 8vo, London, n.d.

**Leckenby's (A. B.) Microscope Pencil-case.** [*Supra*, p. 1065.]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 200.

LEWIS, R. T.—**New Gauge for Wires or Plates.**
[Trotter's Patent.] *Journ. Quek. Micr. Club*, II. (1885) pp. 203–4.

MÖLLER, J.—**Reichert's Condenser.** [Vol. IV. p. 437.]
*Zeitschr. f. Wiss. Mikr.*, II. (1885) pp. 339–40 (1 fig.).

MORRIS, W.—[**New Fluid for homogeneous objectives.**]
[Oil of resin, used pure or thinned with oil of cedar.]
*Journ. and Proc. Royal Soc. N. S. Wales*, XVIII. (1884) p. 177.
„ „ **New Mounting Medium.** [*Supra*, p. 1077.] *Ibid.*, pp. 178–9.

NELSON, E. M.—**Microscopical.**
[1. Reply to F. D'Agen (*ante*, p. 888) as to the effect of bubbles at the back of an objective. 2. As to the resolution of *A. pellucida* (96,000 striæ per inch in Smith's medium 2·4) with a Powell dry 1/12 in. of N.A. 0·94. "Of course it had to be coaxed by using sunlight, heliostat, and a suitable condenser." 3. "With regard to the Abbe theory (theoretical limit of resolving power of objectives as tabulated on cover of R.M.S. Journal), I find it in practice absolutely correct. I also believe the law on which it depends is as certainly proved as is the law of gravitation." 4. Correcting three slips in F. Grant's communication.]
*Engl. Mech.*, XLII. (1885) p. 100 (2 figs.).
„ „ **Podura Scale.**
[Criticism of a suggestion for placing a diaphragm above the condenser instead of, as is preferable, below.] *Engl. Mech.*, XLII. (1885) p. 202.

NELSON, E. M.—Microscopical Binoculars.
[*Supra*, pp. 1073–5. Reply to query by E. P. G., p. 171.]
*Engl. Mech.*, XLII. (1885) pp. 202–3 (6 figs.).

" " **Diaphragms.**
[Diaphragms close to the object or in contact with the lower side of the slip have no effect.]
*Ibid.*, XLII. (1885) p. 239.

" " **Pygidium of the Flea as a test-object.** [*Post.*]
*Journ. Quek. Micr. Club*, II. (1885) p. 197.

" " **Position of Objects with the Binocular.** [*Supra*, p. 1074.]
*Ibid.*, pp. 198–200.

OLDFIELD, W.—**The Construction of Object-glasses.**
[Criticism of Orderic Vital's comments on his articles.)
*Engl. Mech.*, XLII. (1885) p. 205.

PELLETAN, J.—**Les Objectifs à immersion homogène de MM. Bézu, Hausser et Cie.** (The homogeneous immersion objectives of MM. Bézu, Hausser & Co.)
[Commendation of their Microscopes and objectives.]
*Journ. de Microgr.*, IX. (1885) pp. 313–6 (1 fig.).

"PROCELLA."—**Microscopical.**
[1. Correcting some errors in F. Grant's communication, *ante*, p. 889. 2. Strongly recommending B Kellner eye-pieces.]
*Engl. Mech.*, XLII. (1885) p. 100.

QUEEN, J. W.—**Table of Colour-corrections.** [*Supra*, p. 1068.]
*Queen's Micr. Bulletin*, II. (1885) p. 38.

REGNARD, P.—**Sur un dispositif permettant de suivre par la vue les phénomènes que presentent des animaux soumis à une pression de 600 atm.** (On an apparatus allowing the phenomena to be followed which are presented by animals subjected to a pressure of 600 atmospheres. [*Ante*, p. 876.]
*Comptes Rendus*, C. (1885) pp. 1243–4 (1 fig.).
*Nature*, XXXII. (1885) pp. 399–400 (2 figs.), from *La Nature*.
*Journ. Soc. Scientifiques*, I. (1885) pp. 358–9. (*Soc. de Biol.*, 25th July.)

**Robin (C.) Death of.** *Nature*, XXXII. (1885) p. 578.

ROYSTON-PIGOTT, G. [W.]—**Microscopical Advances—Ancient and Modern. I.**
*Engl. Mech.*, XLII. (1885) pp. 231–2.

SMITH, H. L.—**The influence of Science Studies.**
[Presidential Address to the Cleveland Meeting of the American Society of Microscopists.

"Happily we, in the study of microscopy, are untrammelled by metaphysical thoughts. We microscopists do not trouble ourselves with cause and effect, but leave the leaven in the lump, feeling assured that it will in time leaven the whole. The old word has passed away. The age of the hero has passed away. The people have arrived. Science has arrived, and theology, law, and all are on trial. Those who devote their lives to scientific research develope a love for truth."

"Professor Smith said that he could remember when physicians were shy of the Microscope. To-day, while there are a few old practitioners who shrug their shoulders distrustfully when the younger physicians use the Microscope, even the older ones are unconsciously affected in their practice by advancement in microscopical investigations. The President spoke of biology, which owed its existence to microscopy, and which has worked a revolution in medicine. Anything that can claim to aid us in coping with contagious diseases, with blights upon our crops and diseases in our flocks, is of intense interest to the public, and it is with these that biology deals. It is in its infancy yet, but it is destined to become more and more important. The speaker said that it had been shown that a two-hundred millionth part of a drop contains enough bacteria to be deadly infectious. He said that when it is shown that ventilation and sewage have been greatly benefited by microscopic investigations, it may be considered fortunate that some men have microbes on the brain, as has been said in jest. He said that biology may yet prove that the infinitesimal organisms with which it deals are not alone concerned with

disease, but with health as well, and that they, acting in the pores of the human system as workers, carry off the sewage of the system, and thus overcome the effects of violations of nature's laws, and thus work to the end of aiding man in working out in himself the theory of the survival of the fittest. He said that microscopy has a great work to do in geology, and thus in affecting the commerce of the world."]

*Amer. Mon. Micr. Journ.*, VI. (1885) pp. 166–7.

SMITH, H. L.—**Device for Testing Refractive Index.** [*Supra*, p. 1066.]

*Ibid.*, pp. 181–2 (1 fig.).

Cf. *Queen's Micr. Bull.*, II. (1885) p. 40.

SORBY, H. C.—See Wedding, H.

W., E. D.—**Measurement of Power and Aperture of Microscopic Objectives.**

[1. Describes the following method:—Remove the eye-piece; adjust the length of the tube by means of the draw-tube to exactly 10 in. from the back lens of the objective (this may conveniently be done by dropping a straw cut to 10 in. in length into the tube, allowing the lower end of it to rest on the back lens). Place a stage-micrometer divided into hundredths and thousandths of an inch on the stage. Hold a finely ground slip of glass on the top of the draw-tube. Focus until the divisions of the stage-micrometer are clearly visible on the ground-glass slip, when they can be marked on the slip with a pencil. The extent to which the divisions of the micrometer are magnified on the glass slip indicates the power of the objective.

2. Also gives a method for ascertaining the angular aperture of an objective:—Place the Microscope with its tube in a vertical position on a table having a dark-coloured cover. Take out the eye-piece. Rack down the tube until the front of the objective is level with or below the under side of the stage. All substage fittings must be removed. Take two pieces of white card and place them on the table right and left of the Microscope. Look down the tube, and move the pieces of card until you can just see the extreme edge of each piece of card mirrored on each side of the field of the objective on the extreme edge of the circle of the field. Now measure the distance apart of the two pieces of card (their inside edges) and the distance from the table of the front lens of the objective. Draw the first-mentioned distance on a sheet of paper as a horizontal line, and set up the latter distance from the middle of this line, and perpendicular to it. Draw two lines from the ends of the horizontal distance to the top of the perpendicular one—when the angle formed by these two lines will be the angular aperture of the objective, or a close approximation to it.]

*Engl. Mech.*, XLII. (1885) pp. 100–1.

WARD, R. H.—**Choice of Objectives and Oculars.**

["It is probably quite safe to say that objectives anywhere from 1/8 in. to 1/12 in., if not lower, can now be obtained, which will show as well as has ever been done anything that has yet been seen by the Microscope. The question as to the choice of moderate or extreme apertures for objectives is still open, and somewhat evenly disputed." "In the combining of oculars with objectives it is still undecided whether it is preferable to secure a sufficient variety of powers by means of a large number of objectives, or by the high and low eye-piecing of a few."]

*Journ. N. York Micr. Soc.*, I. (1885) p. 164, from article "Microscopy," in 'Appleton's Annual Cyclopedia' for 1884.

" " **The Binocular.** (*Concluded.*)

[Wenham's, Nachet's, and Abbe's, and general remarks.]

*Queen's Micr. Bull.*, II. (1885) p. 38, from *The Microscope in Botany* (Behrens).

WEDDING, H.—**The properties of malleable Iron deduced from its microscopic structure.**

[Includes a letter from Dr. H. C. Sorby, on a "Direct illuminative" contrived by him. *Post.*]

*Colliery Guardian*, 1885, June 5, p. 908.

WRIGHT, L.—**The Optical Lantern.**
[Reply to "Rector," *ante*, p. 891. Waste heat cannot be utilized. As to Newton's new improved 6 in. and 4½ in. objectives for the oil-lantern.]
*Engl. Mech.*, XLII. (1885) pp. 121–2.

WYTHE, J. H.—**The Microscopist**; a Compendium of Microscopic Science; including the use of the Microscope; mounting and preserving microscopic objects; the Microscope in Chemistry, Biology, Histology, Botany, Geology, Pathology, &c.
4th ed., pp. i.–xii. 17–434, 240 figs. and 27 pls., 8vo, Philadelphia, 1883.

### β. Collecting, Mounting and Examining Objects, &c.

**Preserving Eggs of Cephalopoda and preparing Blastoderms.***—Mr. W. E. Hoyle finds that when the young Cephalopods have reached a stage at which the rudiments of the arms are clearly visible it is moderately easy, after a little practice, to extricate them by making an incision into the egg-membrane with a fine scalpel; but previously to this period they so nearly occupy the whole interior of the egg that it is almost impossible to obtain them uninjured. A quantity of such eggs he preserved whole by a method suggested by Dr. Jatta. The strings of eggs are placed whole in a weak solution of chromic acid (about 0·25 per cent.) for a few hours, and then in distilled water for twenty-four hours, after which they are preserved in alcohol. The embryos can then be extracted much more readily than when fresh.

A number of blastoderms in process of segmentation were preserved according to a method proposed by Ussow. The egg, without removal of the membranes, is placed in a 2 per cent. solution of chromic acid for two minutes, and then in distilled water to which a little acetic acid (one drop to a watch-glassful) has been added, for two minutes longer. If an incision be now made into the egg-membrane the yolk flows away and the blastoderm remains; if any yolk still clings to it, it may be removed by pouring away the water and adding more. The blastoderms thus prepared show, when appropriately stained, fine karyokinetic figures.

**Treatment of the Eggs of the Spider.**†—The eggs of the grass spider (*Agalena noevia*) are deposited in cocoons attached to the under side of loosened bark and other sheltered places. During the entire winter cocoons may be found with eggs in early stages of development. The species thrives well in captivity, so that there is no difficulty in obtaining eggs freshly laid.

For studying the egg in a living condition the long-used method of immersion in oil is, Mr. W. A. Locy thinks, excellent. The oil should be perfectly clear and odourless. The external features can be studied to better advantage by mounting the eggs in alcohol after they have been freed from the chorion and stained. Another valuable method for surface study consists in clearing the already stained egg in clove oil. The thickness of the blastoderm is most easily determined in this way.

The best method of hardening preparatory to sectioning is that

* Nature, xxxii. (1885) p. 506 (Report to British Association).
† Amer. Natural., xix. (1885) pp. 102–22.

of heating in water to about 80° C., and then after cooling slowly, treating with the usual grades of alcohol. Good results are obtained with Perenyi's fluid, which renders the yolk less brittle. Osmic acid does not penetrate the chorion, and chromic acid or acid alcohol are not easily soaked out on account of the thickness of the chorion.

Borax-carmine is, on the whole, the best staining fluid. It is difficult to make the dye penetrate the chorion, and, after hatching, the cuticula forms a similar obstacle. This difficulty may be overcome by prolonged immersion in the staining fluid. In some cases seventy-two hours were required to obtain a sufficient depth of colour. In order to avoid maceration, which would result from so long continued immersion in a weak alcoholic dye, the staining process may be interrupted at the end of every twenty-four hours by transferring to 70 per cent. alcohol for an hour or more.

After most methods of hardening the yolk becomes very brittle, and the sections crumble. This difficulty may be overcome by collodionizing the cut surface before making each section, in the manner described by Dr. Mark.*

**Balkwill's Foraminifera Slides.**—Various "triumphs of mounting" have been issued from time to time, including the well-known arrangements of the scales of butterflies, but Mr. F. P. Balkwill must be considered to have carried off the palm by his slides of Foraminifera which he commenced to issue now some years ago. On a

Fig. 249. Fig. 250.

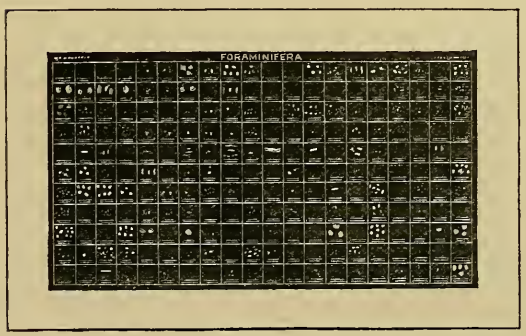



plate only $2\frac{1}{4}$ in. by $1\frac{1}{4}$ in. no less than 220 different collections of species of Foraminifera are arranged and named. Fig. 249 shows the slide in natural size, with the 220 divisions. It has not been possible to reproduce the photographed names, but fig. 250 enlarged 4 times shows how they are placed.

**Preparing Leaves to show Starch-grains.**†—A very interesting experiment, showing the influence of light upon the formation of

* Amer. Natural., xix. (1885) p. 628. See this Journal, *ante*, p. 737.
† Cf. Amer. Mon. Micr. Journ., vi. (1885) p. 178.

starch in leaves, can be readily performed according to a method recently described by Prof. J. Sachs. To show the starch-grains a leaf must be bleached and made transparent in this way: The fresh leaf is placed in boiling water for ten minutes, after which the chlorophyll is extracted by placing it in alcohol. The colour is thus removed without rupturing the cells, which retain the starch. The latter is then made visible by treatment with iodine. The cellular tissues become stained dark blue or lighter, according to the quantity of starch present. Comparative experiments may be made by exposing half of a leaf to sunshine while the other half is protected. A leaf collected in the evening contains much more starch than in the morning.

**Studying Pollen-grains.***—For the study of the development of the pollen-grains of *Campanula Americana*,† Prof. C. R. Barnes used alcohol-fixed buds, which had been twenty-four hours in equal parts of 95 per cent. alcohol and glycerin, commencing with those 2 mm. in length. The sections of the entire bud were stained with an aqueous solution of methyl-blue. The plant is an admirable one for the use of students in this respect.

For the study of the pollen-grains themselves fresh material is requisite. The best results were obtained by staining with Grenacher's borax-carmine. The grains are placed in a drop of 2 per cent. acetic acid, and after a few minutes a drop of borax-carmine added. This is allowed to remain an hour, the slide being protected from evaporation meanwhile. The stain is then washed out with acidulated alcohol (70 per cent. alcohol 100 cc., HCl. 5 cc.), and a drop of dilute glycerin placed on the specimens. The demonstration of the nuclei is extremely difficult.

The grains were germinated in a hanging drop of 3-12 per cent. sugar solution in the usual moist chamber. After three hours they were examined, the cover-glass with the drop being lifted off and allowed to fall on (1) a drop of acetic-iodine-green,‡ or (2) a drop of picro-carmine. After a few minutes dilute glycerin is run under the cover. Both yield excellent results. The nuclei in the tubes are thus more deeply stained than the cytoplasm.

Longitudinal sections of the stigmas serve for the study of the entrance of the pollen-tubes. The author used alcoholic material, without any staining, mounted in glycerin.

The pollen-tubes in the conducting tissue may be studied either in longitudinal sections of the style, or by laying open the style, and drawing a needle through the canal, thus dragging out the conducting tissue. In the latter case care must be taken to tangle the strands as little as possible, and methyl-blue should be used as a stain, otherwise the transparency of the pollen-tubes renders them very difficult to follow. The very greatly elongated cells of the conducting tissue are almost exactly the diameter of the pollen-tubes, and are liable to

* Bot. Gazette, x. (1885) pp. 353–4. † See this Journal. *supra*, p. 1028.

‡ A drop of 1 per cent. acetic acid, to which a small drop of iodine-green is added. (Strasburger, 'Neue Untersuchungen,' p. 6.)

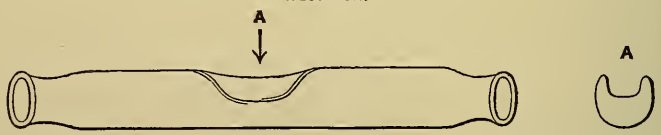
mislead, were it not for the abundant cellulose plugs which occur only in the tubes.

In the study of the ovules material fixed in strong alcohol, in a saturated aqueous solution of picric acid and in chrom-acetic acid,* was used. The contraction of the contents of the embryo-sac is unavoidable. Prof. Barnes thinks the alcoholic material is quite equal to the others and less troublesome. He found it necessary to depend on getting chance sections of the ovules by cutting the whole ovary longitudinally and laying the sections in glycerin. Previous to the cutting, the material is placed in alcohol glycerin for twenty-four hours or more. After being mounted in glycerin the sections become clearer and clearer. He also tried cutting sections in various known directions, by imbedding the ovules in coloured pith to render them more easily seen. The results, on the whole, are not better than by depending on chance sections, and they are much more troublesome.

**Imbedding in Paraffin.**†—Dr. E. Selenka has devised a method for fixing minute objects in a definite position in paraffin.

In a thin-walled glass tube (fig. 251) a central depression of limited extent is formed by heating this portion, closing one end of the tube with the finger, and sucking at the other end. One open end of the tube is then connected with a T-piece, one arm of which is in communication with a vessel of warm water, the other with a

Fig. 251.




vessel of cold water; the other end of the glass tube permits the water to flow out into another vessel. The paraffin is poured in a melted condition into the depression A on the glass tube, which is previously warmed by passing hot water through it, and the object to be imbedded is arranged under a lens; cold water is then admitted, and the object is fixed in the desired position.

**Andrews and Nachtrieb's Water-bath.**‡—The following is a description of a water-bath planned by Mr. E. A. Andrews and Mr. H. F. Nachtrieb, which has been in use for some time in the biological laboratory of the Johns Hopkins University.

The bath proper consists of a closed copper cylinder 28 in. in diameter and 8 in. deep. To the borders of holes cut in the top are soldered four round, flat-bottomed basins, 8 in. in diameter and 4 in. deep, with a distance of 2 in. between the nearest points of any two basins; and nearer the edge of the top, at the angles between the

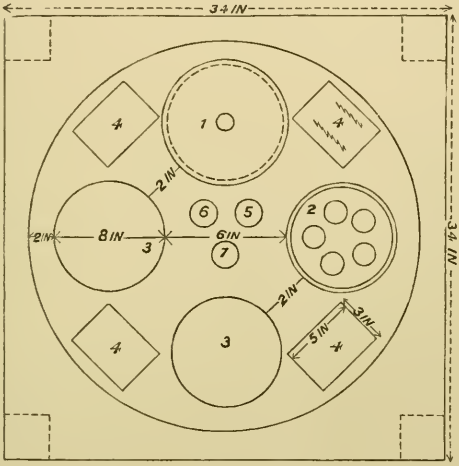
* Chromic acid 0·7, acetic acid 0·3, distilled water 99. Strasburger, loc. cit., p. 328.

† Zool. Anzeig., viii. (1885) pp. 419–20 (2 figs.).

‡ Amer. Natural., xix. (1885) pp. 917–9 (3 figs.).

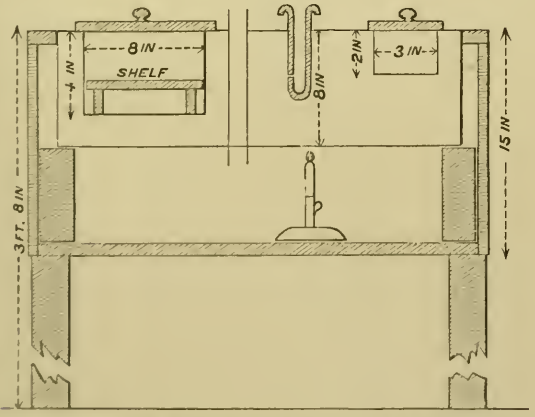
round basins, are four rectangular basins each 5 in. long, $3\frac{1}{2}$ in. wide and 2 in. deep. In each of the large basins is placed, on movable

FIG. 252.




Surface view of the bath in the table. 1, basin with lid on; 2, shelf with holes for dishes in basin; 3, open basins; 4, rectangular basins for slides; 5, tube for gas-pipe; 6, hole for regulator; 7, hole for thermometer.

FIG. 253.

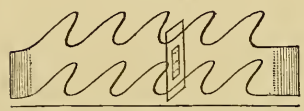



Diagrammatic section to show the depth of the bath and its basins, and its relation to the table. The legs of the table, of course, extend from the top of the box, not from the lower shelf of the table, as indicated above, and they are at the corners of the table.

supports, a shelf for the paraffin cups. This shelf is made from the circular piece of copper which was cut out of the top for the insertion

of the basin. For each basin there is also a copper lid with a button handle in the centre and a hole, 1/2 in. in diameter, near this for a thermometer. When the bath is once regulated this thermometer can of course be dispensed with and the hole in the lid can be plugged up with a cork. By this arrangement the paraffin dishes are always kept dry and at a uniform temperature all over. The four rectangular basins are used for warming the slides. In each of them is a movable rack made of two tin slips, each about 1/2 in. wide, and folded as shown in fig. 254. Each of these basins also has a copper lid with a button handle in the middle.

Fig. 254.



Supports for slides in rectangular basins.

Near the centre of the bath a tube 1 in. in diameter passes from the top down to and through the bottom. This tube is the passage way for the glass tube that connects the burner under the bath with the gas-jet above the centre of the bath, and it should be soldered to the upper side as well as to the under side of the bottom of the bath. Near this tube are two others, each 1 in. in diameter, that project about $1\frac{1}{2}$ in. above the upper surface of the bath, but are soldered with their lower ends flush with the under side of the top of the bath. One of these tubes is for the automatic regulator, and the other is for the thermometer. Through them the water is put in or taken out of the bath. The thermometer and regulator are each in a test-tube with holes blown in the sides, about $1\frac{1}{2}$ in. from the bottom, and with a good flange on the upper edge by which it is supported on the copper tube. A bit of cotton in the bottom of the test-tube protects the mercury bulb of the regulator or thermometer from any jars against the hard test-tube. The holes in the sides of the test-tube allow the water of the bath to come in direct contact with the mercury bulbs and at the same time they are up high enough to keep the mercury from running into the bath should either of the mercury bulbs break while in the tube. The copper bath is supported in a square box-table, the top of the bath being flush with that of the table.

This table is essentially a box on four legs, with a hole in the top slightly more than 28 in. in diameter, and with a door at one end. The bath is supported on four props that rest on the lower shelf of the table, and around the inside of the table is a lining of common tin to protect against possible accident. By this means a steady flame is obtained and the loss of heat is reduced to a minimum; and by grouping the regulator, thermometer and gas-pipe near the centre of the bath, hindrances are practically done away with. There is also connected with the gas-jet a small home-made glass Bunsen burner that is attached to the glass gas-tube a little above the bath. It is very convenient for warming dip-tubes, lifters, &c. In so large a bath as this two flames are required, but both are burned very low. The one burner is connected directly with the gas-jet and the other by way of the regulator. After the bath has, so to speak, been once set it runs on uniformly and requires no attention. It is regulated

by putting a thermometer through the hole in one of the lids into the dry chamber and shutting off the regulator burner when the chamber is warm enough. The temperature, as indicated by the thermometer that dips into the water, is always a few degrees higher than that of the dry chambers. When the thermometer in the water indicates a temperature of 60° C., the basins are warm enough to keep the hardest grade of paraffin melted. The whole stands at a convenient working height, about 3 ft. 8 in.

**Barrett's New Microtome.**—Mr. James W. Barrett exhibited at the last meeting of the Society a microtome which he had devised (with the assistance of Messrs Swift & Son) for the purpose of preparing large sections of tissues imbedded in celloidin, gum, paraffin, or similar material, cutting under spirit, or (if necessary) under water.

The machine is adapted to allow of the preparation of sections up to 12·5 cm. diameter, or even more, but Mr. Barrett has used it chiefly to prepare sections of the whole eye, in which the parts are maintained *in situ*. Fairly serviceable machines for these purposes have hitherto been made by (amongst others) Katsch,* but the object of the present construction has been to obviate the results of faults in those previously devised. The chief improvements are (1) general solidity and large size, (2) accurate raising mechanism which gives a definite minimum movement corresponding to a rise of ·01 mm., and (3) the support given to the knife at *both* ends.

In using the instrument the imbedding mass is fixed to a plate or tube carried inside the bath by the raising mechanism. If celloidin is to be used, the mass is fixed to the cork-covered plate by simply moistening both the cork and a *flat* surface of celloidin with ether, and then firmly pressing the two surfaces together in the air until the ether has evaporated. The mass then becomes most firmly adherent to the plate. The plate is then placed in the bath, which is filled with spirit, and sections may be at once cut.

If paraffin or gum be used, the plate is replaced by an adjustable metal tube which holds the imbedding mass. The size of the plate or tube can be made to vary almost indefinitely, so that if the manufacturer is informed beforehand, the machine can be adapted for the preparation of sections of very great size.

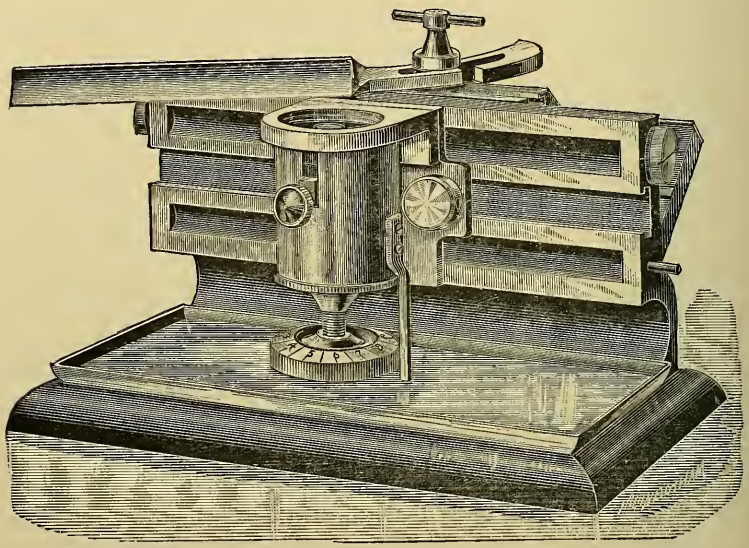
**Bausch and Lomb Optical Co's. Laboratory and Student's Microtome.** — This company have issued a modification of the Schanze microtome, under the name of the "Laboratory Microtome."

A second form, which they call the "Student's," is shown in fig. 255. It retains the main features of the first form, but is limited in its adjustments. The base, curved arm, upright and V-shaped beds for the object-holder and knife, are made of one casting, thus insuring rigidity. The vertical bed has a grooved slot its full length. An adjustable carriage to which the object-holder is attached, slides along the groove and can be fastened at any point. The knife-slide rests on five points upon Prof. Thoma's plan. It has a spring

* See this Journal, ii. (1882) p. 126.

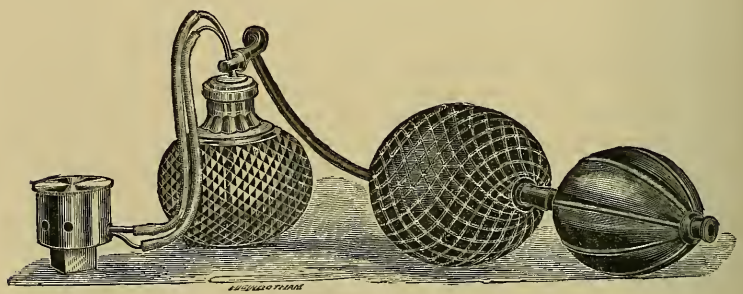
which bears against a projecting flange on the upper end of the V-bed, so that no matter how hard the material may be, the knife moves steadily through it without deviating from its plane or re-

Fig. 255.



quiring any extra pressure. The upper surface has a grooved slot to which is fitted a sliding thumb-screw so that the knife may be fastened at any point. The object-holder has a clamp for holding hard specimens, and a cup which is quickly attached for imbedding soft ones.

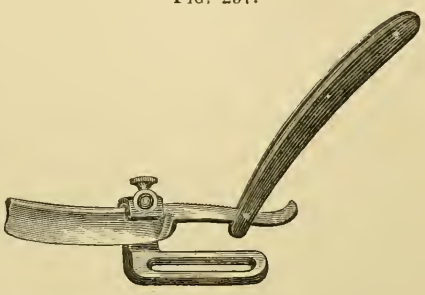
Fig. 256.



For ether freezing a nickel-plated cylinder with atomizer (fig. 256) is fastened in the clamp.

An attachment (fig. 257) is also supplied for holding other knives than those specially made for the microtome. It is provided with a slot so that it may be adjusted upon the block, and with set-screws so that the angle of the cutting edge of the knife may be varied. The knife is fixed by the thumb-screw. It will hold a razor as well as a large knife with handle.

Fig. 257.



**Seiler's Microtome Attachment.**—At the suggestion of Dr. C. Seiler the Bausch and Lomb Optical Co. have devised a special attachment which may be fastened to either of the preceding microtomes. It consists of a circular V-shaped way which is firmly fixed on the vertical bed. A circular block is fitted to it in a manner similar to that used in the straight movement, and is provided with a grooved slot for the attachment and adjustment of the knife. When the block is made to traverse in the circle the knife moves through the specimen in a circular as well as transverse direction, thus bringing each point of the cutting edge in a continually varying position in contact with the specimen. Dr. Seiler is able to cut large and thin sections in a very satisfactory manner.

**Cambridge Rocking Microtome.***—Dr. C. O. Whitman considers that the chief objection to this microtome is, that it is adapted to only one mode of section-cutting, namely, that of producing ribbons of sections imbedded in paraffin. It could not be used for cutting collodion sections, nor can it be conveniently employed in the Duval-Mason method, where the block of paraffin is collodionized before making each section. The position of the object is such that it cannot be conveniently watched during the process of cutting; and this appears to him to form another serious objection to the instrument.

**Suggestions as to the Preparation and Use of Series of Sections in Zootomical Instruction.†**— Prof. R. Ramsay Wright writes on this subject as follows:—It is convenient to have in the laboratory prepared series of certain types, so that the student may supplement the information he has acquired from dissection by the study of these. Thus entire series of *Limax* and *Cyclas* and partial series of the earthworm and leech are almost indispensible for an accurate knowledge of the anatomy of these forms.

Slides 2 × 3 in. (i. e. double the ordinary width instead of double the ordinary length) are most convenient for small stages, and fit into many forms of slide-cabinets. Mica covers may be cut for these, and have the advantage of cheapness.

* Amer. Natural., xix. (1885) pp. 1022–5. † Ibid., pp. 919–20.

Czokor's alum-cochineal * is an exceedingly convenient stain for such purposes, as it penetrates an object of considerable size readily, and differentiates admirably. Thus a *Limax* may be left in the fluid twenty-four hours, afterwards washed in water and the excess of colouring matter removed by 70 per cent. alcohol before it is transferred to stronger alcohol. Sections of tissues stain in the fluid in from two to three minutes to two to three hours, according to the method of hardening that has been adopted. The fluid is prepared as follows:—Rub up 7 grm. of cochineal with an equal quantity of burnt alum in a mortar, add 700 c.c. of water, and boil down to 400 c.c. Add a trace of carbolic acid, and filter.

Bismarck brown in concentrated solution in water or 70 per cent. alcohol also stains well *in toto;* there is no danger of over-staining, as the excess of colour is removed by alcohol. It is particularly to be recommended where cartilaginous parts are to be studied, or where the sections are to be photographed.

Schällibaum's collodion and clove-oil mixture (one volume of the former to three of the latter) is excellent for sticking the sections to the slide. Although it is possible by this method to stain the sections on the slide in either watery or alcoholic media, much time is saved, and on the whole more satisfactory results obtained by staining the objects previously *in toto*. The collodion medium stains slightly in anilin colours, if staining on the slide be resorted to.

The study of a slide containing a large number of sections may, in certain cases, be much facilitated by having a photograph of the slide enlarged two or three times by means of an ordinary view-lens. Such an enlargement is frequently sufficient to indicate where an organ appears or disappears in a series, and thus to save time in the study of the individual sections.

**Series of Sections. Thickness of Sections.**†—Dr. R. v. Lendenfeld considers that there should always be continuous series of sections cut and mounted, one after the other. For certain things, however, and particularly for a preliminary investigation, this is not necessary to such an extent as in others, and it will save time, trouble, and material, if in such a case every second section is cut thick and thrown away, and every other cut to the required fineness and mounted.

As to the thickness of sections—a point on which a great deal depends—the mutual position of whole organs or groups of cells can generally be ascertained much better by means of thick sections and low powers, than by means of very fine sections. For histological details, however, a section is rarely too fine.

For an investigation into the structure of a rare and valuable specimen, a continuous series of sections may be recommended, which are alternately as thin as they can be made, and of medium thickness, say 0·005–0·02 mm.

**Fol's Injection-table.**‡—Dr. H. Fol describes the table (fig. 258) for injecting devised by him. (The fig. is a cliché of the original,

* See this Journal, ii. (1882) p. 426.

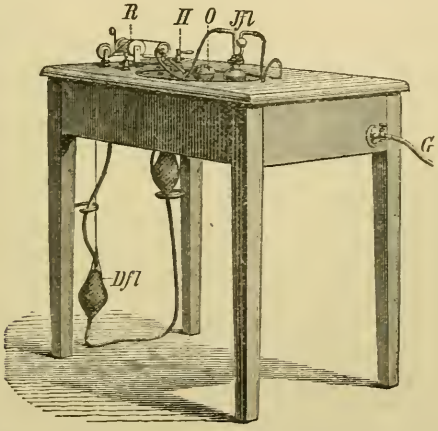
† Proc. Linn. Soc. N.S. Wales, x. (1885) p. 32.

‡ Fol's Lehrbuch d. Vergl. Mikr. Anat., 1884, p. 25 (1 fig.).

and shows more of the table than of the apparatus which it supports.)

The two indiarubber balls *Dfl* underneath the table are raised or lowered by means of a pulley arrangement R. The tap H allows the apparatus to be brought into connection with one or other of the

Fig. 258.




balls, the upper one then communicating with the air. The object O and the vessel with the injecting fluid *Jfl* are both placed in a metal pan sunk in the table and filled with water, and can be kept warm by a gas-jet (tap at G). The table is free, and everything is close at hand for almost instantaneously altering either heat or pressure.

The original explanation is a little meagre as to the action of the apparatus.

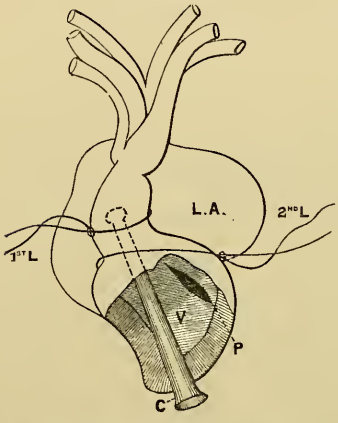
**Simple Method of Injecting the Arteries and Veins in small Animals.***—The principle involved in Prof. H. F. Osborn's method is that by the use of two injecting fluids, of different densities, one passing through the capillaries, the other arrested at the capillaries, the whole vascular system may be injected from the aortic arch.

The application of the principle is as follows:—(1) The animal is immersed in tepid water and the heart is uncovered. (2) The apex of the single ventricle, in the case of an amphibian, or of the left ventricle in the case of higher animals, is then laid widely open and the blood allowed to flow freely from the auriculo-ventricular aperture (see P in fig. 259). (3) A cannula is then inserted a short distance into the arterial bulb and the first ligature is fastened around the nozzle. The second ligature is then made ready around the base of the ventricle, thus surrounding the auriculo-ventricular apertures. (4) An ordinary gelatin injecting mass, stained deep red or purple, is in the meantime prepared. When the body is thoroughly warmed, this mass is slowly injected. As the second ligature is still loose, a

* Amer. Natural., xix. (1885) pp. 920-1.

quantity of blood, gradually followed by the gelatin, issues from the auriculo-ventricular opening. (5) When the gelatin begins to run pretty clear, the second ligature is fastened and the syringe containing gelatin is replaced by another containing a red plaster of Paris injecting mass. The latter drives the gelatin contained in the arteries before it as far as the capillaries, thus completely filling the venous system. When the gelatin is thoroughly cooled the animal is ready for dissection.

Fig. 259.




Illustrating method of preparing the frog's heart. V, ventricle; L A, left auricle; P, auriculo-ventricular opening; 1st L and 2nd L, first and second ligatures; C, cannula.

This method can be applied with considerable ease to all the smaller animals, such as frogs, lizards, and pigeons, in preparation for class-work or investigation. Its advantages are numerous. Among its disadvantages may be mentioned the fact that alcohol cannot well be used as a preservative, because it dehydrates the gelatin, causing it to shrink and break up the veins. This difficulty is entirely obviated, however, by the use of Wickersheimer's fluid, in which the injection remains perfect for an indefinite time.

**New Methods of Preparing Carmine Staining Fluids.***—Sig. G. Arcangeli states that the unsatisfactory results and the instability of the ordinary carmine stains, induced him to try other methods, and he has obtained excellent results by the following modifications.

1. Boil together 100 grms. distilled water, 4 grms. boric acid, and 50 centigrms. carmine for about 10 minutes. Filter when tepid. The fluid gives a beautiful cochineal-red stain, much resembling that of eosin. The nuclei of vegetable tissues attain their maximum of coloration in about twenty-four hours. The cutaneous epithelium and muscular fibres of *Rana esculenta* stain well. It is necessary to be aware that the sections should not be washed more than twice or thrice in water, and should be then transferred to alcohol, which seems to set the stain.

2. Another carmine stain, which gave the best results, was obtained by boiling for about ten minutes 100 c.c. of a saturated solution of alum, 2 grms. of boric acid, and 25 centigms. of carmine. The fluid so obtained is of a fine violet-red colour, and stains the nuclei of animal and vegetable tissues in about twenty-four hours, and according as the sections are placed in an alcoholic or aqueous solution of the stain, so is the greater or less rapidity of its action. When used in an alcoholic solution the staining is rapid, and the whole of the cell

* Atti Soc. Toscana Sci. Nat., Proc. Verb., iv. (1885) pp. 233–7.

participates in the process. When in combination with water only, the action is slower, and the nucleus alone affected.

3. A third stain was made by substituting salicylic for boric acid. 100 grms. of a saturated solution of alum, 25 centigrms. carmine, and 25 centigrms. salicylic acid, are boiled together for ten minutes. The fluid thus obtained has a redder hue, and its stain a more vivid red than that of the preceding fluid. Vegetable and animal tissues stain in about twenty-four hours.

4. Satisfactory results were obtained by boiling 25 centigrms. carmine with 50 c.c. saturated solution of picric acid for ten minutes, and filtering when cold. The fluid thus obtained much resembles in its action and appearance picrocarmine.

**Staining Salivary Glands.***—Dr. N. Kultschizky points out that the secreting cells of the serous salivary glands of the hedgehog (corresponding to the parotid of other mammals) stain badly by the rapid process; slow staining for twenty-four hours or so is better. He specially recommends Prof. Kutschin's method, which consists in immersing thin sections of the organs, previously hardened in chromic acid salts or alcohol, in a 4 per cent. solution of chloral hydrate slightly tinged with picrocarmine. The plasma is differentiated into an outer granular nucleated zone deeply stained with carmine or logwood, and an inner zone, finely granular and less coloured. The epithelial cells lining the small ducts show three zones after staining with logwood or carmine.

2. The mucous glands (corresponding to sublingual of most mammals; the orbital of dogs) contain, in the fresh condition, cloudy cells, which clear up with alcohol or chrome salts. The nuclei and plasma stain equally well with carmine and logwood; the epithelial cells of finer ducts stain well with logwood.

3. The mixed glands (corresponding to submaxillary of man, mouse, and guinea-pig) contain two kinds of cells. (*a*) Muconoid, distinguished from ordinary mucous cells and from serous cells by the fact that their protoplasm is stained deeply with carmine; logwood only stains their nuclei. (*b*) Serous cells, which stain slightly with carmine, strongly with logwood.

**Staining with Hæmatoxylin.**†—Mr. W. A. Haswell, in an account of his experience of histological methods in connection with class-work, says he finds objects which have been hardened by any of the usual methods, after having been at least a fortnight in alcohol, are best stained *en bloc* by an aqueous solution of crystallized hæmatoxylin, followed by bichromate of potash as recommended by Heidenhain.‡ For most organs and tissues, pieces 1/2 in. square are most successfully and uniformly stained through by means of a 1/2 per cent. solution of hæmatoxylin, allowed to act for ten to twenty-four hours; the staining agent is followed by a 1 per cent. solution of bichromate of potash, which should be allowed to act for two or three hours. It

* Zeitschr. f. Wiss. Zool., xli. (1884) pp. 99–106 (1 pl.).
† Proc. Linn. Soc. N. S. Wales, x. (1885) pp. 276–7.
‡ Pflüger's Arch. Gesammt. Physiol., xxiv. (1881) p. 468.

is quite impossible, of course, to lay down any precise rule as to the time required for staining satisfactorily portions of any given organ; though twenty-four hours' immersion in a 1/2 per cent. solution of hæmatoxylin will, in the majority of cases, give satisfactory results, in some instances the object will be rendered too black, and in others will be found not to be stained throughout. The tissues which require the most prolonged staining, when hardened by one method, may become much more rapidly coloured when treated in another way. It will, therefore, be found necessary, in order to insure good specimens of all the organs, to take several pieces of each, prepared in different ways, and subject them all to the same process of staining; or else, taking several pieces of each specimen, to subject each of them to the action of the staining fluid for a different interval. The results obtained by this method excel, in Mr. Haswell's opinion, in the definiteness of the cell-outlines, and the distinctness of the differentiation of the tissues, any that can be obtained by any of the ordinary processes of staining capable of being carried out in a class.

**Imbedding in Paraffin.***—Specimens of animals or of organs stained as above described *en bloc*, and afterwards treated with bichromate of potash, require, after soaking for a few minutes in distilled water, to be treated with strong alcohol for several days—absolute alcohol being used for at least the last two days—in order completely to remove the water with which they have become saturated. As in staining so also in the imbedding, both time and material are saved by preparing a large number of specimens —say twenty or more—at one time. The alcohol is then replaced by chloroform. If the objects are delicate and complicated, this will be very conveniently and thoroughly effected by using some such contrivance as the chloroform-box which Mr. Haswell employs. This is an oblong brass box, divided internally into two compartments by a vertical partition, which does not reach the bottom, but leaves an opening of 3/4 in. Chloroform, with a slight admixture of sulphuric ether, is poured into the box until it rises a little above the lower border of the vertical partition. Absolute alcohol is gently poured by means of a pipette on the surface of the chloroform in one of the compartments; the objects are placed in this, and, as they become saturated with the chloroform, they sink down until they drift through below the partition into the other compartment, which contains only the mixture of chloroform and ether. From this they can be taken out without disturbing the equilibrium of the alcohol and chloroform. Ordinary objects may simply be transferred from absolute alcohol to chloroform, and kept in the latter for twenty-four hours, or until saturated. Saturation with paraffin is then effected by the well-known method of Giesbrecht. Mr. Haswell uses a special water-bath, with trough divided into a number of compartments. To ensure a good result, equal parts, by volume, of chloroform and paraffin (of low melting-point) should be used, and the objects should be left in the bath at the temperature of the melting-point of the soft paraffin for about twenty-four hours.

* Proc. Linn. Soc. N. S. Wales, x. (1885) pp. 277–8.

**Eau de Javelle for Clearing.***—Prof. E. Strasburger calls attention to Eau de Javelle† as a medium for rendering vegetation-points clear.

Eau de Javelle (hypochlorite of potash) is decidedly superior to Eau de Labarraque (hypochlorite of soda). It is made by mixing 20 parts of the officinal (25 per cent.) calcium chloride with 100 parts water: after standing some time, a solution of 15 parts potash in 100 water is added, and after standing some days longer it is filtered. Should the solution be found to contain too much lime, add a few drops of potash and filter off precipitate.

**Fixing Objects to the Cover-glass.**‡—Mr. C. Van Brunt gives one of many methods of fixing objects to the cover-glass which has been used very successfully in glycerin mounts—the albumen method. Mix filtered or strained albumen and glycerin in equal parts, and with a needle apply a thin film of the mixture to the surface of the cover-glass. On this film place the object. If now the albumen is coagulated by a gentle heat it will hold the object so fast that it can be mounted in glycerin, and will always keep its place. The albumen is transparent, except when too much is used.

**Smith's Mounting Media of High Refractive Index.**§—At the Meeting of the American Society of Microscopists at Cleveland, Prof. H. L. Smith described his process of mounting in media of high refractive index, and gave the formulæ for preparing the same. The white medium, which has a refractive index of about 1·7, is very easily prepared, and is pronounced by Prof. Smith and those who have used it, as unchangeable, provided moisture is kept out. The following is the formula as given for this:—

A stiff glycerin-jelly is first made, about the consistency of honey, by dissolving clear gelatin (Cox's) in pure glycerin, by aid of heat, and in two fluid drams of this, 40 gr. of pure stannous chloride are dissolved. The solution is easily affected by a little heat. When this solution is made it will probably be somewhat milky, but by boiling it in a test-tube it will become beautifully clear and about the colour of balsam. This boiling must be done in a test-tube not over one-fourth full, as the bubbles are, towards the last, very large and thrown violently up and liable to eject the fluid from the tube; but with care the whole may in a short time be made not only clear, but when cold about as stiff as thick balsam, and, if in a small vial, it is not readily poured out. This medium should be used in making mounts precisely as balsam is when the mounts are to be finished by heating. The bubbles escape very rapidly and easily, but towards the end of the boiling, as the medium becomes viscid, they are inclined to persist, but by carefully heating, using a small flame, they will disappear, and indeed, as they are mostly steam, they will frequently disappear

* Bot. Centralbl., xxiv. (1885) p. 157.
† See this Journal, *ante*, p. 893.
‡ Journ. N. York Micr. Soc., i. (1885) pp. 158-9.
§ Amer. Mon. Micr. Journ., vi. (1885) pp. 161-3 (1 fig.).

wholly in cooling, when a balsam mount under the same circumstances would be full of bubbles.

If the boiling has been sufficiently prolonged, the cover will be found, on cooling, to be pretty firmly attached, and will allow the excess of material to be cleaned off without danger to the mount—indeed this excess should be hard, requiring a knife or a sharp edge to remove it. It is advisable to put on only so much as is necessary to fill in under the cover, and have no cleaning to do afterwards; or put on a minute drop, and if that should not be enough feed in a little more from the end of the small glass rod used for dipping. The best thing to clean off the excess is hydrochloric acid, a bit of tissue paper rolled up and moistened with this, not too wet, serves the purpose admirably, but water may also be used, and is nearly as good.

As the medium is deliquescent it is necessary to use a protecting ring. For this purpose, after the slide is well cleaned around the cover-glass, and warmed to dry it, apply a good coat of zinc white cement * or shellac coloured to suit the fancy. If the sealing is perfect there will be no change by time. It is recommended, however, to use a wax ring. These rings punched out of sheet wax, of such size as to cover the edge of the thin glass, are put on the mount when it is finished, and, by cautious application of a small flame, just melted but not so as to run. If any bubbles form under the ring they may be removed by touching with a hot needle or pin-point before the wax cools. A mount made in this way will stand indefinitely and can at any time receive a supplemental coloured ring of shellac or other varnish for a finish.

*Amphipleura pellucida* is very beautifully shown in this medium, and the various Pleurosigmas, indeed all diatoms except the very coarse ones, which appear almost black in the medium. A very little experimenting will enable one to use the medium successfully.

The use of the gelatin is only to give such a hold upon the cover as will permit the necessary pressure in cleaning. Many mounts were made in the earlier experiments with this medium, without the gelatin, but in all these cases the cover was less firmly attached to the slide. If the protecting ring keeps out moisture from immersion media, or the atmosphere, the mounts will remain unchanged. As the medium dissolves gelatin, albumen, &c., arranged diatoms must be fastened to the cover by heating the latter, supported on a bit of thin sheet iron or platinum, nearly to a melting or softening point. A larger proportion of the stannous chloride can be dissolved than that mentioned above, even as much as 60 gr., but then on heating to harden the mass, crystals will appear; the crystals never give any trouble when 40 gr. are used.

In a subsequent note † Prof. Smith says, the refractive index may be raised considerably by making a saturated solution ‡ in the glycerin jelly—about 60 gr. to the fluid dram—and mixing this with the

* See the next note. † Amer. Mon. Micr. Journ., vi. (1885) p. 182.

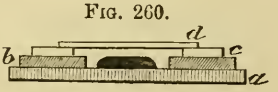
‡ By a saturated solution the author means one which, when *thoroughly cooled*, will show signs of crystallization.

normal solution of 40 gr. The refractive index in this case becomes nearly 2.

The second medium is realgar, the transparent sulphide of arsenic dissolved in bromide of arsenic by aid of heat. Both of these substances should be pure and the mount should be boiled as long as bubbles are readily given off with considerable heat, and when cold the cover should be more firmly attached than with balsam. These mounts are of a deep lemon-yellow colour, and the compound has a refractive index of 2·4.

Excellent and even better mounts, as to permanence, may be made by using realgar only by sublimation. A bit of the realgar is put on a plate of mica about 1 in. square, and thick as a penny. This is melted by strong heat of a spirit-lamp. On this mica plate is placed another, with a hole 5/8 in. in diameter, and above this a thin glass plate with a hole slightly less than the glass cover on which the diatoms are mounted. In fig. 260 *a* and *b* are the two mica plates, c the glass plate, and *d* the cover, with the diatoms facing the realgar. The whole is now supported on a metal ring. A strong heat will volatilize the realgar without change, and often a clear deposit is made all over the diatoms and under side of the cover, and the latter can now be mounted in balsam; but if bubbles are formed in the operation, as probably will be the case, the heat must be continued till these disappear and, as the deposit will now be thickest at the centre just over the realgar, the mount may be finished by putting the cover, realgar side down, on a clean slide and on the top of it to prevent breaking, a piece of thick glass, and then, grasping tightly with forceps to give pressure, heating strongly over a spirit-lamp. The realgar will soften (it must not be melted else bubbles will form which cannot be removed) and spread out, more or less, between the cover and slide making a nice clear mount. The colour of the heated realgar is very much deeper than when cold. Instead of the solid realgar a drop of the solution in bromide of arsenic may be used; but in this case it must be boiled to expel the most of the bromide, before the cover is placed above it; the solid compound now melts at a much lower temperature than the realgar alone. These mounts will not change, but those made from the solution directly will, if the ingredients are not entirely pure, containing no excess of either sulphur or arsenic. As bromide of arsenic will dissolve both sulphur and arsenic there is always danger, if the realgar is not pure, that there will be an excess of one of these, and if so the mount will either crystallize or granulate.

Fig. 260.




Prof. Smith also writes * that he is now testing still another medium of somewhat higher index than the stannous chloride, a full account of which will appear in due time.

**Smith's New Cement.**†—Prof. H. L. Smith has communicated the results of some recent experiments he has made with a new cement,

* Amer. Mon. Micr. Journ., vi. (1885) p. 182. † Ibid.

especially adapted for protecting mounts in his new stannous chloride mounting medium.* It is made by diluting a somewhat thick shellac cement with benzole, and adding sufficient litharge to give a consistency about the same as that of white zinc cement. It dries very quickly, forms a much harder ring than does the white zinc cement, and is not unpleasant in appearance, as it becomes quite brown or dark on exposure. A thin coat should first be applied, and when this is well dried it should be followed by another. So far as tried this seems to promise better than any other for preservation of the stannous chloride mounts. The white zinc often fails, and while the wax rings appear to answer admirably, the cement is more readily applied, and if the future use of it confirms the present promise it will be more acceptable.

**Dry Mounting.**—The ordinary method of fastening on the cover-glass is, in Mr. J. L. W. Miles's opinion,† the cause of a serious defect in most dry mounts, viz. imprisoned moisture on the under side of the cover. With very low powers it is not always noticeable, but with 1 in., 1/2 in., or 4/10 in. objectives definition is seriously impaired. It is usual to put the slide on the turntable and apply brown or other cement freely to the rim of the cell, to which the cover-glass adheres when placed thereon. The cement drying from the outside, the imprisoned portion upon which the cover rests hardens by evaporation within the cell, hence the result mentioned. This difficulty can be minimized, and in many cases, with care, entirely overcome by proceeding as follows:—Select a cover-glass much less in diameter than the cell is, measured across its outer edges; place and hold in position with a wire clip, and unite the edge of the glass to the rim of the cell by means of "tacky" gum, which should not run under, or but slightly, inasmuch as the cover-glass will not overlap the cell rim, but will barely rest upon its inner edge. There is yet another precaution to be taken, namely, file out a small portion of the cell, which will form an orifice or opening after the cover is put on. This is a capital plan when you are in doubt about the dryness of your object, as the minute opening can be plugged or bridged over by cement at any convenient time afterwards. Having got so far, all difficulties would appear to be overcome, but this is not so. It is necessary to carefully finish the slide with varnish or cement of a damp-resisting nature. Use brown cement in the first place, and finish with white zinc, which clings tenaciously to clean glass, and makes a secure and neat finish.

Mr. T. W. Lofthouse,‡ in regard to moisture getting into cardboard cells, considered that if the cell was not entirely coated with cement the moisture would be able to escape at the sides, and tested this by mounting two slides with a drop of water on the under surface of the cover before cementing it down. On warming the slide the cell was soon completely filled with moisture. After being held over

* See the preceding note.
† Trans. and Ann. Rep. Manchester Micr. Soc., 1884–5, pp. 26–9.
‡ Ibid., pp. 32–3.

the lamp for a short time, the slides were put on a warm kitchen mantel-piece for two or three hours, and on examining them a week afterwards they were found to be quite free from moisture.

Mr. E. Ward thinks * that if the moisture could get out of a paper cell it could also get in, unless it is sealed up at precisely the right moment with protective cement, and the difficulty is as to *when* is the right moment. He prefers to use a metal cell, to be careful to have dry objects, and having got rid of the moisture from the gum, &c., to seal up the cell. In this way he has mounted thousands, few of which have shown even a trace of moisture or fungi.

His plan is this. Having mounted an object in the cell and allowed it to become thoroughly dry, spin a ring of brown cement upon the cell and let it dry till it can be indented with the finger-nail without sticking. Then warm a cover-glass, and place it on the cell. Choosing then a *strong* glass slip, make it hot in the centre by means of a spirit-lamp, and press it down on the top of the cover-glass; the warmth melts the cement, and the cover is fixed firmly without evaporation inside the cells.

The slide should now be put away for a day or two for the cement to harden, and then, if another layer is applied, we may be sure of a dry mount.

**White Zinc Cement.**†—Dr. F. L. James briefly recapitulates the objections which have been made to this cement, and his answers thereto.

It is objected (1) that it does not attach itself firmly and evenly to glass at all points; (2) that it is brittle when dry, and easily cracks and scales off; (3) that it is peculiarly liable to "run in" under the cover-glass; and (4) that it is unreliable.

To these he replies:—(1) That if the cement works well at one time it certainly will do so at any and every other time, if the same conditions exist. A cement that attaches itself to glass at one point will do so at all points, if the surface is equally ready to receive it; but if one part of the surface is clean and dry, and another is dirty or moist, or both, no cement can be expected to act upon it with uniformity. (2) A cement made as hereafter described will neither scale nor crack, as a proof of which he can exhibit mounts made with it twelve or thirteen years ago, and which have been carried many thousands of miles with no especial precautions against breakage, and which are yet perfect. (3) As to the liability of the cement to run when used with balsam mounts, the fact is admitted; but it will do so only when the proper precautions against such an accident have been neglected. (4) "It is the very height of folly and absurdity to charge an inanimate substance with caprice and unreliability. If it acts well at one time and fails to do so at another, the fault lies not with the substance, but with its manipulator."

White zinc cement made as follows, has, Dr. James considers, no superior for general microscopical purposes:—Dissolve gum damar in pure benzol sufficient to make a solution of the consistency of

* Trans. and Ann. Rep. Manchester Micr. Soc., 1884-5, pp. 33-6.

† St. Louis National Druggist, vii. (1885) p. 181.

a thin syrup, and filter through absorbent cotton. Into a small porcelain capsule put a small quantity of chemically pure zinc oxide, free from moisture (a precaution which is very important and which is best secured by heating the oxide in a muffle for a short time prior to making use of it), and having previously wet it with a small quantity of benzol, add sufficient of the damar solution to make a paste the consistency of cream, or of thick paint. Rub with the muller or pestle until perfectly smooth, and then pour into a stock bottle. Repeat the operation until a sufficient amount of the cement is obtained. The material should now be allowed to stand until the zinc has separated and sunk to the bottom, and when this has occurred, enough of the damar solution should be added to make the fluid about equal the bulk of the precipitated zinc. Shake up again until the zinc is thoroughly mixed with the damar solution, and filter through a thin layer of absorbent cotton, to get rid of the grosser particles of zinc which escaped the action of the muller. The operation is finished by the addition of a small amount of some drying oil, to give the cement a proper toughness. Some persons use boiled or clarified linseed-oil for this purpose, but it is apt to make the cement "stringy," and hence good nut or poppy-oil is preferable. The amount added should not be over 12 or 15 minims to the ounce of cement. If too much of the damar solution has been added, it is easily got rid of by decantation, after allowing the zinc to separate by standing a few days in a quiet place. If the cement becomes thick after using a while, cut it with pure benzol—not benzin under any circumstances, nor impure benzol.

Dr. James also writes:—"Since writing and printing the foregoing, I have had occasion to make up quite a large amount of the cement, and have improved the processes somewhat. The principal point in which I have made a change is in doing away with the filtering process, as it is troublesome, slow, and wasteful. I now obtain better results by decantation. After mixing the cement as directed, I give it a vigorous shaking and set the vessel containing it in a quiet place. In the course of a few hours the grosser particles will have sunk to the bottom, and the cement, thus freed from them, may be decanted into other bottles. By repeating this process two or three times, a cement of the most exquisite fineness and finish may be obtained."

**Leakage of Cells.***—On the cause of the leakage of cells, Dr. F. L. James writes as follows:—

"Many microscopists are in the habit of making their cells only when they are needed, allowing the rings to dry just so much that the cover-glass will not stick when applied. Some do this from thoughtlessness, or rather from never having experimented or investigated the relative merits of a fresh and thoroughly dried and seasoned cell. Others claim actual advantages for this procedure. They say that when the cover-glass is applied while the cell rings are yet plastic, a more accurate coaptation, or fit, is obtained. It is also claimed that a more homogeneous mass is made with the cement which is subsequently applied to seal the cell.

* St. Louis National Druggist, vii. (1885) p. 181.

These advantages, if indeed they be such, in all except dry mounts, are more than counterbalanced by a radical defect, which all such hastily prepared mounts must have, whether the cement be zinc white or Brunswick black, or the mounting medium be glycerin or balsam. And in this defect lies the secret of most of the failures and disappointments which produce the bitter complaints against this or that cement or mounting medium in the technical journals.

All the cements described in the preceding chapters, with the exception of gold size, consist of some solid material or materials dissolved or held in suspension in a medium more or less volatile, the evaporation of which again leaves a solid mass. The exception, gold size, hardens partly, though very slightly, by evaporation, its solidification depending principally upon oxidation. In the process of hardening or setting, the bulk or mass of the cement is very materially altered, a decrease in volume occurring which is proportionate to the amount of volatile matter lost in drying. *The cement shrinks.*

Now, when a cell is properly finished it must be entirely filled with the mounting medium. If it is not so filled we are bound to have air-bubbles, the *bête noir* of microscopists, which are not only unsightly, but will, in process of time, ruin the mount. If the cell walls were not entirely dry when the cell was closed it is plain that the process of shrinkage had not yet been completed, and that it is yet to occur to a greater or less extent. What is the inevitable result? The fluid within the cell is practically incompressible, yet pressure is brought upon it. It has no space within its container into which it can retreat, and consequently it must force its way out of it. This it does slowly and gradually. It may be some time before it is noticed, but it is bound to come. The cement gives way at its weakest point, and the fluid exudes—'creeps' out. It is discovered, washed off, and a fresh ring of cement applied. This puts off the evil day a while, but in a few months the process has to be repeated. Meanwhile the pressure is continuously exerted, and minute quantities of the mounting medium gradually infiltrate the walls at fresh points; the cement disintegrates, scales and splits off."

It should therefore be an axiom "never to use a cell until the cement walls are thoroughly dry and hard."

**Coloured Crayons for Marking Preparations—Finder.***—Prof. E. Strasburger recommends Faber's coloured crayons for writing on glass or porcelain for marking preparations provisionally. The yellow crayons are most suitable for this object.

In order to find given places in a specimen, circles should be made with some sharp instrument on both sides of the aperture in the stage of the Microscope, similar circles being drawn with the crayon in corresponding positions on the slide.

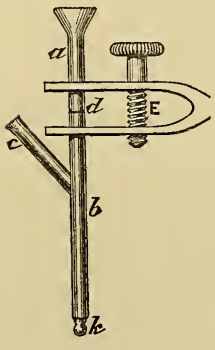
**Filtering Minute Quantities.**†—The ordinary method of filtering by means of paper funnels is not practicable for quantities less than

* Bot. Centralbl., xxiv. (1885) pp. 156–7.

† Haushofer, K., 'Mikroskopische Reactionen,' vii. and 162 pp., 137 figs., 8vo, Braunschweig, 1885.

300 cmm. If it is desired to obtain a sediment without loss Beudant's method should be adopted. In this, two watch-glasses, one placed at a higher level than the other, are made use of. The upper one contains the fluid to be filtered, and the two are connected by means of a moistened strip of filter-paper. This automatic action may be further increased if it be desirable to wash the filtrate. This is effected by a third watch-glass, filled with distilled water, and placed above that which contains the substance to be washed.

Fig. 261.




For filtering very small quantities Dr. K. Haushofer recommends two glass tubes, *a*, *b*, fig. 261, placed in vertical apposition, and connected by a screw-clamp E which allows the upper tube to be approximated to or removed from the lower one. From the lower tube another, *c*, projects upwards at an angle. Between the two tubes at *d*, a sheet of moistened filter-paper is inserted, and the tubes are then closely adjusted by means of the screw. The bottom of the tube *b* is closed by a stopper *k*. The fluid is then poured in, and suction made at the side tube. The filtrate is always perfectly clear, and the residue is collected in a small space.

**Examining Blood in Typhoid Fever.***—Mr. T. S. Ralph states the results of his experiments on blood with phloroglucen, phosphoric acid, ozonic ether, and hydrocyanic acid.

With normal blood, phloroglucen causes the corpuscles to separate into a larger greyish solid portion and a smaller fluid residuum, presenting one or more spots of a reddish hue. A similar but less decided effect is produced by the action of phosphoric acid. Ozonic ether causes an active effervescence, followed on its cessation by the appearance of numerous large cells varying in size from 1/2000 to 1/1000 of an inch. Each of these cells contains a small vesicle or gas-bubble of a reddish or orange hue. By the action of hydrocyanic acid on dry films of blood, the presence of minute reddish or orange-coloured spots may be detected. These increase in size, vary in number, may be arranged in circles, or may be replaced by larger ones.

Similar changes can be brought about in typhoid blood by the use of these reagents, but typhoid blood examined without the aid of chemical agents presents under ordinary circumstances orange and red vesicular forms imbedded in the plasma. These vary in size from 1/10,000 to 1/7000 of an inch in diameter, are mobile, and surrounded by a white halo-like appearance. The action of ozonic ether and other reagents appears to release orange-coloured vesicular forms in a more permanent condition and in larger numbers than in healthy blood. Hydrocyanic acid is stated to produce certain appearances

* Ralph, T. S., 'Microchemical Observations on the Blood in Health and in Typhoid Fever,' 12 pp. (1 pl.), 8vo, Sydney, 1885.

which present on the one hand crystalline resemblances, and on the other more nearly approach in their appearance and character the low and obscure forms of vegetable life.

The author also records the fact that, after chloroform, the blood plasma exhibits escaped vesicular forms, and perhaps more abundantly than in typhoid and other febrile conditions.

**Measurement of Blood-corpuscles.***—Dr. M. D. Ewell has endeavoured to determine whether there is a constant average size of the human red blood-corpuscles, so as to render it possible by means of micrometric measurements to distinguish human blood from that of domestic animals.

He used two accurate standards, one consisting of lines ruled on speculum metal 1/2000 in. apart, by Prof. W. A. Rogers, a Bulloch cobweb eye-piece micrometer and a 1/10 in. Spencer hom. imm. 1·35 N. A., with a Bausch and Lomb achromatic amplifier giving an amplification of about 1500; also Prof. H. L. Smith's immersion fluid.

An examination of the tabular statement of results shows that the difference between the greatest and smallest averages of 25 corpuscles is 0·000028 or 1/35714 in., a magnitude that may be easily measured by any person having the requisite skill and apparatus.

The difference between the highest and lowest averages of 50 corpuscles is 0·000015, or 1/66666 in., which approaches more nearly the limit of micrometric measurement, though probably not beyond it.

The difference between the highest and lowest averages of 75 corpuscles is 0·000012, or 1/83333 in., which approximates the limit of micrometric measurement.

The difference between the highest and lowest averages of 100 corpuscles is 0·000009, or 1/111111 in., which is within the limits of personal and instrumental error, "according to the highest living authority upon this subject," who writes, in substance, that it is easy to measure 1/50,000 in., but to be sure of 1/100,000 in. is not possible.

The conclusion to be deduced from the above figures is obviously, Dr. Ewell says, "that, when a sufficient number of corpuscles are measured, there appears to be an average size which varies within very narrow limits, which may possibly be accounted for, or, at least, is consistent with personal and instrumental errors; for, though I have carried out the figures to the sixth decimal place, I have not the presumption to declare that the results can be relied upon further than the fifth place, and have carried out the figures to the sixth only to insure accuracy in the fifth so far as possible. Another conclusion is, that granting for the moment that it is possible to identify blood by measurement of the red corpuscles, of which I am by no means satisfied, it is reckless in the last degree, if not criminal, to express an opinion upon the measurement of less than 100 corpuscles. To express an opinion upon the measurement of only 10 corpuscles,

* The Microscope, v. (1885) pp. 183–6. Amer. Mon. Micr. Journ., vi. (1885) p. 150–1, from 'Chicago Legal News.'

as I am informed has been done within the last year or two, to take the most charitable view of the subject, betrays such culpable ignorance of a subject involving such momentous consequences as ought for ever to invalidate the testimony of one who should swear so recklessly. In a case involving the issue of life and death it would be better to measure several hundred corpuscles."

An examination of the unabridged table of measurements, from which the above summary is tabulated, discloses the further fact that by selecting the corpuscles it would be possible for a dishonest observer to make the average much larger or smaller than that above given without the possibility of detection; a fact the bearing of which upon the value of expert testimony upon this subject is so obvious as to need no comment.

**Styles of Indian Corn for Examining Movement of Protoplasm.*** —Prof. C. E. Bessey recommends the long styles of Indian corn for the study of the movement of the protoplasm. By taking a young style from an ear which has been kept in a warm place for an hour or so, clipping off a piece a couple of inches in length and carefully mounting it in water under a large cover-glass, there will be no difficulty in seeing a great deal of activity in the protoplasm. Care must of course be taken to have the style lie flat, remembering that it is not cylindrical in shape, but somewhat ribbon-shaped. The cells are much elongated, and the walls are so transparent that with careful focusing their contents may be seen, even in the interior parts of the style.

The protoplasm is sufficiently granular to be easily seen. It moves along the side of the cell in a strong steady stream, occasionally heaping up a great mass, which is eventually pushed onward by the current. As an easily obtained and instructive example of protoplasmic activity, Prof. Bessey knows of nothing which is superior to such a specimen.

**Haushofer's Microscopical Reactions.†**—Dr. K. Haushofer's work is intended as an introduction to the recognition of various elements and compounds by the aid of the Microscope, and deals with the application of the Microscope to petrographical research.

The author's method depends for its *raison d'être* on the constancy of crystalline forms and combinations of elements, crystallization being considered a constant property, just as colour, solubility, melting point, &c. The methods which, by the aid of the Microscope, aim at demonstrating the presence of different substances through these crystallizable compounds, for the most part possess the advantage, not only of being applicable to extremely small quantities, but of requiring very little apparatus and only very simple operations. Hence they are of great practical importance if we desire to analyse very minute quantities and do not possess other sufficiently sensitive tests. But for bodies which are demonstrable in very minute quan-

* Amer. Natural., xix. (1885) p. 888.

† Haushofer, K., 'Mikroskopische Reactionen,' vii. and 162 pp., 137 figs. 8vo, Braunschweig, 1885.

tities, such as iodine, iron, and manganese. microscopic tests depending on crystal formation will only be occasionally employed. The like holds good for substances which may be distinguished by spectroscopic appearances, as iridium, thallium, lithium, &c. This branch of petrology, though of comparatively recent date, has lately received greater attention, so that now quite a series of petrographic researches are known, and which may compare in exactitude with the most accurate analytical methods. The microscopic crystals which serve for proof of the existence of certain substances are formed either as precipitates after definite reactions or on evaporation of solutions. In practice the former method is usually found to be the more speedy in the end, for the slower the process the more perfect is the crystal. When, however, crystallization is defective from any cause, the crystals become skeletal, malformed, or jumbled together in masses. These aggregate malformed or skeletal forms are for many substances very characteristic, and certain combinations can only be obtained in such forms as, for example, copper nitrate, thorium nitrate, thallium chloride, &c. The formation of normal crystals is favoured by the employment of very dilute solutions. Very insoluble substances, such as barium sulphate, lead sulphate, silver chloride, are little suitable for the microscopic test applied directly.

The general method of examination when only small quantities are available, is to place a drop of the solution to be tested on a slide on the stage of the Microscope, and then add a drop of the precipitation-reagent. Cover-glasses are not needed unless any development of gas occurs, or when observations are made on fluorine and its compounds. In the latter case it is necessary to protect the objective by fixing a cover-glass in front of the face of the anterior lens. It is also necessary when hydrofluoric acid is given off during the reactions to cover the slides with a thin layer of Canada balsam, and to conduct preliminary operations in platinum vessels.

In the majority of the examinations carried out by these methods perfectly trustworthy results are obtained with 1–2 mgrm. of substance. Thus in a drop of gypsum solution which weighs only 10 mgrm. is contained merely ·03 mgrm. gypsum or ·01 mgrm. calcium oxide, and they can be recognized with certainty under the Microscope as sulphate or oxalate.

For the examination of the composite silicates the methods of Boricky and Behrens are recommended. Boricky's method is founded on the property of hydrofluosilicic acid to develope hydrofluoric acid on evaporation, and thereby to set free silicates even without the aid of heat. A minute fragment of the size of a pin's head is placed on a slide protected by a layer of Canada balsam and a drop of a 3–4 per cent. hydrofluosilicic acid is added. After acting from two to six hours, the decomposition is so far advanced that the crystallized double salts of fluorine permit the recognition of the basic constituents of silicates. This method, although simple, is not free from defects.

Behrens proceeds by completely decomposing the mineral to be tested with hydrofluoric acid, and by removing any fluorosilicons by

the aid of sulphuric acid. The powdered mineral, of which 1 mgrm. is sufficient, is heated to dryness with sulphuric acid in a platinum dish. The residue is treated with water, and a drop of the solution placed on a slide. Certain tests demonstrate the presence of basic constituents in solution. In the residue are found gypsum, the insoluble sulphates of barium and strontium; these are dissolved in strong sulphuric acid, and crystallize out on cooling.

The characteristics of microcrystals would be unsatisfactory and imperfect if their optical properties were left out of consideration. Therefore, with the study of crystal forms which aid the analysis of any substance, examination of crystals by polarized light must be associated. The optical characteristics of microcrystals gain in importance because, while their angular measurement does not attain the same distinctness as in the larger crystals, yet the optical anomalies of microcrystals are more rare than those of the large.

Dr. Haushofer's arrangement of the subject matter of his work is alphabetical. This, if not strictly scientific, at least saves all trouble of hunting for a given subject, and any compound can be found at once. The text is copiously illustrated by woodcuts of crystal forms of almost infinite variety.

In this connection it may be noted that Dr. J. L. W. Thudichum, in a discussion * on "Medico-legal and Chemical Microscopy," considers that in all cases chemical tests should be relied upon, crystalline form not being trustworthy evidence, for it frequently happens that these forms are determined by impurities present, so that often the substance in its pure form cannot be made to crystallize at all. Even when substances form definite crystals, these vary in appearance according to the mass of the substance used, the heat, and other circumstances. The microscopical detection of octahedral crystals is merely a confirmation of the presence of arsenic, but not diagnostic, since other substances produce similar crystals. Dr. Thudichum also considers that the micro-spectroscope has no advantage over the ordinary spectroscope, since both require the same amount of material to produce definite results. The Microscope is especially useful in the preliminary stages of an inquiry; thus, in dealing with 1500 ox brains, he had found it invaluable in preparing phrenosine from these.

**Examining Diamonds and Cut Gems.**†—In the microscopical examination of diamonds and cut gems the best results are obtained when they are submerged in glycerin or balsam. A temporary cell, large enough to contain the gem, is easily made by cutting or punching a hole in a cake of ordinary white wax, and it is firmly attached by heating the slide slightly. Small gems may thus be examined without removing them from their settings. The cell should be entirely filled with the mounting fluid and a cover-glass applied. Canada balsam gives better effects with most gems than glycerin does, but the difficulty of cleaning it off makes the latter preferable.

* Engl. Mech., xlii. (1885) pp. 219–20.

† St. Louis National Druggist, vii. (1885) p. 197. (Microscopy, by Dr. F. L. James.)

Many stones which do not show flaws when examined in the ordinary manner, will be found to contain cavities filled with fluid when examined as above.

ARCANGELI, G.—**Sopra alcune dissoluzioni carminiche destinate alla coloritura degli elementi istologici.** (On some carmine solutions for staining the histological elements.) [*Supra*, p. 1094.]
*Atti Soc. Tosc. Sci. Nat.—Proc. Verb.*, IV. (1885) pp. 233–7.

BARNES, C. R.—**The Process of Fertilization in *Campanula Americana* L.** [Methods. *Supra*, p. 1085.] *Bot. Gazette*, X. (1885) pp. 353–4 (1 pl.).

BJELOUSSOW, A. K.—**Eine neue Methode von Injection anatomischer Präparate vermittelst kalter Masse.** (A new method of injecting anatomical preparations by cold masses.) [*Post.*]
*Arch. f. Anat. u. Physiol.*, 1885, pp. 379–84.

BUCHNER, H.—**Ueber d. Verhalten d. Spaltpilzsporen zu den Anilinfarbstoffen.** (On the behaviour of the spores of Schizomycetes with anilin dyes.)
*SB. Gesell. f. Morphol. u. Physiol.*, 1885.

CAMPBELL, D. H.—**On growing the spores of Botrychium ternatum.**
["The spores are devoid of chlorophyll, both before and after germination, which suggests that they should be grown in rich earth or humus. When prothallia of similar plants have been found they have been below the surface of the ground, and he devised a plan [not described] for sowing the spores under the soil yet so far as to be kept under constant observation."]
*Bot. Gazette*, X. (1885) p. 340.

COLE, A. C.—**Studies in Microscopical Science.** (Parts IX. and X., pp. 33–6, 37–40.)
Sect. I. (Botanical Histology). (IX.) Non-sexual organs of reproduction in Vascular Cryptogams. Type II. Cone of *Selaginella*. Plate IX. *S. inæqualifolia*. Lon. Sect. Fertile spitu × 13. (X.) Structure of Macrosporangia (Anthers) in *Taxus*. Plate X. Vert. Sect. of Ovule of *Taxus*.
Sect. II. (Animal Histology). Respiratory organs. Plate IX. Lung of Frog. Plate X. Lung of Duck. Tr. Sec. × 270.
Sect. III. (Pathological Histology). (IX.) Brown Induration of the Lung. Emphysema. Plate IX. Lung, Emphysema × 18. (X.) Pleurisy. Plate X. Pleurisy × 68.
Sect. IV. (Popular Studies). (IX.) The Tracheal System of Insects. (Methods, *post.*) Stem of *Bignonia*. Plate IX. Tr. Sec. × 75. (X.) Insectivorous and Carnivorous Plants. Plate X. Carnivorous Plants.

DETMERS, H. J.—**[Importance of reliable Microscopical Evidence.]** [*Post.*]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 199.
Remarks at Cleveland Meeting of American Society of Microscopists.

DRAPER, E. T.—**Graphic Microscopy.** XXII. Transparent section of tooth of Ant-eater. XXIII. *Polysiphonia fastigiata.*
*Sci.-Gossip*, 1885, pp. 217–8 (1 pl.), p. 241 (1 pl.).

FEBIGER, C.—See James, F. L.

FŒTTINGER, A.—**Renseignements Techniques.** (Technical Information.)
[1. Chloral hydrate for the study and preservation of the lower animals. 2. Collodion for fixing on the glass objects to be preserved in alcohol. 3. Process for purifying and hardening the paraffin of commerce. *Post.*]
*Arch. de Biol.*, VI. (1885) pp. 115–25.

GARRISON, F. L.—**The microscopic structure of Iron and Steel.** [*Post.*]
*Journ. Franklin Inst.*, CXX. (1885) pp. 300–6 (5 pls.), from *Trans. Amer. Inst. of Mining Engineers.*

GIBBES, H.—**Practical Histology and Pathology.**
3rd ed., xii. and 196 pp., 8vo, London, 1885.

GIERKE, H.—**Färberei zu mikroskopischen Zwecken. Nebst Nachtrag.** (Staining for microscopical purposes. With Appendix.)
[Separate reprint of articles in Zeitschr. f. Wiss. Mikr. Cf. *ante*, p. 900.]
243 pp., 8vo, Braunschweig, 1885.

Goodale, G. L.—**Physiological Botany. I. Outlines of the Histology of Phænogamous Plants.**

[Vol. II. of Gray's Botanical Text-book, 6th ed. An important feature of this volume is the concise introduction in which the histological appliances and methods most frequently used are brought together for discussion.]

8vo, New York and Chicago, 1885.

Graber, V.—**[Preparing Eyes of Annelids.]**

[From Arch. f. Mikr. Anat. xvii. (1879) p. 250.—Decolor by soaking in glycerin with a little 35 per cent. caustic potash added—check by neutralizing with dilute hydrochloric acid—carefully wash before transferring to a hardening or mounting fluid—preserve in glycerin.]

*Amer. Nat.*, XIX. (1885) p. 1137.

Hart, C. P.—**A new, cheap, and quickly constructed adjustable Microtome.**

[Title only of paper read at Ann Arbor Meeting of Amer. Assoc. Adv. Sci., 1885. Cf. *ante*, p. 861.]

*Amer. Journ. Sci.*, XXX. (1885) p. 327.

Haswell, W. A.—**New Microtome.**

["Mr. Haswell described his new microtome based upon Mr. Caldwell's pattern, but with a new ribbon take-off of a very ingenious construction."]

*Journ. and Proc. Roy. Soc. N. S. Wales*, XVIII. (1885) p. 178.

„ „ **On some recent Histological Methods, and their adaptation to the teaching of practical Histology.** [*Supra*, p. 1095.]

*Proc. Linn. Soc. N. S. Wales*, X. (1885) pp. 276–8.

Haushofer, K.—**Mikroskopische Reactionen.** Eine Anleitung zur Erkennung verschiedener Elemente und Verbindungen unter dem Mikroskop als Supplement zu den Methoden der qualitativen Analyse. (Microscopical Reactions. A guide to the recognition of different elements and compounds under the Microscope, as a supplement to the methods of qualitative analysis.) [*Supra*, p. 1106.]

vii. and 162 pp. and 137 figs., 8vo, Braunschweig, 1885.

*Henking, H.*—**Neue Construction des Objecthalters an Schlittenmikrotomen.** (New construction of the object-holder of the slide microtome.)

[Abstract of article in Zeitschr. f. Wiss. Mikr. I. p. 491, with criticism. *Post.*]

*Zeitschr. f. Instrumentenk.*, V. (1885) pp. 314–5 (1 fig.).

Horner, J.—**Work for the Microscope.** III. Instruments for dissection. IV. Solutions and Mounting Media. *Our Corner*, VI. (1885) pp. 75–9, 137–42.

James, F. L.—**Microscopical Technology.**—IX. Mounting Diatoms arranged in series. The Mechanical Finger. Preparing the Slide. [C. Febiger's method. *Post.*] X., XI. Mounting Diatoms in series. Selecting and placing the Diatoms. XII. Mounting Diatoms *in situ*. Fixing anilin colours.

*St. Louis National Druggist*, VII. (1885) pp. 196, 208, 219, 233–4, 234.

„ „ **Cement.**

["In pulverized gum arabic, with an equal bulk of powdered burnt alum, we have the material for a cement of great adhesiveness and brilliancy. The mixture should be kept dry, and wet up only when required for use, just enough being prepared for the work in hand."]

*St. Louis National Druggist*, VII. (1885) pp. 196–7.

„ „ **Examination of Diamonds and Cut Gems.** [*Post.*]

*St. Louis National Druggist*, VII. (1885) p. 197.

Latham, V. A.—**The Microscope, and how to use it.**

[IV. Practical Histology. Stains.]

*Journ. of Microscopy*, IV. (1885) pp. 231–45.

Lee, A. B.—**Cedernholzöl für Paraffineinbettung.** (Cedar-oil for paraffin imbedding.) [*Post.*] *Zool. Anzeig.*, VIII. (1885) p. 563–4.

Leone, T.—**Sui microorganismi delle acque potabili: loro vita nelle acque carboniche.** (On the micro-organisms of potable water: their life in carbonic acid water.)

[Contains methods. *Post.*]

*Atti R. Accad. Lincei.—Rendic.*, I. (1885) pp. 726–32.

Locy, W. A.—**Treatment of the Eggs of the Spider.** [*Supra*, p. 1083.]
*Amer. Natural.*, XIX. (1885) pp. 1021–2.

Mark, E. L.—**Repairing Balsam Preparations.** [*Post.*]
*Amer. Natural.*, XIX. (1885) p. 1137.

Morris, W.—**New Mounting Medium.** [*Supra*, p. 1077.]
*Journ. and Proc. Royal Soc. N. S. Wales*, XVIII. (1884) pp. 178–9.

**Naples Zoological Station, Third Catalogue of Marine Animals supplied by the.**
[List of different objects, with prices.]
Issued with *MT. Zool. Stat. Neapel*, VI. (1885) Part 2.

Ognew, J.—**Zur Frage von der Morphologischen Bedeutung des fibrillären Bindgewebes.** (On the morphological significance of the fibrillar connective tissue.) [Methods *post.*] *Arch. f. Anat. u. Physiol.*, 1885, pp. 437–50 (1 pl.).

**Queen & Co.'s (J. W.) Slide Case.**
[Four trays holding 6 slides—falling front—3/4 in. thick—cover with flanged sides and front.]
*Queen's Micr. Bull.*, II. (1885) p. 39 (1 fig.).

Ralph, T. S.—**Microchemical Observations on the Blood in Health and in Typhoid Fever.** [*Supra*, p. 1104.] 12 pp. and 1 pl., 8vo, Sydney, 1885.

Ryder, J. A.—**A Cheap Bell-glass for the Laboratory Table.**
["Taking a plain glass finger-bowl 4 or 5 in. wide and about 2 in. deep, a handle may be prepared by gluing a 1/4 in. cork to the bottom. Cut off the smaller end of the cork smoothly and cover it with marine glue. If the end of the cork is now heated over a spirit-lamp until the glue takes fire, and the cork is quickly pressed with its glue-covered end upon the centre of the bottom of the dish, you have a cork handle by which you can lift the dish."]
*Amer. Natural.*, XIX. (1885) p. 920.

Smith, H. L.—**New Cement and new Mounting Medium.** [*Supra*, pp. 1097–9.]
*Amer. Mon. Micr. Journ.*, VI. (1885) p. 182.

Sollas, W. J.—**On *Vetulina stalactites* (*O. S.*) and the Skeleton of the Anomocladina.**
[Contains a description of his method of examination.]
*Proc. R. Irish Acad.—Science*, IV. (1885) pp. 486–92 (2 pls.).

Strasburger, E.—**Zur Mikroskopischen Technik.** (Microscopical Technique.) [*Supra*, pp. 1097 and 1103.] *Bot. Centralbl.*, XXIV. (1885) pp. 156–7.

Stuhlmann, F.—**Ueber Nachbehandlung der Schnittserien mit Osmiumsäure.** (On treating series of sections with osmic acid.) [*Post.*]
*Zool. Anzeig.*, VIII. (1885) pp. 643–4.

Trachsel-Crozet.—**[Le Microtome à triple pince.]** (The microtome with triple pincers.)
[Reply to A. Eternod, *ante*, p. 925.]
*Journ. de Microgr.*, IX. (1885) pp. 317–8.

Van Brunt, C.—**Prof. H. L. Smith's new Mounting Medium.**
[Remarks on the composition and use of the medium. Cf. also *supra*, p. 1097. Also on fixing objects to the cover-glass. *Supra*, p. 1097.]
*Journ. N. York Micr. Soc.*, I. (1885) pp. 158–9.

Whitman, C. O.—**Methods of Research in Microscopical Anatomy and Embryology.** ix. and 255 pp., 37 figs., 8vo, Boston, 1885.

„ „ **The Cambridge Rocking Microtome.** [*Supra*, p. 1091.]
*Amer. Natural.*, XIX. (1885) pp. 1022–5 (1 fig.).

„ „ **A means of differentiating Embryonic Tissues.** [*Post.*]
*Ibid.*, pp. 1134–7.

„ „ **A new solvent of Chitin.** [*Post.*] *Ibid.*, pp. 1137–8.

## PROCEEDINGS OF THE SOCIETY.

Meeting of 14th October, 1885, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 10th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Bausch, E., Manipulation of the Microscope. 96 pp. and 27 figs. (8vo, Rochester, N.Y., 1885) .. .. .. .. | *The Author.* |
| Braithwaite, R., The British Moss Flora. Part IX., Tortulaceæ. pp. 213–44, 4 pls. (8vo, London, 1885) .. .. | *The Author.* |
| Bell, F. Jeffrey, Comparative Anatomy and Physiology. 555 pp. and 229 figs. (8vo, London, 1885) .. .. .. | *The Author.* |
| Klein, E., Microbes et Maladies. Guide pratique pour l'étude des Microorganismes traduit par Fabre-Domergue. iii. and 291 pp., 116 figs. (8vo, Paris, 1885) .. .. .. | *Mr. Crisp.* |
| Mantou, W. P., Beginnings with the Microscope. 73 pp. and 6 figs. (8vo, Boston and New York, 1884) .. .. | *The Author.* |
| Retzius, G., Das Gehörorgan der Wirbelthiere. II. Das Gehörorgan der Reptilien, der Vogel und der Saugethiere. viii. and 368 pp., 39 pls. (4to, Stockholm, 1884) | *The Author.* |
| Transactions of the Sei-I-Kwai, or Society for the Advancement of Medical Science in Japan. Nos. 41, 42, and 43 | *The Society.* |
| Six Slides of Material taken from the intestines of one of the victims of the Greeley Arctic Expedition .. .. .. | *Mr. C. E. Alling and Dr. F. A. Mandeville.* |
| Slide of *Navicula Durrandii* n. sp. .. .. .. .. .. .. | *Mr. F. Kitton.* |

Mr. Crisp called special attention among the donations to the second part of Prof. Retzius' magnificent work on the organ of hearing of the vertebrates; also to the Japanese publications, mostly printed in the Chinese character.

Mr. Crisp exhibited D'Arsonval's Water Microscope. He said he did not know that they were bound to notice every instrument which any one chose to devise; but the one before them had been designed by an eminent Frenchman, and had been recorded in their Proceedings by high authorities in France, and he thought, therefore, they were entitled to criticize it (*supra*, p. 1054).

Dr. Anthony, in commenting upon the instrument, said that the simplest method of giving a last touch to the adjustment of the focus was by gently pulling out the eye-piece, by which means a very delicate focusing was obtained.

Mr. J. Mayall, jun., said that the plan of focusing by the eye-piece by means of a specially-devised rack was applied by Prof. Amici some 50 years ago, and consequently long before Prof. Ranvier's suggestion, which was noted and figured in the Journal two or three years ago. He also remembered some time ago seeing a plan adopted by M. Prazmowski for obtaining a cover-glass correction,

which he said answered the purpose very well. The plan was to place behind the objective a piece of cover glass of the same thickness as the one upon the slide, and if the one corresponded precisely to the other the aberration would be corrected approximately as by the screw-collar.

Dr. Anthony thought this might be of some use where a person always used cover-glasses of a uniform thickness; he adopted this course himself, always using those of a thickness of ·005. But if they had a number of objects by various mounters, how were they to deal with the matter, not knowing what thickness was used? He should be glad to hear what the President thought of the idea.

The President said he thought the idea was excellent in principle, but open to great difficulty in practice, as the correcting glass must continually be altered according to the thickness of the cover. He was afraid that it could not be regarded as a practical method except for very special cases.

Dr. Matthews also considered that the plan would be unsuitable for general use as they were now-a-days called upon to deal with covers of unknown thickness.

Mr. J. Mayall said that the cover-glasses at one time were marked according to their thickness ·005, ·006, &c

---

**Mr. J. Mayall, jun.**, described Riddell's Binocular Microscope, which was exhibited by Mr. Crisp, and was of considerable interest as being a duplicate of Prof. Riddell's original Microscope, which now belonged to the Army Medical Museum at Washington (*supra*, p. 1059). He pointed out as a noteworthy feature that it was provided with a means of separating the prisms so as to give to each eye-piece a full field of view. There was also a screw with a right- and left-handed thread for separating the tubes to suit the width of the observer's eyes. An ingenious application of reflectors at the top of the eye-pieces effected a perfect inversion of the image, so that the instrument could be used for dissecting purposes. He had tried a few experiments with it, and had found its performance to be very fair. There were some inconveniences which might be improved upon with advantage, such as the rotation of the prisms above the eye-pieces, so that it was not easy to prevent them from getting shifted and causing a confusion of the images. There was also too little room for the nose between the tubes, and during a protracted observation the breath condensed upon them to a great extent. There was no fine adjustment, but he believed the Microscope was only intended to be used with low powers. It was, he thought, an instrument of great interest as having been made so early as 1853. He hoped that English makers would take up the point of providing some means of separating the prisms, which offered such advantages that he wondered a similar method had not been adopted hitherto. Prior to this instrument being made Prof. Riddell had devised another, also described in the Society's Journal—the form afterwards adopted by M. Nachet. It was, he thought, a point of special interest in the history of the development of the modern Binocular Microscope, that so early

as the invention of this Microscope Prof. Riddell had applied two mirrors for the purpose of equalizing the illumination in both fields.

Mr. J. Beck said that the form of Binocular Microscope made by Prof. Riddell was an extremely ingenious failure. He believed he was quite correct in saying so, because it never came into practical use at all; whilst the merit of bringing the binocular into practical use was undoubtedly due to Mr. Wenham. He saw the instrument at New Orleans in the year 1871, but with the exception of that, and the one on the table before them, there was never another made, because, though it was ingenious, it was not useful. Whenever a thing was made which was useful, it would be sure to come into use, as was shown in the case of Mr. Wenham's arrangement, for which the demand had been enormous. Though he thought the instrument was not of any great practical use, it was very useful to have these successive stages in the history of the Binocular Microscope brought before them.

---

**Mr. Crisp** exhibited a "twin" simple Microscope having two lenses of different powers (*ante*, p. 862), also two forms of magnifiers sent by Mr. Hippisley as examples of the capabilities of lenses made out of spherules of glass, and of a simple method of holding them.

---

**Mr. Badcock** called attention to the fact of the re-discovery of *Cordylophora lacustris* at the Victoria Docks, by Mr. C. Mitchell of the East London Natural History Society. Some years ago it was very abundant there, but since then it had entirely vanished until a few weeks ago. Some further interest attached to it on account of there being a quantity of *Freia elegans* parasitic upon it. The same gathering also contained some *Bacillaria paradoxa*.

The President regarded this as a highly interesting gathering, especially that of the *Bacillaria*.

---

**Dr. Maddox** read his paper, "Further Experiments on Feeding Insects with the curved or 'comma' Bacillus" (*supra*, p. 941).

The President thought the Society would be very pleased to have before it the further results of Dr. Maddox's researches in this direction, which was one in which there was not merely very much of interest, but also much of practical importance yet to be learned. The fact that no practical result had yet been arrived at was no doubt disappointing, but it was, after all, only an incitement to still patiently pursue the subject until it was overcome.

Mr. Cheshire said that perhaps some of the difficulty experienced by Dr. Maddox might be got over by using invert sugar instead of the ordinary kind. By using barley sugar, or boiled sugar, they would get it in a form which would not give up its moisture so soon.

Dr. Maddox said he should prefer to feed the insects entirely on fluid food, if it were possible to do so, but evaporation was the drawback there.

Mr. Cheshire had some experience in feeding bees, and would

suggest that the difficulty met with as to the feet might be got over by feeding the insects through a grating.

Mr. Michael thought it would be much more difficult to feed flies in this way than bees, on account of the very different structure and length of their tongues.

Mr. Groves suggested that it might be useful to place a cover-glass over the preparation, having a small hole in the middle.

---

**Mr. Crisp** exhibited one of Messrs. Beck's new pasteboard boxes to hold 300 slides (*ante*, p. 910). He had found them very convenient for storing long series of slides, such as diatoms, micro-fungi, minerals, &c.

Mr. Groves said that though not a very new suggestion it was a very useful one. He had had some half dozen of them in use for years.

Dr. Anthony feared the material of which the case was made was too slight for the purpose, so that if pressure was exerted the flexure would give space enough for the slides to override each other and knock the cover-glass off.

Mr. Groves said he had never found this to occur in practice; indeed, he often used two of the trays—without the box—to carry slides about in, and he put them under his arm without ever finding they got displaced.

---

**Mr. Crisp** said they had received six slides of material taken from the intestines of Lieut. Kisslingbury, U.S.N., one of the victims of the unfortunate Greeley Arctic Expedition. When the question of cannibalism was being discussed, his body was exhumed, and a good deal of the flesh was found to have been cut off the bones. In order to ascertain if possible what was the last food of which the deceased had partaken, and to establish whether the officers had joined in the cannibalism of the men, the contents of the stomach were submitted for examination. The letter of Mr. C. E. Alling accompanying the slides (which were sent by Dr. Mandeville and himself) was read to the meeting.

Mr. Groves said that although it might be possible to say from an examination of these slides whether the material consisted of the flesh of a mammal, a bird, or a fish, it would be quite impossible to say if it was human flesh or not, unless it happened that a large quantity of hair had been taken with it.

Mr. Crisp said that he had submitted the matter to Prof. Stewart, the Conservator of the Museum of the Royal College of Surgeons, who had given him the same opinion as Mr. Groves, adding only that a means of identification might be found in the small hairs of the general surface of the body. He (Mr. Crisp) had examined the slides, but could find no trace of hairs.

---

**Mr. D. P. Penhallow's** note was read as to a handle for cover-glasses, as follows:—

"In the August number of the Journal (p. 753) Mr. Cheshire mentions the use of a semicircular disc of wax, somewhat smaller

than the cover, for lifting the latter and adjusting it in mounting. Several difficulties appear in the use of the wax as recommended, and I now use what seems to me a more convenient form. An ordinary penholder, with a ferrule which is not split, is employed. The ferrule is cut off to such length as to leave a short tube 1/4 in. long on the handle. This tube is filled with wax in such manner as to leave a well-rounded end; this is easily done, by simple dipping. A permanent handle is now ready for use at all times. In use, the wax only requires to be applied very lightly to the centre of the cover, when the latter may be lifted and placed in position without the least difficulty. The advantages of this handle are: (1) Minimum contact of wax and glass: (2) the specimen can be seen and its proper position secured as the cover goes on; (3) very slight pressure with a needle seems to release the cover from the handle; (4) there is the least quantity of wax to clean off."

Mr. Cheshire said he was not in the least disposed to criticize the method suggested, though it appeared to him to have its disadvantages, for if they had a contact on one side only the pressure would be so unequally distributed as to be very likely to unsettle the object or to displace it, particularly when working at the end of a penholder.

---

**Mr. C. Beck** exhibited a compact form of Mr. Stephenson's Catadioptric illuminator.

The President said that those who saw Mr. Stephenson's original apparatus would notice how very much more compact the one now before them was. He had tried the former, and found it to work exceedingly well.

---

**Mr. Kitton's and Mr. Kain's** notes on Balsam of Tolu were read. Mr. Kitton wrote:—

"Since the publication of my note on Balsam of Tolu, I obtained another sample of the gum. This was very different from the first, which was darker in colour, not brittle, and dissolved freely in benzole without residue. The second sample was brittle, and capable of being pounded in a mortar. It was also soluble in hot benzole, which, on cooling, deposited a very dark viscid mass, leaving a pale golden brown liquid above. This is said to contain all the cinnamic acid, the denser gum being Tolu, and which is only soluble in absolute alcohol or chloroform. I tried it in the latter, but its very dark colour made it very objectionable, excepting in the very thinnest film.

"The lighter fluid was apparently about the same refractive index, and I mounted several diatoms in it, which, in the course of a week or two, showed a plentiful crop of crystals. It afterwards occurred to me that heat would volatilize the cinnamic acid. I therefore prepared a slide on which I placed a drop of the medium and boiled it, and when cool covered it. By the side of this I placed a second drop, warming it to drive off the benzole; this I also covered. After the lapse of a fortnight, I found this contained plenty of crystals, whilst the adjoining drop was entirely free from them.

"I afterwards ascertained that the second sample had been boiled in water in order to extract some of its medicinal properties."

Mr. Kain's note (in reply to a letter from Mr. Crisp) was as follows :—

"As you remark in your letter, there is considerable confusion in regard to the matter of Tolu. I am unable to account for the differences, unless upon the supposition that different samples of the gum behave differently. By reference to the 'U. S. Dispensatory' (15th edition, 1883, Wood and Bache), I notice that there is a factitious Balsam of Tolu containing about 60 per cent. of styrax. Now styrax is soluble in benzole, and it is just possible that some experimenters may have got hold of this factitious balsam. The following extract from the same work may be of interest to you :—

"'It (Tolu) is entirely soluble in alcohol, and the solution shows an acid reaction with test paper. It is almost insoluble in water and benzine. Warm disulphide of carbon removes from the balsam scarcely anything but cinnamic and benzoic acids. On evaporating the disulphide, no substance having the properties of resin should be left behind. Boiling water extracts its acid.'

"From the above, it would appear that the easiest way to get rid of the acids, whose crystals are so objectionable, is to use disulphide of carbon, water being objectionable on account of the difficulty in getting rid of it by evaporation. I ought, perhaps, to add that my use of benzole for that purpose was the result of an accident, I having attempted to make a solution of the gum in benzole. After digesting several days, none of the gum was dissolved, but the benzole yielded beautiful crystals of cinnamic and benzoic acids upon evaporation."

---

**Mr. Kitton's** note on a new diatom, *Navicula Durrandii*, was read (*ante*, p. 1042).

---

**Mr. J. C. Stodder's** note was read as follows :—

"Inasmuch as I have noticed in your Journal occasional expressions of the opinions of different microscopists as regards the formation of a small battery of objectives which should cover reasonably well all the requirements of the general Microscopist, and inasmuch as I have never seen any published statement of the views held upon this subject by the late Mr. R. B. Tolles, I venture to send you a copy of a memorandum which I have just found among my loose microscopical papers.

'Boston, May 26th, 1882.

Meeting Mr. R. B. Tolles to-day at the office of Mr. Charles Stodder, I asked him what he thought was the best series of, say, four or five objectives to cover as well as possible the whole range of 'general microscopy.' He answered, after some reflection :—

'For four only—3 in., 1 in. 30°, 4/10 in. 110° dry, 1/10 in.—oil-glycerin-water immersion, which will work through 1/100 in. covers, and should have a balsam angle of not much less than 120° for best results.' He added : 'An excellent and useful lens to add to the above series would be a 1/5 in. 110° or 120° dry'" (*ante*, p. 863).

---

**Mr. C. D. Ahrens'** paper on "An improved Form of Stephenson's Erecting and Binocular Prisms" was read, in which he proposed to

unite the lower prisms by a wedge of glass. He also proposed an alteration in the upper prisms (when they are used in place of a plate of glass (*supra*, p. 959).

Mr. Michael said he thought Mr. Ahrens' plan provided the one thing wanting to perfect the Stephenson form of binocular, as the prisms, as at present arranged with cork to separate them, not unfrequently got displaced.

---

**Mr. T. B. Rosseter's** paper on "The Uses and Construction of the Gizzard of the Larva of *Corethra plumicornis*" was read by Professor Bell, and prepared specimens in illustration were exhibited under Microscopes (*supra*, p. 991).

---

**Mr. Dowdeswell's** paper on "The Cholera Comma Bacillus" was read (*supra*, p. 953).

---

**Mr. Crisp** stated that a communication had been received from the American Society of Microscopists on the subject of the Society Screw-gauge, which had been referred to a committee, and its consideration had better, therefore, be adjourned until the committee had reported.

---

**The President** called the attention of the meeting to the death of Prof. Robin, the eminent histologist, and one of the Honorary Fellows of the Society. He might be termed the creator in France of histology, for which a special chair was instituted. He had been Professor at the Faculty of Medicine in 1832. In 1871 he worked with Littré in founding the Society of Sociology "for the application of the positive and scientific methods to the study of social doctrines." By his death (in his 65th year) the French Senate had lost all but the last of its scientific men. He was the author of the two well-known text-books, 'Du Microscope et des Injections,' published in 1849, and the 'Traité du Microscope,' the first edition of which was published in 1871, and the second in 1877, and contributed largely to the current scientific publications. In conjunction with Littré, he recast the 'Dictionnaire de Nysten,' and developed it into the now popular 'Dictionnaire de Médecine,' published by Baillière et Fils.

**The following Instruments, Objects, &c., were exhibited :—**

Mr. C. E. Alling and Dr. Mandeville :—Slides illustrating Mr. Alling's note.

Mr. Badcock :—*Cordylophora lacustris.*

Mr. C. Beck :—New form of Stephenson's Catadioptric Illuminator.

Mr. Bolton :—*Anuræa stipitata.*

Mr. Cheshire :—Salivary glands and sac of Cockroach.

Mr. Crisp :—(1) D'Arsonval's Water Microscope; (2) Riddell's Binocular Microscope; (3) "Twin" Single Microscope; (4) Beck's slide boxes.

Mr. Dowdeswell :—Slides illustrating his paper.

Mr. Kitton :—New Diatom, *Navicula Durrandii*, n. sp.

Mr. Rosseter :—Slides illustrating his paper.

---

**New Fellow :—**Mr. Edward Y. Weston was elected an *Ordinary* Fellow.

MEETING OF 11TH NOVEMBER, 1885, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

**The Minutes** of the meeting of 14th October last were read and confirmed, and were signed by the President.

---

**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Candolle, A. de, Lois de la Nomenclature Botanique. 2me ed., 64 pp. 8vo, Genève, 1867 .. .. .. .. .. .. .. .. | *Mr. Crisp.* |
| Dodel-Port, A., Biologische Fragmente. Beiträge zur Entwicklungsgeschichte der Pflanzen. 104 pp., 24 figs., and 10 pls. 4to, Cassel and Berlin, 1885 .. .. .. .. .. .. .. .. | *The Author.* |
| Fischer, H., Kritische Mikroskopisch-Mineralogische Studien. Part 1, 69 pp., Part 2, 64 pp., Part 3, 96 pp. and 2 pls. 8vo, Freiburg, 1869-73 .. .. .. .. .. .. .. .. .. | *Mr. Crisp.* |
| Nägeli, C., and Schwendener, S., Das Mikroskop: Theorie und Anwendung desselben. 2te Aufl., xii. and 679 pp. and 302 figs. 8vo, Leipzig, 1877 .. .. .. .. .. .. .. .. | „ |
| Power, H., Experimental Philosophy. xx. and 193 pp. and 2 figs. and 1 plate. 4to, London, 1664 .. .. .. .. .. | „ |
| Reinicke, F., Beiträge zur Neuern Mikroskopie. Heft 1, 57 pp. and 1 pl., Heft 2, vi. and 85 pp. and 6 figs., Heft 3, iv. and 74 pp. and 2 figs. 8vo, Dresden, 1858–62 .. .. .. .. | „ |
| Schacht, H., Die Prüfung der im Handel vorkommenden Gewebe durch das Mikroskop und durch Chemische Reagentien. viii. and 64 pp. and 8 pls. 8vo, Berlin, 1853 .. | „ |
| Willkomm, M., Die Wunder des Mikroskops, oder die Welt im Kleinsten Raume. 4te Aufl., x. and 400 pp., 285 figs. and 1 pl. 8vo, Leipzig, 1878 .. .. .. .. .. .. .. | „ |

---

**The President** said that before proceeding to the ordinary business of the meeting, it fell to him to take notice of what was to all present a personal sorrow, and to their Society a sorrow in a pre-eminent degree—he referred to the lamented death of Dr. W. B. Carpenter. For his own part he could only speak of him with the utmost reverence; he had been in correspondence with him for some years upon subjects in which they were mutually interested, and in course of which he had found him ever ready with advice, and not less so with his constant urbanity, ready to place all that he possessed mentally and physically—the stores from his brain or from his cabinet—at the disposal of those who needed such help to enable them to accomplish work which they had taken in hand. The Fellows of the Society knew—so far as had been made public—the circumstances of the unhappy incident which had deprived them of a man who had occupied so high a position in biological science, and they could not but lament that he had thus been taken from them, as they might almost say, before his time. Those who had followed his labours and had been acquainted with his work from its earliest time, would remember that he was one of the first of those who gave a true foundation to the science of physiology; they would know how his works had become a power in themselves in the days immediately

touching those in which they lived; they knew how his energies had been directed towards the promotion of the interests of medical science, and how his efforts had been successful in giving to the interests of science generally a meaning and an influence which they had not previously possessed. To them it was his work as it related to the Microscope that claimed their special notice, and they were well aware that he had made this instrument specially his own and they knew how he had at his fingers' ends all that was known in connection with it—at least up to a certain time—and not only so, but he was also well acquainted with all that workers in this field of science were doing around him, and to whom his ready sympathy was at all times extended. His deep and untiring interest in all the work which the Microscope could do had no small share in enabling it pre-eminently to preserve its position as an instrument of research in the study of pathology and histology. They knew also how, in addition to subjects such as these, he had taken up such subjects as that of the Foraminifera, and that he had worked them out, not merely as regarded tabulating or classification, but as to thoroughly investigating the structure and development of the organisms themselves. Throughout the greater part of his life he had been carefully familiarizing himself with the structure and the advances made in the instrument itself, and although he might not have been associated so closely with it of late as was formerly the case, yet he had looked on with the greatest interest at the wonderful advances it had made, perhaps with considerable conservatism, but yet with a mind wide enough to follow and to recognize the real progress which was taking place. As a Society they could not but feel that they had in his departure sustained a heavy loss; he had been one of their most honoured Presidents, and in many ways he had brought honour to their Society, whilst his versatility and his genial temper in debate would be features clear in the recollection of all who had known him.

Personally, he for one felt that he had lost an honoured friend and valued scientific helper; he had lost a thread in his scientific life, and should ever regard the memory of their departed friend with an affection which would endure as long as memory remained. It was therefore with the deepest feelings of personal regret at the circumstances of the occasion that on behalf of the Council he begged to move the following resolution:—

"That this meeting has heard with the deepest concern of the death of Dr. W. B. Carpenter, C.B., F.R.S., a past President of the Society, one of the most eminent of microscopists, and desire to record their sense of the great loss which science in general and microscopy in particular have sustained by his decease, as well as their deep sympathy with his family under their bereavement."

Dr. Millar seconded the motion and it was carried unanimously.

Mr. J. Beck said he should like, knowing the prominent position which Dr. Carpenter had occupied amongst them, to propose that the Society should be represented at the funeral by one of the Fellows.

It was agreed that Prof. Stewart should attend on behalf of the Society.

Mr. Crisp reminded the meeting that it was arranged some time ago that they should give, in the Journal, photographic portraits of all the Presidents of the Society; a full-page plate of Sir R. Owen, as the first President of the Microscopical Society, and another of Mr. Glaisher, as the first President of the Royal Microscopical Society after its charter had been granted, the other Presidents being given in two groups of eight. Proofs of the portraits were upon the table for the inspection of the Fellows. In view of criticism as to the general effect of the groups, he might mention that the trouble which had been required to get them into order was beyond anything that could have been supposed, arising from the very various character of the originals and otherwise, and their thanks were largely due to Mr. J. Mayall, jun., for the pains he had taken in the matter. As to the style of the particular portraits, he might say that nearly all the photographs had been selected either by the persons themselves or by their families, as being those which they considered the best.

---

The President said that the death of Prof. Robin, announced at the previous meeting, created a vacancy in their list of Honorary Fellows which it was proposed to fill up by the election of Prof. H. de Lacaze-Duthiers, whose nomination would be suspended in the usual way, and brought forward for ballot at their next meeting.

---

Mr. C. Beck exhibited a modification of the "Star" Microscope, which could be folded up into a small compass as a portable Microscope.

---

Mr. Crisp exhibited a Microscope in which the adjustment was made by winding a piece of catgut on an axle.

---

Mr. John Mayall, jun., exhibited and described the Trouvé-Helot electric lamp for microscopic use, worked by a portable battery of six cells, each containing two zincs and three carbons. When not in use the elements were lifted out of the bichromate solution and retained in position at the top of the vulcanite case, whilst by a simple arrangement they could be lowered into the exciting liquid when needed, and any number of the cells could be connected up as required. The photophore consisted of a small incandescence lamp, fitted in a cylinder, with a condensing-lens in front. The best way to use it was to commence with three cells, and then, as the light got weak (which would occur in about an hour), to increase the number in circuit until the whole six were in use, each additional cell enabling the light to be kept up for about twenty minutes, or about two hours in all, with fairly continuous amount of light. He thought that M. Trouvé had, to some extent, sacrificed efficiency to portability. The ebonite case for the cells appeared far too slight for the purpose, considering that it contained sulphuric acid. He had the promise of one of the Jablochkoff dry batteries for exhibition at the Soirée,

and he was told that this would maintain a light efficiently for ten or twelve hours consecutively. He had seen the working of the Trouvé lamp at Antwerp, when it was successfully used by Dr. Van Heurck, who made a number of difficult observations with it. He used it with some care, only employing a very little battery-power to begin with; but the light was so perfectly under command, especially for purposes of oblique illumination, that he certainly saw some of the most brilliant effects produced by it. He thought a more powerful battery than Trouvé's was needed. Dr. Van Heurck had a dynamo in his house, and could therefore employ incandescent lamps of any desirable power, and with such advantages he had certainly shown him (Mr. Mayall) the strongest and finest resolution that he had ever seen by artificial light.

Mr. Michael said that the practical difficulty in the use of electric lamps of this kind was not only as to the quantity of light obtainable, but also as to its quality; because it was only when burnt at its full strength that they got a white light: at other times it was either red or yellow. If any means could be devised by which they could get even a very small point of constant bright light it would be very much better; under present circumstances, if they reduced the quantity of the current, they at once reduced the quality of the light.

The President said he quite agreed with Mr. Michael in his remarks as to the desirability of getting a constant quality of light as well as a sufficient quantity. He could see that the advantage of a lamp like this was the exceeding ease with which it could be applied to any point they wished, and he had long felt that if anything of this kind could be well and easily applied, it would be a very efficient aid to research.

Dr. Matthews believed that in point of economy it would be very much better to obtain more or less light by immersing the whole of the plates more or less in the liquid than to immerse the whole of them and then only to use one or two at a time, because the others would meanwhile only be wasting by chemical action.

---

**Mr. J. W. Groves** exhibited a very large microtome, made under the directions of Mr. J. W. Barrett, M.B., for the purpose of cutting sections of large substances. One particular advantage was that both the razor and the object were immersed in spirit, so that the sections when cut floated off without any danger of adhering to the blade (*supra*, p. 1089).

Mr. J. Beck said he had not yet had an opportunity of examining this apparatus, but it occurred to his mind very vividly that he saw one very much like it in 1865, which was used for cutting sections 8 in. across. He believed he saw it at Utica, where it was being used to cut sections of an entire human brain.

---

**Mr. Badcock** described an unrecognized specimen of *Actinophrys*, which he submitted to the meeting for identification. The central bodies were described as being very bright when seen under the

Microscope; they were of a sarcodic character and apparently of an amœboid nature, and were furnished with long and very fine setæ.

The President remarked that the organism had a very *Actinophrys*-like appearance; but he had seen so many variations in form, that he thought this might very likely prove to be only a variation, though if there were many specimens found under similar conditions, it might be regarded as a new species. It would hardly be safe to conclude much from a single specimen.

---

**Mr. W. B. Turner's** paper, "On some new and rare Desmids," was read (*supra*, p. 933).

---

**Dr. E. Giltay's** paper "On the Amplifying Power of a Lens or Objective" was read, in which he criticized a note on the same subject by Prof. Abbe (*supra*, p. 960).

---

**Mr. Crisp** gave a *résumé* of his paper "On the Limits of Resolution in the Microscope," in which he pointed out that when monochromatic light and photography were used in place of white light (line E), the limit of resolution rose from 146,543 lines to the inch to 158,845 and 193,037 respectively (*supra*, p. 968).

Dr. Maddox asked if it was likely that photography would depict details which the eye could not see. Theoretically it had been shown by what Mr. Crisp had stated that this might be possible, and in practice he had always thought he could detect in a good negative details which he was unable to make out by direct vision.

The President said that there appeared to be reason for supposing that such would be the case. Prof. Koch, some six years ago, mentioned the case of a bacterium, in which he could not see the flagella with the Microscope, but had photographed them.

Mr. J. Mayall, jun., said that some years ago he had been in correspondence with Dr. Woodward on that very point, and he had stated that in his experience nothing whatever could be seen by the aid of photography which the eye could not see with the Microscope, using monochromatic light.

The President said that Prof. Koch published his results at the time and sent them to him; and he remembered that he stated that, though the flagella were suspected, he was unable to detect them with the eye, but that he had done it with the camera.

Mr. Mayall said that the point to which he referred related simply to Nobert's lines. He had himself taken the same view of the matter as that now mentioned, but Dr. Woodward took the opposite side. He thought he could count the lines more readily in the photographs, but Dr. Woodward said it was not so in his experience. The correspondence was commenced in consequence of a criticism published by Dr. Woodward in a paper in the Monthly Microscopical Journal in 1870.

---

**Dr. Lavis's** paper "On the Preparation of Sections of Pumice and other Vesicular Rocks" was read.

Prof. Stewart said that sections were made in this way by Prof. Moseley, in which the hard and soft tissues were shown together. Copal was the medium employed in mounting.

---

Mr. Crisp called attention to the fact that amongst the Cantor Lectures to be delivered at the Society of Arts this session, there was a course on "The Microscope," by Mr. J. Mayall, jun., commencing on Monday, the 23rd November, and continued on the four following Mondays. For the purpose of illustrating these lectures, Mr. Mayall would exhibit several of the instruments belonging to the Society, and also many from his (Mr. Crisp's) collection. The first lecture would be on "The Origin of the Microscope, and its construction to the date of the application of achromatism," a limited number of tickets for which would be placed at the disposal of the Fellows of the Society.

---

It was announced that the Council had resolved to close the Library on Wednesday evenings at 9.30 instead of at 10 o'clock as formerly. The Fellows who attended on Wednesday evenings had always left by 9.30, and it was unnecessary to keep the Library open later.

---

The following Instruments, Objects, &c., were exhibited:—

Mr. Badcock:—Drawing of an unrecognized organism.

Mr. C. Beck:—Portable "Star" Microscope.

Mr. Bolton:—*Lucernaria Auricula.*

Mr. Crisp:—Microscope with Catgut Focusing Adjustment.

Mr. Dowdeswell:—Drawings of the Cholera Microbe from an undried stained preparation mounted in acetate of potash; ×2400, in an early stage of development showing the first turn of the spiral; ×1950, the mature *Spirillum*-form showing the straight and coiled flagella at either end. (Cf. *supra*, p. 954.)

Mr. Groves:—Barrett's large Microtome.

Mr. J. Mayall, jun.:—Helot-Trouvé Electric Photophore.

Mr. E. M. Nelson:—*Triceratium septangulatum* showing small markings in the areolation, with a 2/3 in. objective of 0·29 N.A.

---

New Fellows:—The following were elected *Ordinary* Fellows:—

Lord Edward S. Churchill, Messrs. R. Aberdein, M.D., J. Budgell, J. Clark, E. Crookshank, M.B., W. Godden, R. G. Hebb, M.D., J. Johnson, J. A. Kay, M.D., W. P. Manton, M.D., G. Meek, A. D. Y. Shelley, Lieut. R.E., T. S. Taylor, J. A. Thomson, W. C. Walker, and G. E. Western.

# INDEX.

*** The Index includes the names of the Authors of all Papers, &c., printed in the Transactions, or noted in the Summary or Bibliography, as well as those of the Designers of any Instruments or Apparatus described under the head of Microscopy. Where the author's name stands alone, the reference is to the Bibliography only.


A.

Abbe, E., 530, 726.
—— Condenser, 123, 530, 1065.
—— ——, Modification of, 124, 125.
—— ——, Zentmayer's, 710.
——, Note on Limits of Resolution, 970.
——, Testing the Different Sectors of Objectives, 324.
Abbe's 'Note on the proper Definition of the Amplifying Power of a Lens or Lens-system,' Remarks on, 960.
Absorbing Organs of Albuminous Seeds, 829.
Absorption by the Plant of Non-nutrient Substances, 1032.
Acanthodrilus sp., Nephridia of, 813.
Acari inhabiting the Quill of Feathers, 236.
Acarina, Descriptions of New, 449.
Accessories, Instruments, &c. See Contents, xxxiii.
Acids, Periodical Formation of, in Succulent Plants, 97.
Acineta grandis, Peculiar Variety of, 167.
Actiniæ, Chromatology of, 464, 656.
Actinic and Visual Foci, 331.
Actinomyces, Cultivation of, 534.
—— in Swine's-flesh, 290.
Adamkiewicz, A., 745.
——, New Method of Staining the Spinal Cord, 742.
——, Parietal Cells in Nerve-fibres, 428.
Adamsia palliata, 816
Adlerz, E., Anatomy of the Fruit of Ranunculaceæ, 831.
Adolph, E., Wings of Hymenoptera, 234.
Adrianowsky, A., Influence of Light on the Germination of Seeds, 93.
Adriatic, Copepoda of, 454.
Adults, Relation of Marine Larvæ to, 788.
Ady, J. E., 161, 363, 562, 745, 924.
Æpophilus Bonnairei, Marine Hemipterous Insect, 448.
Æschna, Optic Ganglion of, 800.
Æthalium septicum, Thermotropism of the Roots of, 844.
Agalma, Development of, 1009.
Agaricini, Fries' Nomenclature of Colours in, 105.
Agen, F. D., 888.
Ahrens, C. D., On an Improved Form of Stephenson's Erecting and Binocular Prisms, 959.
—— and Foucault's Polarizing Prisms, Madan's Modification of, 328.
Air, Curved Bacilli in, 697.
——, Determination of the Number of Germs in, 561.
——, Freeing Objects from, 898.
—— in Water-conducting Wood, 679.
——, Ozonized, Action of, upon Micro-organisms and Albumen in Solution, 1053.
——, Purity of, in Alpine Regions, 511.
——, Supply of, to the Roots and Root-pressure, 490.
"Akakia," 139.
Alaska, Arctic, New Arenicola from, 456.
——, ——, New Crustacea from, 453.
Albumen, Formation of, in Green Plants, 274.
—— in Solution, Action of Ozonized Air upon Micro-organisms and, 1053.
Albuminoid Constituents of Plants, 97.
Albuminoids, Idioblasts containing, in some Cruciferæ, 672.
Alcohol, Müller's Methylized, for Fungi and other Plants, 164.
Alcoholic Ferments, Preservation of, in Nature, 114.
Algæ. See Contents, xxviii.
Algiers, Bay of, Lower Animals of, 65.
Algo-Lichen Hypothesis, 103, 688.
Alimentary Canal of Blatta peripla-neta, Physiology of, 991.
—— —— of Crustacea, 994.

Alimentary Canal of Insects, 442.
Almond, Sweet, and Flax, Germination of, 271.
Almqvist, E., 161.
Alpine Regions, Purity of Air in, 511.
Amann, J., Balsam of Tolu as a Medium for Mounting, 353.
Amarœcium proliferum, Development of, 437.
—— ——, Preparing Embryos of, 731.
Ambronn, H., Heliotropic and Geotropic Torsion, 95.
Ambulacra of Echinoderms, 815.
America, North, Fresh-water Turbellaria of, 648.
American Association for the Advancement of Science, 888.
—— Fresh-water Sponges, New, 464.
—— Society of Microscopists, 139, 335, 363, 726, 888, 1078.
—— ——, "Working Session" of, 356.
—— (South) Isoetes, 279.
—— Sponges, Wide Distribution of some, 76.
Amici's Microscopes, 531.
Ammonia, Action of, upon Lepidopterous Pigments, 52.
Ammoniacal Ferment, 680.
Amœba infesting Sheep, 1018.
——, Pseudocyclosis in, 1019.
Amœbæ, Critical Notes on, 1018.
——, Studies in, 260.
Amœboid Movements of Spermatozoa of Polyphemus pediculus, 239.
Amœboideæ, 506.
Amphibia, Development of the Cœlom and Cœlomic Epithelium of, 423.
Amphipleura, Beads of, 380.
—— pellucida and the Diffraction Theory, 529.
—— —— resolved into "Beads," 169, 173.
Amphipoda, Polymorphism in, 997.
——, Urinary Organs of, 640.
Amphipodous Crustacean, New, 238.
Amplifying Power of a Lens or Lens-system, Remarks on Prof. Abbe's Note on the Proper Definition of, 960.
Amylase, Presence of, in Leaves, 97.
Amyot, T. E., Direct Vision Microscopes, 1056.
Analysing Prism and Goniometer, Boecker's Holder for, 705.
Anatomy of the Phanerogamia. See Contents, xxi.
Anchinia, Genetic Cycle and Germination of, 630.
Anderson, J., jun., 562.
André, Formation of Nitrates in Plants, 275.
Andrews, E. A., Anatomy of the Spider Crab, 60.
—— and H. F. Nachtrieb's Water-bath, 1086.
Androœcium, Movements of, in Sunflowers, 268.
Angiosperms, Fecundation of Ovules in, 270.
Angiostomum, 1001.
Anilin-green, 903.
Anisotropy of Organic Substances, Causes of, 487.
Annelids, Lymphoid Cells of, 454.
——, Pelagic, 998.
——, Polychætous, Nervous System of, 644.
——, Preparing Eyes of, 1110.
Anodonta, Organs of Bojanus in, 795.
——, Relations of Cavernous Spaces in Connective Tissue of, to the Blood-vascular System, 794.
Anomocladina, Structure of the Skeleton in, 464.
Anoplophrya circulans, 818, 819.
Ant, Tasmanian White, Infusorial Parasites of, 662.
Ant-harbouring Organs of Plants, 484.
Antennæ of Myriopoda, Demonstrating Nerve-end Organs in, 896.
—— ——, Nerve-terminations on, 448.
Anther of Flowering Plants, Bursting of, 1032
Anthers, Dehiscence of, 91.
——, Opening of, in Ericaceæ, 675.
——, Structure and Dehiscence of, 832.
Anthony, J., Structure of the Tongue of the Blow-fly, 174.
——, W. A., 335.
Ants, Sensorial Organs of the Antennæ of, 441.
Aperture and Power of Microscopic Objectives, Measurement of, 1082.
——, Large, Cost of Objectives of, 325.
——, Numerical, Table, 972.
—— Puzzles, 721, 882.
——, Supposed Increase of, of an Objective, by using highly refractive Media, 1077.
Aphides, Development of, 53.
——, Treatment of the Ova and Embryos of, 147.
Aphrophoridæ, Australian, Larvæ and Larva-cases in some, 992.
Apical Growth of Phanerogams, 487.
Apios tuberosa, Nectar-glands of, 269.
Apospory in Ferns, 99, 491.
Apothecia of Lichens, Development of, 499.
Apple-trees, "Cancer" of, 106.
Apus, Nervous System of, 805.

Aquatic Plants, Epidermis of Leaves of, 674.
—— ——, Structure of Stem of, 480.
Aquiferous Pores in Lamellibranchs, 227.
Arachnida. See Contents, xiv.
Arbaciadæ, 652.
Arcangeli, G., New Methods of Preparing Carmine Staining Fluids, 1094.
Archegonium and Sporogonium of Muscineæ, 279.
Archenchytræus Möbii, 643.
Archerina Boltoni, 259.
Archiannelides, Nervous System of, 62.
Arctic Expedition, Greely, 1115.
—— Ocean, Algal-flora of, 1039.
Ardissone, F., Florideæ of the Mediterranean, 102.
Arenicola, New, from Arctic Alaska, 456.
Argiope Kowalevskii, 49.
Aril, Structure and Function of, in certain Leguminosæ, 829.
Arloing, S., Influence of Light on the Vegetation and on the Pathogenous Properties of Bacillus anthracis, 297.
——, —— of the Sun on the Growth and Activity of Bacillus anthracis, 1050.
Arnaud, W., Identity of the Orange-red Colouring Matter of Leaves with Carotine, 670.
Arnold, C., 161.
Arsenic, Tribromide of, 909.
Arthropoda. See Contents, xiii.
Arthur, J. C., Pear-Blight, 1053.
Arum italicum, Blooming of, 835.
Ascidians, Eggs of, 987.
——, Simple, New Species of, 45, 631.
——, Social Development of, 627.
Asclepias Cornuti, Fertilization of, 834.
Ascomyces, Development of, 689.
Ascomycetes, Monascus, A New Genus of, 291.
Asellus, Brain of, 238.
Ash of Equisctaceæ, Composition of, and its Bearings on the Formation of Coal, 681.
Aspergillus niger, Remarkable Development of, 289.
Assimilating Cavities in the interior of Tubers of Bolbophyllum, 671.
Assmann, R., Microscopical Observations on the Constituents of Clouds, 919.
Astacus, Development of, 805.
—— fluviatilis, Extraction of Uric Acid Crystals from Green Gland of, 805.
Asterida, Histology of, 652.
Asteroidea of Mauritius, 1009.
Asteromphalus flabellatus, 380.
Astrangiaceæ, Structures liable to Variation in, 73.
Athyrium Filix-fœmina, Singular Mode of Development in, 491.
Atlas of Practical Elementary Biology, 787.
Attenuation of the Choleraic Virus, 1051.
Atwater, W. O., Absorption of Atmospheric Nitrogen by Plants, 680.
Atwood's (H. J.) Apparatus for Photomicrography, 330.
Atyephira compressa, Development of, 996.
Aubert, A. B., Styrax and Balsam, 744.
Aulophorus vagus, Anatomy and Histology of, 1001.
Aulosira, 692.
Aurantiaceæ, Fungi Parasitic on, 106.
Australia, South, New Sponges from, 465, 1013.
Australian Aphrophoridæ, Larvæ and Larva-cases of some, 992.
—— Bryozoa, 633.
—— Crustacea, 998.
—— Hircinidæ, Fibres of certain, 254.
—— Hydroid Zoophytes, 656.
—— Hydromedusæ, 252, 1011.
—— Pycnogonida, 994.
—— Serpulea, Anatomy of, with Characteristics, 241.
—— Sponges, 76, 1014.
Austria, Latzel's Myriopods of, 638.
Autumnal Tints of Foliage, 97.
Avicularian Mandible, On the use of, in the Determination of the Chilostomatous Bryozoa, 774.
Axes, Primary, Anatomy of Peduncles compared with that of, and of Petioles, 833.
Axolotl Ovum, Karyokinesis in Segmentation of, 976.
Ayers, H., Structure and Functions of the Sphæridia of the Echinoidea, 1009.

## B.

B.Sc., 139, 161, 335, 363, 530.
Baccarini, P., Mechanical Function of Crystals of Calcium Oxalate, 265.
——, Morphology of the Receptacle, 831.
Bachmann, E., Structure and Function of the Aril in certain Leguminosæ, 829.
Bacilli, Curved, in Air and Water, 697.
—— of Hydrophobia, 573.
—— of Malaria, 1052.
——, Tubercular, Diagnostic Value of, 298.

Bacillus alvei, Pathogenic History and History under Cultivation of, 581.
—— Amylobacter, Development of, in Plants in a Normal Condition of Life, 297.
—— anthracis, Artificial Attenuation of, 696.
—— ——, History of Development and Morphology of, 297.
—— ——, Influence of Light on the Vegetation and on the Pathogenous Properties of, 297.
—— ——, —— Sun on the Growth and Activity of, 1050.
——, Cholera, 113, 383, 509, 697, 850, 953, 1050.
——, Comma, 383, 566, 953.
—— ——, Experiments on Feeding Insects with, 602, 941.
——, ——, Inoculation of Guinea-pigs with, 509.
——, ——, Morphology of, 1051.
——, ——, Odour and Poisonous Effects of the Fermentation produced by, 298.
——, ——, of Cholera, First Discovery of, 383.
——, Koch's, Staining of, 557.
—— lepræ, Discrimination of, 362.
——, New Chromogenous (B. luteus suis), 1052.
—— of Cattle Plague, 114.
—— of Syphilis, Preparing, 539.
—— of the Vine, 1053.
—— subtilis, Chemistry of, 508.
—— ——, Double Staining, 363.
——, The Niesen, 769.
—— tuberculosis, Discrimination of, 362.
—— ——, Modified Method of Staining, 924.
—— ——, Staining the Spores of, 342.
Bacteria, 695.
——, Aerial, Hourly Variations in, 111.
——, ——, Resistance of, to Cold, 511.
——, Balsam for Mounting, 166.
——, Cornil and Babes', 853.
——, Culture Media for, 363, 564.
——, De Bary's, 108.
——, Development of, 110.
——, Examining, 362.
—— Investigation, Dolley's Technology of, 917.
——, Pathogenic Pleomorphy of, 1049.
——, Relations of, to Asiatic Cholera, 299.
——, Staining, for Photo-micrographic Purposes, 166.
——, —— with Dahlia, 558.
——, Systematic Position of, 850.
Bacteriaceæ, Systematic Position of, 1048.
Bacterial Pathology, 745.
Bacterioidomonas undulans, 300.
Bacterium, Development and Pathogenous Properties of a, 852.
—— fœtidum (Thin), Identity of, with Soil Cocci, 696.
—— lactis, On Some Unusual Forms of, 205.
—— ureæ, 696.
Baikal, Lake, Crustacea of, 807.
Bainier, G., Zygospores of Mucorini, 505.
Balanoglossus, Anatomy of, 69.
—— Kowalevskii, Development of, 461.
——, Later Stages in the Development of, 650.
Balanus, Embryology of, 643.
Balbiani, E. G., Anoplophrya circulans, 818.
Baldini, A., Spur of Cucurbitaceæ, 831.
Baldwin, L. A., 161.
Bale, W. M., Australian Hydroid Zoophytes, 656.
Balkwill's (F. P.) Foraminifera Slides, 1084.
Balsam and Glycerin Mounts, 353.
—— and Styrax, 744.
—— for Mounting Bacteria, 166.
——, Mounting in Cells with, 909.
—— of Tolu, 160, 1116, 1117.
Banks, C. W., Electric Spark under the Microscope, 888, 1078.
Barfurth, D. Comparative Histochemical Observations on Glycogen, 981.
Barnes, C. R., Fertilization in Campanula americana, 1028.
——, Stomata of Marchantia, 1036.
——, Studying Pollen-grains, 1085.
Barrett, J. W., 161.
——, New Microtome, 1089.
Barringtonia, Embryo of, 271.
Barrois, J., Development of Chelifer, 449.
——, Genetic Cycle and Germination of Anchinia, 630.
——, T., Byssogenous Glands and Aquiferous Pores in Lamellibranchs, 227.
Barthélemy, A., Head and Mouth of the Larva of Insects, 441.
Bary's (A. de), Fungi, Mycetozoa, and Bacteria, 108.
——, Vegetative Organs of Phanerogams and Ferns, 93.
Basidiomycetes, Glycogen in, 503.
Bast-fibre, Influence of Cortical Pressure on, 89.
Bastin, E. S., 745.
Bates, C. P., 530.

Bates, F., Sexuality in Zygnemaceæ, 285.
Bateson, W., Development of Balanoglossus Kowalevskii, and the Affinities of the Enteropneusta, 461.
——, Later Stages in the Development of Balanoglossus, 650.
Batrachospermum, 494.
Battery, Beck's Portable, for small Incandescence Lamps, 172.
Baumgarten, P., Discrimination of Bacillus lepræ and B. tuberculosis, 362.
——, Staining Method for Karyokinetic Figures, 341.
Bäumler, J. A., Parasitic Fungus on the Red-currant, 291.
Bausch, E., 335, 888.
——, Universal Screw for Microscope Objectives, 335.
Bausch and Lomb Optical Co.'s Laboratory and Student's Microtomes, 1089.
—— —— —— Mirror Diaphragms, 523.
—— —— —— "Universal Accessory," 713.
Bayberry Tallow for Imbedding, 735.
Bayerl, B., Demonstrating the Origin of Red Blood-corpuscles in Cartilage at the Margin of Ossification, 537.
Beads, Amphipleura pellucida resolved into, 109, 173.
—— of Amphipleura, 380.
Beard, J., Preparing Myzostoma, 897.
——, Structure and Development of Myzostoma, 66.
Beauregard, H., Alimentary Canal of Insects, 442.
——, Natural Development of Cantharis, 798.
——, Structure of the Wings of Vesicating Insects, 992.
Beccari, O., Ant-harbouring Organs of Plants, 484.
Béchamp, A., Organisms Productive of Zymosis, 693.
——, Origin of Microzymes and Vibrios of Air, Water, and Soil, 295.
Beck, C., Modification of the "Complete" Lamp, 380.
——, E. J., Muscular and Endoskeletal Systems of Limulus and Scorpio, 992.
——, G., Trochobryum, a New Genus of Seligeriaceæ, 281, 841.
Beck's (R. & J.) Automatic Microtome, 153.
—— Combined Substage Apparatus, 115.
—— Portable Battery for Small Incandescence Lamps, 172.
Beck's (R. & J.) Portable National Microscope, 115.
—— —— "Star" Microscope, 1121.
—— Rings for Throwing the Coarse Adjustment out of gear, 525.
—— "Star" Microscope, 512.
—— Universal Microtome, 344.
—— Vertical Illuminator, Diaphragms for, 522.
Becke, F., 161.
Beckwith, E. F., 726.
——, Method for Showing the Distribution and Termination of Nerves in the Human Lungs, 894.
Beddard, F. E., Nephridia of a New Species of Earthworm, 999.
——, Acanthodrilus sp., 813.
——, Structure of the Body-wall in Earthworms, 243.
Bedot, M., Histology of Porpita mediterranea, 463.
——, Structure of Velella, 1010.
Bee, Bacillus alvei, Cause of Foul Brood, 581.
Beeching, S., 889.
Bees and Wasps, Apparatus for Differentiating the Sexes in, 1.
—— ——, Receptaculum seminis of, 1.
Beggiatoa alba, 1046.
—— roseo-persecina, 508.
Begonia socotrana, Bulbils of, 676.
Behrens, W. J., 335, 363, 726, 1079.
——, Modification of the Abbe Condenser, 124.
——, Text-book of General Botany, 677.
Belgium, Van Heurck's Synopsis of the Diatoms of, 686.
Bell, F. J., Comparative Anatomy and Physiology, 620.
——, Cotton-spinner, 462.
——, Gordius verrucosus, 1002.
——, New Minyas, 1010.
——, Peculiar Variety of Acineta grandis, 167.
Bell-glass, Cheap, for the Laboratory Table, 1111.
Bellonci, J., Karyokinesis in Segmentation of Axolotl Ovum, 976.
Beneden, E. van, and C. Julin, Fœtal Appendages of Mammals, 423.
—— —— ——, Postembryonal Development of Phallusia scabroides, 795.
Benham, W. B. S., Muscular and Endoskeletal Systems of Limulus and Scorpio, 992.
Bergh, R., 'Challenger' Nudibranchs, 43.
——, Genus Melibe, 226.
——, Metamorphosis of Nephelis, 241.
Bergonzini, Collodion and Phenol in Microscopical Technique, 559.

Berner, H., Causes of Sex, 215.
Bernimoulin, E., Division of the Cell-nucleus in Tradescantia, 475.
Beroid of Port Jackson, 1011.
Bert, P., 1079.
Berthelot and André, Formation of Nitrates in Plants, 275.
Berthold, G., Fertilization of Cryptonemiaceæ, 683.
——, V., 563.
Bertkau, P., Digestive Apparatus of Spiders, 235.
——, Seasonal Dimorphism in Spiders, 993.
——, Sense-organ of Spiders, 993.
Bertrand's (E.) Adapter Nose-piece, 525.
——, Polarizing Prism, 133.
Bessey, C. E., Bisexuality of the Zygnemaceæ, 1038.
——, Inflorescence of Cuscuta glomerata, 1026.
——, Opening of the Flowers of Desmodium sessilifolium, 1026.
——, Styles of Indian Corn for Examining Movement of Protoplasm, 1106.
Betts, J. B., and T. Taylor, Discrimination of Butter and its Substitutes, 918.
Beyerinck, W., Cecidomyia-galls on Poa, 1026.
Bibliography. See Contents, xliv.
——, Thompson's, of Protozoa, Sponges, Cœlenterata, Worms, and Molluscoida, 983.
Biehringer, J., and P. M. Fischer, Imbedding and Examining Trematodes, 735.
Bienstock, Double Staining Bacillus subtilis, &c., 363.
Bigelow, H. R., Cholera Bacillus, 697.
Bilharzia hæmatobia, Anatomy of, 1003.
Billet, A., Bacterium ureæ, 696.
——, Formation of the Spores of Cladothrix, 692.
Biniodide of Mercury and Potassium as a Swelling Agent, 341.
Binocular, Focal Depth with, 726.
—— M.D., 530.
——, Position of Objects with, 1075.
Binoculars, Adjusting the Eye-pieces of, to eyes of unequal focal length, 1065.
Biondi, D., Origin of the Spermatozoids in the Seminiferous Canals, 979.
Birds, Pneumonomycosis of, 848.
Bisexuality of the Zygnemaceæ, 1038.
Bivalves, Hinge of Shells of, 229.
Bizzozero, G., 924.
——, Microphytes of Normal Human Epidermis, 849.
Bizzozero, G., and Torres, Staining for the Study of Red Blood-corpuscles, 741.
Bjeloussow, A. K., 1109.
Black Sea Algæ, Morphology and Classification of, 1039.
Blackburn, W., 139.
Blacking Brass Diaphragms, &c., 1079.
Bladderwort and Diatoms, 685.
Blanc, H., Collecting Rhizopods, 534.
——, Development of the Egg and Formation of the Primitive Layers in Cuma Rathkii, 238, 641.
——, Variability and Mode of Reproduction of Ceratium hirundinella, 479.
Blanchard, R., New Type of Sarcosporidia, 820.
Blastoderm, Formation of, in the Bird's Egg, 615.
Blastoderms, Preparing and Preserving Eggs of Cephalopoda, 1083.
Blastopore in Phoronis, 242.
—— of Rana temporaria, Fate of, 425.
——, Yolk, Position of, as determined by the Size of the Vitellus, 978.
Blatta periplaneta, Physiology of the Alimentary Canal of, 991.
Bleaching Agent, Hydrogen Peroxide as, 340.
"Bleeding" of Parenchymatous Tissues, 837.
Bles, E. J., 889.
Blight, Pear, 1053.
Blochmann, 563.
——, F., Brachiopoda, 440.
——, Direct Nuclear Division in the Embryonic Investments of Scorpions, 448.
Blood, Examining, in Typhoid Fever, 1104.
——, New Constituent of, and its Physiological Import, 428.
——, Stained Human, Method of preparing permanent specimens of, 537.
Blood-corpuscles, Demonstrating Nuclei in, 730.
—— ——, Measurement of, 1105.
—— ——, Red and White, Formation of, 220.
—— ——, Red, Origin of, in Cartilage at the Margin of Ossification, 537.
—— ——, ——, Staining for the Study of, 741.
Blood-vessels of the Test in Tunicata, Evolution of, 230.
Blooming of Arum italicum, 835.
Blowfly, Influence of some Conditions on the Metamorphosis of, 441.
——, Mounting Proboscis of, in Biniodide of Mercury, 733.
——, Tongue of, 174, 751.
——, ——, Photo-micrograph of, 1077.

Blue Rays for Optical Work, Madan's Method of isolating, 327.
Bluudstone, E. R., Glycogen in "Vesicular Cells" of Mollusca, 986.
Body, Vertebrate, Primitive History of, 780.
Body-tube, Microscope with Bent, 517.
—— -tubes, Short v. Long, 339.
—— -wall in Earthworms, Structure of, 243.
Böcker's Dissecting Microscope with Brücke Lens, 319.
—— Holder for Analysing Prism and Goniometer, 705.
Bohemia, Algæ of, 684.
Böhm's Carmine Acetate, 341.
Bojanus, Organs of, in Anodonta, 795.
Bokorny, T., and O. Loew, Silver-reducing Animal Organs, 619.
Bolbophyllum, Assimilating Cavities in the interior of Tubers of, 671.
Bolina Chuni, Metamorphosis of, 1010.
Boltenias, Slimy Coatings of certain, 233.
Bombus, Male, Copulatory Apparatus of, 50.
Bombyx, Composition of Ova of, 441.
Bone and Teeth Sections, Rapid Method for Making, 348.
Bonnet, R., 563.
Bonnier, G., and L. Mangin, Respiration and Transpiration of Fungi, 104.
—— ——, ——, of Germinating Seeds, 272.
—— ——, —— of Leaves in Darkness, 488.
—— ——, —— of Plants, 835.
—— ——, —— —— at Different Seasons, 836.
—— ——, —— of Tissues not containing Chlorophyll, 94.
—— ——, Variation of Respiration with Development, 679.
Booth, M. A., 745.
——, White Zinc Cement, 363.
Borax-methylen-blue, Application of, in the Examination of the Central Nervous System, 731.
Bornet, E., and C. Flahault, Aulosira, 692.
Borodin, J., Comparative Anatomy of Leaves of Chrysosplenium, 91.
——, Crystals in the Leaves of Leguminosæ, 823.
Boro-glyceride for Mounting, 742.
Borzi, A., Nowakowskia, a new Genus of Chytridiaceæ, 846.
Botanical Lectures, Apparatus for, 312.
Bothriocephalidæ, Nervous System of, 646.
Bothriocephalus, New, 810.
Botrychium ternatum, Growing the Spores of, 1109.
Botrytis cinerea, Nocturnal Spore-formation in, 690.
Botterill, C., 335.
Bottone, S., 745.
Botys hyalinalis, Embryology of, 447.
Boulay, M., Mosses of France, 281.
Bourne, A. G., Communication of the Vascular System with the Exterior in Pleurobranchus, 794.
——, Hydroid Phase of Limnocodium, Sowerbii, 72, 251.
Boutan, L., Anatomy of Fissurella, 985.
——, Nervous System of Fissurella, 624.
Boutroux, L., Preservation of Alcoholic Ferments in Nature, 114.
Bouvier, E. L., Nervous System of Buccinidæ and Purpuridæ, 793.
Bower, F. O., Apex of the Root in Osmunda and Todea, 1033.
——, Apospory in Ferns, 99.
——, Morphology of Phylloglossum Drummondii, 1034.
——, and E. T. Druery, Apospory in Ferns. Singular Mode of Development in Athyrium Filix-fœmina, 492.
——, and S. H. Vines, Examining the Spectrum of Chlorophyll, 527.
—— —— and W. T. T. Dyer, Practical Botany, 484, 563.
Box Microscope, 701.
Brachiopoda. See Contents, xiii.
Bradbury, W., 139, 335.
Brain of Asellus and Cecidotæa, 238.
—— of Urodela, Preparing, 536.
Branchiobdella, Oogenesis and Spermatogenesis in, 643.
Brass, A., Chromatine in Cell-division, 263.
——, Methods of Investigating Animal Cells, 729.
Brasse, L., Presence of Amylase in Leaves, 97.
Braun, M., Mounting Media for Nematodes, 897.
Brayley, E. B. L., 363.
Brearley, W. H., 363.
Brefeld, O., Conidiobolus, a New Genus of Entomophthoreæ, 106.
——, Cultivation Methods for the Investigation of Fungi, 534.
Breidler, J., and G. Beck, Trochobryum, a New Genus of Seligeriaceæ, 281, 841.
Brevoort, H. L., Construction of Fur Fibres, 173.
Brieger, L., Bacteria, 695.
Brightness, Sense of, and of Colour in Animals, 38.

Briozi, G., Heterophylly of Eucalyptus globulus, 1025.
Brisingidæ of the 'Talisman' Expedition, 1009.
Britton, N. L., Fecundation of Ovules in Angiosperms, 270.
Brock, J., Development of Generative Organs of Pulmonata, 623.
Bronold, A., Influence of Electricity on the Growth of Plants, 835.
Brook, G., Development of Motella mustela, 785.
——, ——, of the Lesser Weever-Fish, 34.
——, Origin of the Hypoblast in Pelagic Teleostean Ova, 214.
——, Spawning of the Cod, 786.
Brooks, W. K., Life-history of Eutima mira, 251.
——, New Law of Variation, 216.
——, Recognition by Marine Animals of the Hour of the Day, 431.
Broths, Sterilized, New Method for Transfer of, 359.
Brown, G. D., Mounting Dry Opaque Objects without cover-glass, 161.
——, Use of the Chitinous Element in the Classification of the Polyzoa, 381.
——, H. H., Spermatogenesis in the Rat, 783.
Brownell, J. T., Staining and Mounting Pollens and Smuts, 349.
——, Turntable, 350.
——, Wax Cells, 363.
Bruchmann, H., Development of the Vegetative Organs of Selaginella spinulosa, 279.
——, Prothallium of Lycopodium, 839.
Brucin, Micro-chemical Test for, 920.
Brücke Lens, Dissecting Microscopes with, 319.
Brücke's Electrical Apparatus, 869.
Brun, J., Double Staining, 558.
Brunchorst, J., Galvanotropism of Roots, 836.
Brunn, A. v., Westien's Universal Lens-holder, 316.
Brunt, C. Van, Fixing Objects to the Cover-glass, 1097.
Bryaceæ, Peristome of, 1035.
Bryozoa, see Polyzoa.
Buccal Membrane of Cephalopoda, 622.
Buccinidæ, Nervous System of, 793.
Buchner, Cholera Bacillus, 509.
——, E., Influence of Oxygen on Fermentation by Schizomycetes, 850.
——, H., 1109.
Buck, E., Unstalked Variety of Podophrya fixa, 662.
Bud-cones of the Carob, Hypertrophy of, 675.
Buffham, T. H., Conjugation of Rhabdonema arcuatum, 842.
Bulbils of Begonia socotrana, 676.
Bulloch, W. H., Combination Microtome, 548.
——, Magnifying Power of Objectives and Position of Wollaston Camera, 335.
——, New Lamp, 133.
Bungener, H., Degeneration of Yeast, 693.
Burch, G. J., Supposed New Infusorian, 1015.
Bureau of Scientific Information, 745.
Burgerstein, A., Physiological and Pathological Effect of Camphor on Plants, 837.
Burrill, T. J., 746, 889, 1079.
——, Mechanical Injury to Trees by Cold, 1029.
Bursting of Sporangium of Ferns and the Anther of Flowering Plants, 1032.
Busk, G., 'Challenger' Polyzoa, 47.
Bütschli, O., 563.
——, Eye of Gastropoda, 222.
——, Marine Rhizopoda, 1016.
——, Origin of the Nervous System of Nematodes, 458.
Butter and Fats, Examination of, 356.
——, Discrimination of, and its Substitutes, 918.
Butterflies, Structure of Scales of, 165.
Buysman, Influence of direct Sunlight on Vegetation, 678.

## C.

C., L. P. de, 889.
Cabbage, Red, Amplification of Colouring Matter of, in Histology, 558.
Cabinet, Microscopist's Working, 365.
Cactaceæ, Annular and Spiral Cells of, 672.
——, Elasticity in the Fruit of, 1027.
Cactuses, Use of Spines in, 1027.
Calanidæ, Sense-organs of, 997.
Calcareous Sponges, Histology and Nervous System of, 1011.
Calcituba polymorpha, 258.
Calcium Oxalate, Mechanical Function of Crystals of, 265.
Caldwell, H., Embryonic Membranes of Marsupials, 34.
——, W. H., Automatic Microtome, 150.
——, Blastopore, Mesoderm, and Metameric Segmentation in Phoronis, 242.
——, Oviparous Reproduction in the Monotremes, 33.
Callitriche, Fertilization of, 677.

Cambridge Rocking Microtome, 549.
Camera, Direct Vision, 336.
—— Lucida, Schröder's, 140.
—— ——, Wollaston, Position of, 335.
——, Robinson's Miniature Microscopic, 528.
——, Small, 529.
Camerano, L., Distribution of Colour in the Animal Kingdom, 37.
Cameron's (P.) British Phytophagous Hymenoptera, 440.
Campanula americana, Fertilization in, 1028.
——, Reduced Organ in, 675.
Campbell, D. H., Growing the Spores of Botrychium ternatum, 1109.
——, Third Coat in the Spores of the Genus Onoclea, 493.
Camphor, Physiological and Pathological Effect of, on Plants, 837.
"Cancer" of Apple-trees, 106.
Cantharis, Natural Development of, 798.
Cantor Lectures on the Microscope, 1124.
Caplatzi, A., 889.
Capus, G., Direct Observation of the Movement of Water in Plants, 359.
Car, L., Copepoda of the Adriatic, 454.
Carbolic Acid Shellac, Mayer's, 909.
Carbon dioxide, Evolution of, in Leaves kept in Darkness, 678.
Carmine Acetate, Böhm's, 341.
—— Solution, New, 740.
—— Staining Fluids, New Methods of Preparing, 1094.
Carnot, A., Composition of Mineral Oil in Relation to the Plants which have produced it, 276.
Carnoy's (J. B.) Biology of the Cell, 669
Carob, Hypertrophy of the Bud-cones of, 675.
Carotine, Identity of the Orange-red Colouring Matter of Leaves with, 670.
Carpenter, H. S., and W. O. Nicholson, Examination of Water for Organisms, 560.
——, P. H., New Species of Metacrinus, 815.
——, Stalked Crinoids of the 'Challenger' Expedition, 653.
——, Vascular System of Echinoids, 814.
——, W. B., 335, 1079.
——, Death of, 1119.
——, Focal Depth with the Binocular, 726.
——, Standard Thickness of Glass Slips, 329.
Carrière, J., Eyes of some Invertebrata, 39.
Carter, H. J., Circulation in Spongida, 816.
Carter, H. J., New Sponges from South Australia, 465.
——, New Variety of Meyenia fluviatilis, 658.
——, Spongilla fragilis, and a New Species of Spongilla, 255.
——, J., & Co., 363.
Cartilage, Origin of Red Blood-corpuscles in, at the Margin of Ossification, 537.
Cartilages of Limulus and Sepia, Chitin as a Constituent of, 222.
Castellarnau, J. M. de, 746.
Castracane, F., Deep-sea Diatoms, 498.
——, Fossil Diatoms, 498.
——, Internal Spore-formation in Diatoms, 1041.
Caterpillar of Lagoa, Unusual number of Legs in, 990.
Cattaneo, L., Fixing, Staining, and Preserving Infusoria, 538.
Catti, J. T., Manner in which Lamellibranchs attach themselves to Foreign Objects, 626.
Cattle-disease, "Rauschbrandpilz," a parasitic, 300.
—— Plague, Bacillus of, 114.
Cecidomyia-galls on Poa, 1026.
Cecidomyians, Relations of Two, to Fungi, 291.
Cecidotæa, Brain of, 238.
Cell, Carnoy's Biology of, 669.
——, Live, 134.
——, ——, Giles', 135.
——, Structure, Vital Phenomena, and Reactions of, 86.
Cell-contents, Small Rod-like, of certain Cercariæ, 1003.
Cell-continuity, 426.
Cell-division, 217.
—— ——, Chromatine in, 263.
—— —— in Melosira, 497.
—— ——, Influence of Gravity on, 426.
—— ——, Preparing Tissues to show, 893.
Cell-nuclei, Significance of, in the Processes of Heredity, 975.
Cell-nucleus, Division of, in Plants and Animals, 666.
—— —— in Tradescantia, Division of, 475.
—— —— Structure and Division of, 474.
Cell-wall, Behaviour of Optical Axes of Elasticity of, under Tension, 476.
—— —— of Diatoms, Structure of, 685.
—— —— of Epidermal Cells, Changes in, and in the Hairs of Pelargonium zonale, 668.
—— —— Siliceous Membrane with Properties of, 263.
—— —— thickenings in Chara and Vaucheria, 838.

Cells, Animal, Methods of Investigating, 729.
——, Annular and Spiral, of Cactaceæ, 672.
——, Chapman's Mould for, 911.
——, Epidermic, of Tadpoles, 977.
——, Follicular and Granular, of Tunicates, 44.
——, Forms of, 820.
——, Hard-rubber, 925.
——, Leakage of, 1102.
——, Male Germinal, Development of, in Hydroids, 462.
——, Mounting in, with Canada Balsam, 909.
——, Parietal, in Nerve-fibres, 428.
——, Sexual, Origin of, in Obelia, 250.
——, Spiral, of Nepenthes, 1023.
——, "Vesicular," of Molluscs, Glycogen in, 986.
——, Wandering, in Epithelium, 980.
——, Wax, 363.
Cellulin-grains in Chara and Vaucheria, 838.
Cellulose, Sensitive Tests for, 897.
Cement, 1110.
—— for Glass, Porcelain, &c., 162.
——, Glycerin and Litharge as a, 743.
——, Smith's New, 1099.
——, White Zinc, 363, 365, 1101.
Cephalophorous Molluscs, Radula of, 434.
Cephalopod Liver, Pancreatic Function of, 622.
Cephalopoda, Buccal Membrane of, 622.
——, Fecundation in, 983.
——, Integument of, 40.
——, New, 984.
——, New 'Challenger,' 435.
——, Preserving Eggs of, and preparing Blastoderms, 1083.
——, Retina of, 41.
Ceratium hirundinella, Variability and Mode of Reproduction of, 470.
Ceratophyllum, Anatomical Structure and Development of, 825.
Cercariæ, Action of Sodium Chloride on, 814.
——, Small Rod-like Cell-contents of certain, 1003.
Certes, A., Employment of Colouring Matters in Study of Living Infusoria, 555.
——, and D. Cochin, Effect of High Pressures on the Vitality of Ferments and on Fermentation, 693.
Ceylon, Echinodermata of, 462.
Chadwick, W. J., 1079.
Chætopoda, Muscles of, 456.
Chætotaxy, Comparative, 52.
Chairy, M., Action of various Compounds on Tyrothrix, 510.
'Challenger' Cephalopoda, New, 435.
—— Cirripedia, 61.
—— Myzostomida, 68.
—— Nudibranchs, 43.
—— Polyzoa, 47.
—— Stalked Crinoids of, 653.
Chalon, J., 726.
Chamberland, C., Removal of Microbes by Filtering, 561.
Chaney, L. W., jun., 726.
Chapman's Mould for Cells, 911.
Chara and Vaucheria, Staining, 557.
——, Cell-wall thickenings and Cellulin-grains in, 838.
Characeæ. See Contents, xxviii.
Chareyre, J., Anatomy of Pitcher-plants, 1024.
Chatin, J., Appendages of the Jaw of Mandibulate Insects, 50.
——, Morphology of the Mouth-organs of Hymenoptera, 989.
Cheeseman, E. L., Growing Slide, 335.
Chelifer, Development of, 449.
Chemical and Medico-legal Microscopy, 1108.
—— Phenomena of the Respiration of Plants, 488.
Chemistry of Bacillus subtilis, 508.
Cheshire, F. R., The Apparatus for differentiating the Sexes in Bees and Wasps. An Anatomical Investigation into the Structure of the Receptaculum Seminis and adjacent parts, 1.
——, and W. W. Cheyne, The Pathogenic History and History under Cultivation of a New Bacillus (B. alvei), the Cause of a Disease of the Hive Bee hitherto known as Foul Brood, 581.
Chester Society of Natural Science, 139.
Cheyne, W. W., Cholera Bacillus, 850.
—— and F. R. Cheshire, The Pathogenic History and History under Cultivation of a new Bacilllus (B. alvei) the Cause of a Disease of the Hive Bee hitherto known as Foul Brood, 581.
Chilton, C., Australian Crustacea, 998.
——, Marine Species of Philougria, 239.
——, New Species of Idotea, 454.
——, Polymorphism in the Amphipoda, 997.
Chitin as a Constituent of the Cartilages of Limulus and Sepia, 222.
——, Distribution of, 984.
——, Method of Softening, 896.
Chitinous Element, Use of, in the Classification of Polyzoa, 381.
Chitonidæ, Eyes of, 224.

Chitons, Generative and Urinary Ducts in some, 42.
Chiusoli, V., 140.
Chloræmidæ, Problematical Organ in, 457.
Chlorophyll, 87.
—— and its Combinations, 822.
——, Chemical and Physiological Action of Light on, 837.
——, —— Reactions of, 264.
——, Conditions of the Development and of the Activity of, 1020.
——, Decomposition of Solutions of, by Light, 669.
——, Examining the Spectrum of, 527.
—— in Leaves, Fluorescence of, 88.
—— of Fucaceæ, 282.
——, Respiration of Tissues not containing, 94.
Chlorophyll-grains, Morphology of, 88, 475.
Chlorophyll-green of Fucaceæ, 1038.
Chlorophylloid Granules of Vorticella, 78.
Chlorosporeæ, Vegetative Changes of Form in, 283.
Choano-Flagellata, New, 258.
—— ——, Relationship of Sponges to, 657.
Cholera-bacillus, 113, 509, 697, 850, 953, 1050.
—— ——, first discovery of, 383.
——, Relations of Bacteria to Asiatic, 299.
Choleraic Virus, Attenuation of, 1051.
Cholodkovsky, N., Malpighian Vessels of Lepidoptera, 51.
——, Testes of Lepidoptera, 51.
Chromatine in Cell-division, 263.
Chromatology of Actiniæ, 464, 656.
Chromatophores and Nuclei, Distribution of, in the Schizophyceæ, 691.
——, Occurrence of, in the Phycochromaceæ, 102.
——, Structure of, 109, 293.
Chromic Acid, Action of Light on Objects hardened in, 148.
Chrysosplenium, Comparative Anatomy of Leaves of, 91.
Chun, C., 726.
Chytridiaceæ, New, 846.
——, Nowakowskia, a new Genus of, 846.
Circulation in Ephemera Larvæ, 637.
—— in Spongida, 816.
—— of Schizopoda and Decapoda, 60.
Circulatory and Nephridial Apparatus of the Nemertea, 810.
Cirripedia, Anatomy of, 641.
——, 'Challenger,' 61.
Cladothrix, Formation of Spores of, 692.
Clam, Parasitic Copepod of, 239.
Classification, Phylogenetic, of Animals, 221.
—— of Fungi, 689.
—— of Polyzoa, Use of the Chitinous element in, 381.
—— of the Lower Algæ, 495.
Claus, C., Circulation of Schizopoda and Decapoda, 60.
——, Cyclical Development of Siphonophora, 1010.
—— Elementary Text-book of Zoology, 38, 431.
——, Morphology of Crustacea, 803.
Cleaner, James' Cover-glass, 354.
Cleaning Fluid for Vegetable Tissues, 366.
Clepsine, Development of the Sexual Organs of, 455.
Cleve, P. T., Fossil Marine Diatoms, 1042.
Clouds, Microscopical Observations on the Constituents of, 919.
Cloudy Mounts, 366.
Coal, Composition of the Ash of Equisetaceæ, and its Bearing on the Formation of, 681.
—— Seams, Carboniferous, Structure and Origin of, 406.
Coarse Adjustment, Rings for throwing out of gear, 525.
Cocain, Action of, on Invertebrates, 621.
—— for Mounting Small Animals, 893.
Cocardas, E., Penicillium-Ferment in Pharmaceutical Extracts, 1046.
Cocci, Soil-, Identity of Bacterium fœtidum (Thin) with, 696.
Cochin, D., Effect of High Pressures on the Vitality of Ferments, and on Fermentation, 693.
Cocoon of Periplaneta orientalis, Orientation of the Embryo, and Formation of, 991.
Cod, Spawning of, 786.
Cœlenterata. See Contents, xviii.
Cœlenterate Nature of Sponges, 816.
Cœlom and Cœlomic Epithelium of Amphibia, Development of, 423.
Cœlopleurus Maillardi, "Tag" of, 815.
Cœnonia, a New Genus of Myxomycetes, 293.
Cohn, F., Mould-fungi as Ferments, 1045.
Cold, Mechanical Injury to Trees, by, 1029.
——, Resistance of Aerial Bacteria to, 511.
Cole, A. C., 364, 563, 746, 924, 1109.
——, Preparing Tail of Puppy, 894.
——, Studies in Microscopical Science, 355.

Coleman, J. J., and J. G. M'Kendrick, Action of Ozonized Air upon Micro-organisms and Albumen in Solution, 1053.
—— ——, Effects of Very Low Temperatures on Living Organisms, 619.
Coleoptera, Scales of, 442.
Coleps hirtus, 1015.
Collecting-bottle, Hardy's Improved, 145.
—— Objects. See Contents, xxxviii.
Collins, C., 746.
——, Portable Microscope, 701.
Collodion and Phenol in Microscopical Technique, 559.
——, Uses of, 908.
Colloids and Carbonate of Lime, On Erosion on the Surface of Glass, when exposed to the joint action of, 761.
Coloration of the Anterior Segments of the Maldanidæ, 999.
Colour, Distribution of, in the Animal Kingdom, 37.
——, Sense of, and of Brightness in Animals, 38.
Colour-Corrections, Table of, 1068.
Colour-varieties, Local, of Scyphomedusæ, 71.
Coloured Crayons for Marking Preparations, 1103.
Colouring Matter of Red Cabbage, Application of, in Histology, 558.
—— ——, Orange-red, of Leaves, Identity of, with Carotine, 670.
—— Matters, Employment of, in the Study of Living Infusoria, 555.
—— —— of Flowers and Fruits, 264.
—— ——, Susceptibility of the Different Tissues to, 554.
Colours, Fries' Nomenclature of, in the Agaricini, 105.
—— of Birds' Eggs, 618.
Comatula, Development of, 655.
—— mediterranea, Process resembling Copulation in, 70.
Combustion, Respiratory, 95.
Comes, O., Gummosis of Figs, 1053.
——, New Parasitic Oidium, 505.
Comma Bacillus, 566.
—— ——, Inoculation of Guinea-pigs with, 509.
Compositæ, Anatomical Structure of the Stem of, 480.
——, Function of Latex in, 266.
Compressor, Cover-, A Simple, 564, 925.
Compressorium, Jung's, 136.
——, Viguier's, 137.
Compton, B., 140.
Condenser, Abbe's, 123, 1065.
——, ——, Modification of, 124, 125.
Condenser, Nelson's Simple, 327.
——, Swift's Cone and Achromatized Immersion Paraboloid, 126.
——, Wallich's, 127.
——, Zentmayer's Abbe, 710.
Conidia, Mycelial, of Polyporus sulfureus, 289.
Conidiobolus, a New Genus of Entomophthoreæ, 106.
Conifers, Anatomy of Wood of, 825.
——, Comparative Anatomy of the Tissue of the Medullary Rays and Annual Zones of Growth in, 826.
Conjugation of Rhabdonema arcuatum, 842.
Conn, H. W., Formation of Trochosphere in Serpula, 240.
——, Marine Larvæ and their Relations to Adults, 788.
Connor, R., Pen-and-Ink Drawings of Microscopic Objects, 1077.
Contraction, in Striated Muscles, Phenomena of, 428.
Convoluta Schultzii, New Sensory Organ of, 1004.
Cooke, M. C., 746.
——, Monograph of Polyporus, 289.
——, Some Remarkable Moulds, 848.
Cooper, W. A., 889.
Copepod, Parasitic, of the Clam, 239.
Copepoda, Morphology of Cyclops and Relations of, 452.
—— of the Adriatic, 454.
—— of the North Pacific, 454.
Copulation, Process resembling, in Comatula mediterranea, 78.
Copulatory Apparatus of the Male Bombus, 50.
Corethra plumicornis, Uses and Construction of Gizzard of Larvæ of, 991.
Cornil (A.) and V. Babes' Bacteria, 853.
Corry, T. A., Fertilization of Asclepias Cornuti, 834.
Corsinia, Exudation of Water from the Female Receptacle of, 1035.
Cortex, Formation of Secondary, 673.
Cortical Pressure, Influence of, on the Bast-fibre, 89.
Corvo, L. A., Bacillus of the Vine, 1053.
Corynelia, 105.
Costantin, J., Epidermis of the Leaves of Aquatic Plants, 674.
——, Influence of the Medium on the Structure of Roots, 832.
——, Structure of the Stem of Aquatic Plants, 480.
—— and L. Morot, Fibrovascular Bundles of Cycadeæ, 1023.
Cotton-spinner, 462.

Cotyledons and Endosperm, Comparative Anatomy of, 481.
Coulter, J. M., Relation of Ovary and Perianth in the Development of Dicotyledons, 1026.
Council's Report for 1884, 372.
Councilman, W. T., Weigert's Staining Method for the Central Nervous System, 159.
Counting of Microscopic Objects for Botanical Purposes, 744.
Courroux, E. S., Preparing Diatoms from the Stomachs of Mollusca and Crustacea, 734.
Cover, Fixing Objects to, 1097.
Cover-glass Cleaner, James', 354.
Cover-glasses, Handle for, 1115.
Coverdale, G., Action of Ammonia upon Lepidopterous Pigments, 52.
Cox, C. F., 530.
——, Hard-rubber Cells, 925.
——, J. D., 336.
——, Actinic and Visual Foci, 331.
——, —— —— —— in Photo-micrography with High Powers, 1070.
——, Structure of Diatoms, 168, 175.
——, —— of the Diatom Shell. Siliceous Films too thin to show a broken edge, 398.
Coxal Gland in the Phalangida, 58.
Crab, Spider-, Anatomy of, 60.
Crania, Anatomy of, 633.
——, Digestive and Reproductive Organs of, 233.
Crayons, Coloured, for Marking Preparations, 1103.
Creutzburg, N., Circulation in Ephemera Larvæ, 637.
Crinoids, Stalked, of the 'Challenger' Expedition, 653.
Crisp, F., 338.
——, On the Limits of Resolution in the Microscope, 968.
Crombie, J. M., Algo-Lichen Hypothesis, 103, 688.
Cross-breeding and Hybridization of Plants, 1028.
Crozier, A. A., Node of Equisetum, 840.
Cruciferæ, Idioblasts containing Albuminoids in some, 672.
Crustacea. See Contents, xv.
Crustacean inhabiting the Tubes of Vermilia, 238.
Cryptica, a New Genus of Tuberaceæ, 105.
Cryptogamia. See Contents, xxvii.
—— Vascularia. See Contents, xxvii.
Cryptonemiaceæ, Fertilization of, 683.
Crystals in the Leaves of Leguminosæ, 823.
Crystals of Calcium Oxalate, Mechanical Function of, 265.
Cuboni, G., Formation of Starch in the Leaves of the Vine, 670.
Cucurbitaceæ, Cystoliths of, 87.
——, Sieve-tube System of, 477.
——, Spur of, 831.
Cugini, G., Anatomy of the Female Inflorescence of Dioon edule, 832.
Cultivation Methods for the Investigation of Fungi, 534.
—— of Actinomyces, 534.
Culture Chamber, Simple, 163.
—— Media for Bacteria, 564.
Culture-tube, Salmon's, 145.
Cuma Rathkii, Development of the Egg and Formation of the Primitive Layers in, 238, 641.
Current Apparatus, Fabre-Domergue's, 526.
Curties, T., 140.
——, Improved Hardy's Collecting-bottle, 145.
——, Modification of the Abbe Condenser, 125.
Curvature of Ovules, 267.
Cuscuta glomerata, Inflorescence of, 1026.
Cutting Ribbons of Sections, 157, 158.
Cyanea, Identity of the two British Species of, 464.
Cybulsky, J. B., Staining the Nervous System of the Muzzle and Upper Lip of the Ox, 555.
Cycadeæ, Embryo of, 270.
——, Fibrovascular Bundles of, 1023.
Cyclas cornea, Development of, 625.
Cyclical Development of Siphonophora, 1010.
Cyclops, Development of, 641.
——, Morphology of, and Relations of the Copepoda, 452.
Cyclostoma and Pomatias, 436.
Cymbulia, General Characters of, 627.
Cynthiidæ, Microscopic Elements serving for the Determination of, 230.
Cyperaceæ and Gramineæ, Homology of Floral Envelopes in, 676.
Cyphonautes, Metamorphosis of, 798.
Cystitis and Nephritis produced by Micrococcus urcæ, 1047.
Cystoliths of Cucurbitaceæ, 87.
Cystopus Capparidis, 107.
Czapski, S., 1079.

D.

D., E. T., 140, 336, 564.
——, Glass Slips for Collecting, 364.
——, Preserving Hydrachnæ, 364.
D'Agen, F., 530.

Dahl, F., Anatomy of Spiders, 640.
——, Organs of Sense in Spiders, 58.
——, Season Dimorphism in Spiders, 803.
——, J., Foot-glands of Insects, 989.
Dallinger, W. H., The President's Address, 177.
Danilewsky, B., Hæmatozoa in Cold-blooded Animals, 472.
Daphne, Embryo-sac of, 830.
Daphnia, Fungus-disease in, 1046.
Dareste, C., Physiological Purpose of Turning the Incubating Hen's Egg, 617.
Darkness, Leaves kept in, Absorption of Oxygen and Evolution of Carbon dioxide in, 678.
——, Respiration of Leaves in, 488.
D'Arsonval, Illumination for Projection Microscopes, 866.
——, Water Microscope, 1054.
Date, Peculiar Structures in Flesh of, 824.
Davidson, J., Influence of some Conditions on the Metamorphosis of the Blow-fly, 441.
Davies, T., 162.
Davis, G. E., 140.
——, J. J., A Simple Cover-compressor, 564, 925.
——, J. R., Habits of the Limpet, 225.
Davison, J., Navicula cuspidata as a Test-object, 140.
Day, E. G., 925.
——, Balsam of Tolu as a Medium for Mounting, 352.
Debes, E., Cleaning and Preparing Diatom Material—Mounting Diatoms, 898.
Deby, J., Test for the Hand-Lens, 720.
——, Twin Microscope, 854.
—— and A. B. Aubert, Styrax and Balsam, 744.
Decalcification and Staining of Osseous Tissue, 905.
Decapod Crustacea, New, 453.
—— ——, Spermatogenesis in, 237.
Decapoda, Circulation of, 60.
Decomposition and Fermentation of Milk, 1048.
Deecke, T., New Protozoon, 663.
Deep Fauna of Swiss Lakes, 238.
Degeneration of Yeast, 693.
Dehérain, P. P., and L. Maquenne, Absorption of Oxygen and Evolution of Carbon dioxide in Leaves kept in Darkness, 678.
Dehydrating Apparatus, Haacke's, 148.
Dekhuijzen, M. C., 162.
Delage, Y., Evolution of Sacculina, 454.
Delage, Y. Nervous System of Acœlomate Planarians and new Sensory Organ of Convoluta Schultzii, 1004.
Delogne, 162.
Deniker, J., Fœtus of Gibbon and its Placenta, 783.
Dentalium, Anatomy of, 623, 984.
Departure, A New, 745.
Descent, Theory of, 1027.
Desmidieæ, Movement and Formation of Mucilage by, 1040.
Desmids, On some New and Rare, 933.
——, New Fresh-water, 497.
——, Staining, 742.
Desmodium sessilifolium, Opening of Flowers of, 1026.
Detmer, W., Formation and Fermenting Action of Diastase, 98.
——, Formation of Hydrochloric Acid in Plants, 274.
Detmers, H. J., 1109.
Dewitz, H., How Insects adhere to flat vertical Surfaces, 801.
Diamonds and Cut Gems, Examining, 1108.
Diaphragms, &c., Blacking Brass, 1079.
—— for Beck's Vertical Illuminator, 522.
——, Mirror-, 523.
Diastase, Formation and Fermenting Action of, 98.
——, —— of, 276.
Diatom Material, Cleaning and Preparing, 898.
——, Mysterious Appearance of, 1041.
—— Shell, Structure of. Siliceous Films too thin to show a broken edge, 406.
—— Valve, Structure of, 286, 498.
Diatom-synonymy, Lagerstedt's, 287.
Diatomaceæ, Styrax for Mounting, 166.
Diatomaceous Deposit, New, at Santa Monica, 173.
—— Deposits in Scotland, 287.
Diatomescope, Osborne's, 128.
Diatoms and Bladderwort, 685.
——, Deep-sea, 498.
——, Filamentous Projections on, 571.
——, Fossil, 498.
——, Fossil Marine, 1042.
—— from Lago Trajano, 103.
—— in Phosphorus, 354.
——, Internal Spore-formation in, 1041.
——, Mounting, 898.
——, Nature of the Striæ of, 169, 173.
——, New, from the "Saugschiefer" of Dubrávica, 497.
—— of Belgium, Van Heurck's Synopsis of, 686.
——, Prepared, in Fluid ready for Mounting, 927.

Diatoms, Preparing, from the Stomachs of Mollusca and Crustacea, 734.
——, Sections of, from the Jutland "Cementstein," 843.
——, Structure of, 168, 175, 286.
——, —— of Cell-wall of, 685.
——, Zenger's Mounting for, to view them on both sides, 161.
Dichroiscope, Sorby's, 121.
Dicotyledons, Relation of Ovary and Perianth in the Development of, 1026.
——, Sieve-tubes in Leaves of, 1020.
Dienelt, F., 364.
Dietzsch, O., 162.
Dietzell, B. E., Source of the Nitrogen of the Leguminosæ, 680.
Dieulafait, Composition of the Ash of Equisetaceæ and its Bearing on the Formation of Coal, 681.
Difflugia cratera, 819.
Diffraction Theory, Amphipleura pellucida and the, 529.
Digestion, Mode of, in Sponges, 74.
—— of Proteids in Plants, 1030.
Digestive Apparatus of Spiders, 235.
—— Organs of Crania, 233.
Dimmock, G., Scales of Coleoptera, 442.
Dimorphism, Seasonal, in Spiders, 993.
Dinobryon, 258.
Dioon edule, Anatomy of the Female Inflorescence of, 832.
Diphtheria, Micro-organisms as a cause of, in Man, Pigeons, and Calves, 694.
Diplosomidæ, The Synascidian, 796.
Dippel, L., 140, 336.
——, Biniodide of Mercury and Potassium as a Swelling Agent, 341.
——, Diatoms in Phosphorus, 354.
——, Electrical Apparatus, 872.
——, Polarized Light in Vegetable Histology, 357.
——, Testing the different Sectors of Objectives, 324.
Diptera, Structure of Halteres of, 636.
Dissecting Insects, 166.
—— Purposes, Double Injections for, 905.
Distaplia, Structure of, 233.
Distribution, Wide, of some American Sponges, 76.
Division and Structure of the Cell-nucleus, 474.
—— —— of the Nucleus, 262.
——, Artificial, of Infusoria, 472, 658.
——, Behaviour of Nucleus after, 475.
——, Cell-, Chromatine in, 263.
——, ——, in Melosira, 497.
——, ——, Influence of Gravity on, 426.
——, ——, Preparing Tissues to show, 893.
Division, Direct Nuclear, in the Embryonic Investments of Scorpions, 448.
—— of the Cell-nucleus in Plants and Animals, 666.
—— —— in Tradescantia, 475.
—— of the Nucleus, 86.
Doassansia, Development of, 502.
Döderlein, L., Japanese Echinoidea, 1009.
Dogfish, Formation of Egg-shell in, 425.
Dogs, Domestic, Frequent occurrence of Tænia Echinococcus in, 1002.
Dohrn, A., Primitive History of the Vertebrate Body, 780.
Doliolum, 231.
Dolley, C. S., 564.
——, Technology of Bacteria Investigation, 917.
Dormitories, Pneumonia-cocci in, as a cause of Pneumonia, 300.
Dorocidaris, Anatomy of, 815.
—— papillata, Larval Form of, 1008.
Double-Drum Microscope, 703.
Douglas, J. C., Litharge and Glycerin as a Cement, 743.
Dowdeswell, G. F., On a Septic Microbe from a high altitude. The Niesen Bacillus, 769.
——, Occurrence of Variations in the Development of a Saccharomyces, 16.
——, The Cholera "Comma" Bacillus, 953.
Doyen, Cholera Bacillus, 509.
Draper, E. T., 746, 925, 1109.
Drawings, Multiplying, 527.
——, Pen-and-Ink, of Microscopic Objects, 1077.
Dripping Apparatus, Gannett's, 900.
Druery, E. T., Apospory in Ferns, 99.
—— and F. O. Bower, Apospory in Ferns—Singular Mode of Development in Athyrium Filix-fœmina, 491.
Dry Mounting, 1100.
—— —— of Opaque Objects, 560.
—— —— —— ——, without Coverglass, 161.
—— Preparations, Modification of Semper's Method of making, 898.
Dry-rot, 505.
Duboscq's (T. and A.) Projection Microscope, 861.
Dubrávica, New Diatoms from the "Saugschiefer" of, 497.
Duchartre, P., Bulbils of Begonia socotrana, 676.
——, Influence of want of Moisture on the Growth of the Chinese Yam, 1029.

Duclaux, E., Effect of Sunlight on Micrococcus, 1047.
——, Influence of Sunlight on the Vitality of Germs, 508.
——, Origin of Microzymes and Vibrios of Air, Water, and Soil, 295.
——, Vitality of Germs of Microbes, 296.
Ducts, Generative and Urinary, in some Chitons, 42.
Dudley, P. H., 889.
Duffield, G., 364.
Dufour, J., Influence of Gravitation on the Movements of Stamens, 272.
Dunant, P. L., Effect of Prolonged Repose and Filtration through Porcelain on the Purity of Water, 561.
Duncan, P. M., "Tag" of Cœlopleurus Maillardi, 815.
—— and W. P. Sladen, Arbaciadæ, 652.
Duncker, H. C. J., Actinomyces in Swine's-flesh, 290.
Duplessis-Gouret, G., Fresh-water Monotidæ, 813.
Durand, W. F., 889.
Durkee, R. P. H., Structure of the Diatom Valve, 286.
Du Sablon, L., Dehiscence of Anthers, 91.
——, —— of the Sporangia in Vascular Cryptogams, 276.
——, Development of the Sporangium of Frullania, 840.
——, Elaters of Hepaticæ, 682.
——, Structure and Dehiscence of Anthers, 832.
Düsing, K., Regulation of the Proportion of the Sexes in Man, Animals, and Plants, 214.
Duval, M., Formation of the Blastoderm in the Bird's Egg, 615.
Dybowski, B., Crustacea of Lake Baikal, 807.
Dyer, W. T. T., 484, 563.
——, Apospory in Ferns, 99.
Dynamo-electric Machines, 889.

E.

Earthworm, Nephridia of a new Species of, 999.
Earthworms, Structure of the Body-walls in, 243.
Eau de Javelle as a Medium for Clarifying and Dissolving Plasma, 893.
—— —— for Clearing, 1097.
Ebeling, M., Absorbing Organs of Albuminous Seeds, 829.
Echinodermata. See Contents, xviii.
Echinoidea, Japanese, 1009.
Echinoidea, Structure and Functions of the Sphæridia of, 1009.
Echinoids, Morphology of, 1008.
——, Vascular System of, 814.
Echinorhynchi, Preparing, 147.
Echinorhyncus clavæceps, Host of the Larva of, 459.
Edible Dipterous Larvæ from Alkaline Lakes, 53.
Edinger, L., Apparatus for Botanical Lectures, 312.
——, Preparations of the Central Nervous System for Projection, 146.
Egg, Bird's, Formation of Blastoderm in, 615.
——, Development of, and Formation of the Primitive Layers in Cuma Rathkii, 238, 641.
——, Fowl's, Electromotive Function of, 34.
Egg-shell in Dogfish, Formation of 425.
Eggs, Birds', Colours of, 618.
——, ——, Hatching of, after Lesion of the Shell, 784.
——, Incubating Hen's, Physiological purpose of Turning, 617.
—— of Ascidians, 987.
—— of Cephalopoda, Preserving, and preparing Blastoderms, 1083.
—— of Spider, Treatment of, 1083.
Ehlers, "Rauschbrandpilz," a parasitic cattle-disease, 300.
Ehrenbaum, E., Preparing Thin Sections of Shells and Teeth, 348.
——, Structure and Formation of the Shell of Lamellibranchs, 44.
Ehrlich, Susceptibility of the Different Tissues to Colouring Matters, 554.
Elasticity in the Filaments of Helianthus, 268.
—— in the Fruit of Cactaceæ, 1027.
—— of Cell-walls under Tension, Behaviour of the Optical Axes of, 476.
Elaters of Hepaticæ, 682.
Electric Lamp, New, 339.
—— Light, Homologous Sections and Molecules, 337.
—— —— in Microscopy, 1080.
—— ——, Stein's Microscopes for use with, 303.
Electrical Apparatus, Microscopical, 867.
—— Illumination, Helot-Trouvé Apparatus for, 864.
Electricity, Influence of, on the Growth of Plants, 835.
—— under the Microscope, 1078.
Electromotive Function of the Fowl's Egg, 34.
Elfving, F., Ascent of Water in Plants, 274.

Ellis, A. J., 1079.
Elsner, F., 140.
Elytra of some Polynoina, 456.
Embryo, Human, Tail of, 781.
—— of Peripatus Edwardsii and P. torquatus, Preparing, 734.
——, Orientation of, and Formation of the Cocoon of Periplaneta orientalis, 991.
Embryo-sac of Santalum and Daphne, 830.
Embryology of Vertebrata. See Contents, viii.
Embryonic Forms of Gadinia garnotii, 224.
—— Membranes of Marsupials, 34.
Embryos and Ova of the Aphides, Treatment of, 147.
—— of Amarœcium proliferum, Preparing, 731.
—— of Limacina, Nervous System of, 228.
—— of Physoclist Fishes, Translocation forwards of the Rudiments of the Pelvic Fins in, 618.
——, Preparing, 729.
Emery, C., Preparing Luciola italica, 733.
Emmerlich, R., Pneumonia-cocci in Dormitories as a Cause of Pneumonia, 300.
Emmerling, A., Formation of Albumen in Green Plants, 274.
Enal, 530.
Endoskeletal and Muscular Systems of Limulus and Scorpio, 992.
Endosperm and Cotyledons, Comparative Anatomy of, 481.
——, Development of, in Hordeum, 485.
Engelmann's Electrical Apparatus, 874.
Enteric Glands in the Crustacea, 61.
Enterochlorophyll and Allied Pigments, 621.
Enteropneusta, Affinities of, 461.
Entomogenous Fungus, New, 505.
Entomophthoreæ, Conidiobolus a new Genus of, 106.
Entz, G., Infusoria of the Gulf of Naples, 80.
——, Tintinnodea, 470.
Enzyma and Ferments, 1031.
Eosin and Ribesin, 342.
Ephemera Larvæ, Circulation in, 637.
Epicrium, Development of, 618.
Epidermic Cells of Tadpoles, 977.
Epidermis, Formation of Centrifugal Thickenings in the Walls of Hairs and in, 267.
——, Mechanical Function of, 91.
——, Normal Human, Microphytes of, 849.
Epidermis of Petals, 481.
—— of the Leaves of Aquatic Plants, 674.
Epipodium of Gastropoda, 223.
Epithelial Tissues, Demonstration of Karyokinesis in, 730.
Epithelium, Cloacal, of Scyllium Canicula, Preparing 731.
——, Intercellular Spaces and Bridges in, 221.
——, —— —— of, and their significance in Pulmonate Mollusca, 435.
——, Wandering Cells in, 980.
Equisetaceæ, Composition of the Ash of, and its Bearings on the Formation of Coal, 681.
Equisetum, Node of, 840.
——, Stomata of, 99.
——, Transitional, 681.
Ericaceæ, Opening of Anthers in, 675.
Eriksson, J., New Fungus-parasite on the Rose, 847.
Erlicki's Hardening Solution, 341.
Ermengem, E. van, 140, 336.
——, Cholera-bacillus, 113, 851.
——, Inoculation of Guinea-pigs with Comma-Bacillus, 509.
Erosion of the Surface of Glass, when exposed to the Joint Action of Carbonate of Lime and Colloids, 761.
Errera, L., 140.
——, Glycogen in the Basidiomycetes, 503.
——, Hydrocarbon Reserve-products of Mushrooms, 1044.
——, Law of Growth of the Fructification of Phycomyces, 288.
Error, Sources of, in the Examination of Fresh Tissues, 896.
Erythropsis agilis, 77, 255, 1016.
Eternod, A., 726.
——, Microtome with Triple Pincers, 900.
Etiology of Tuberculosis, 851.
Etti, 564.
Eucalyptus globulus, Heterophylly of, 1025.
Euglena, Preparing, 539.
Euphorbiaceæ, Anatomy of, 824.
European Sphagnaceæ, 281.
Entima mira, Life-history of, 251.
Evaporative Surfaces of Plants and Influence of Moisture in Soils on Plant Growth, 486.
Evergreen Plants, Behaviour of Leaf-trace-bundles of, as the stem increases in thickness, 826.
Ewart, J. C., 564.
—— and G. Brook, Spawning of the Cod, 786.
Ewell, M. D., 140.

Ewell, M. D., Measurement of Blood-corpuscles, 1105.
—— and H. L. Tolman, Eye-piece Micrometers, 704.
Examining Objects. See Contents, xxxviii.
Excretion of Healing Substances into Wounds, 476.
Excretory Organs of Nemertines, 244.
—— —— of Worms, 243.
Exhibitions, Microscopical, 926.
Exner, S., 530.
Exogens, Growth of the Thickening-ring in, 478.
——, Relation of Annual Rings of, to Age, 1023.
Eye and Optic Tract of Insects, 633.
——, Microscopical Technique of, 895.
——, Morphology of, and Compound Vision, in Insects, 234.
—— of Gastropoda, 222.
Eye-piece Micrometers, 704.
Eye-pieces of Binoculars, Adjusting, to eyes of unequal focal length, 1065.
—— ——, Report on, 338.
—— ——, Standard, 322.
Eyes, Compound, and Multiple Images, 356.
——, Keeping both, open in Observation, 881.
—— of Annelids, Preparing, 1110.
—— of Chitonidæ, 224.
—— of Gasteropods, Preparing, 895.
—— of some Invertebrata, 39.
Eyferth, B., 564.

F.

F. R. M. S., Oblique Illuminations, 130.
F., W., 140.
——,Osborne's Diatomescope. Modified Wenham Disk Illuminator, 128.
Fabre-Domergue, P., 564, 746.
——, Current Apparatus, 526.
Famintzin, A., Development of the Sclerenchymatous Fibres of the Oleander, 478.
——, Siliceous Membrane with Properties of the Cell-wall, 263.
Fasoldt, C., 889.
Fat Absorption, Study of, in the Small Intestine, 731.
Fats and Butter, Examination of, 356.
Fauna of Shallow Seas, Influence of Wave-currents on, 38.
Feathers, Acari inhabiting the Quill of, 236.
——, Histology of, 35.
Febiger, C., 1109.
Fecundation, Artificial, of Mollusca, 623.
—— in Cephalopoda, 983.
—— of Ovules in Angiosperms, 270.
Feeding Insects with Curved or "Comma" Bacillus, Further Experiments on, 941.
Fell, G. E., 336.
Fellows, H., Organs of Bojanus in Anodonta, 795.
Female and Male Plants, Production of, 677.
—— Receptacle of Corsinia, Exudation of Water from, 1035.
Ferment, Ammoniacal, 680.
——, Lactic, on some unusual forms of, 205.
——, Penicillium, in Pharmaceutical Extracts, 1046.
Fermentable Liquids, Sterilization of, in the Cold, 562.
Fermentation and Decomposition of Milk, 1048.
—— by Schizomycetes, Influence of Oxygen on, 850.
—— Odour and Poisonous Effects of, produced by the Comma Bacillus, 298.
Fermenting Fungus, New, 292.
Ferments, 849.
——, Alcoholic, Preservation of, in Nature, 114.
—— and Enzyma, 1031.
——, Effect of High Pressures on the Vitality of, and on Fermentation, 693.
——, Mould-fungi as, 1045.
——, Peptonizing, in Secretions, 491.
Ferns and Phanerogams, Vegetative Organs of, 93.
——, Apospory in, 99, 491.
——, Bursting of Sporangium of, 1032.
——, Dorsiventral Development of Organs, and Growth at the Growing Point of, 276.
Ferran, J., Morphology of the Comma Bacillus, 1051.
Fertilization in Campanula americana, 1028.
—— of Asclepias Cornuti, 834.
—— of Cryptonemiaceæ, 683.
—— of Naias and Callitriche, 677.
—— of the Wild Onion, 1028.
——, Problem of, and of the Isotropy of the Ovum, 421.
Fertilizers, Insects as, 990.
Feuilleaubois, Structure of Phallus impudicus, 505.
Fever, Typhoid, Examining Blood in, 1104.
——, ——, Human, Microbe of, 299, 1052.
——, Yellow, Microbe of, 694.
Fewkes, J. W., Development of Agalma, 1009.
——, Larval forms of Spirorbis borealis, 644.

Fibres of certain Australian Hircinidæ, 254.
——, Sclerenchymatous, of the Oleander, Development of, 478.
Fibrovascular Bundles, Cortical, of Viciæ, 266.
—— —— of Cycadeæ, 1023.
Field, A. G., Mounting Urinary Deposits, 365.
Fielde, A. M., Tenacity of Life and Regeneration of Excised Parts in Lumbricus terrestris, 455.
Figs, Gummosis of, 1053.
Filaria sanguinis hominis, Metamorphosis of, in the Mosquito, 65.
Filter, Francotte's Paraffin, 343.
Filtering Minute Quantities, 1103.
——, Removal of Microbes by, 561.
Finder, 1103.
——, Francotte's, 325.
Finkler and Prior, Cholera Bacillus, 1050.
Firket, C., 925.
Firmness of Tissues, 476.
Firtsch, G., Geotropic Sensitiveness of the Apex of the Root, 96.
Fisch, C., Development of Ascomyces, 689.
——, —— of Doassansia, 502.
——, Flagellata and allied Organisms, 1016.
——, New Chytridiaceæ, 846.
——, Systematic Independence and Position of Saccharomyces, 294.
——, —— Position of the Bacteria, 850.
Fischer, A., Sieve-tube System of Cucurbitaceæ, 477.
——, Sieve-tubes in the Leaves of Dicotyledons, 1020.
——, Starch in Vessels, 671.
——, E., Development of the Gasteromycetes, 501.
——, G., 140.
——, H., Comparative Anatomy of the Tissue of the Medullary Rays and Annual Zones of Growth in Conifers, 826.
——, P. M., and J. Bichringer, Imbedding and Examining Trematodes, 735.
Fishes, Osseous, Development of the Rays of, 213.
——, ——, Primitive Streak in, 425.
——, Parasites of Fresh-water, 617.
——, Physoclist, Translocation forwards of the Rudiments of the Pelvic Fins in Embryos of, 618.
——, Phytophagous, as Disseminators of Algæ, 813.
——, Viviparous Osseous, Development of, 978.
Fissurella, Anatomy of, 985.
——, Nervous System of, 624.
Fixing Objects to the Cover-glass, 1097.
Flagellata and allied Organisms, 1016.
—— (Dinobryon) as Members of the Pelagic Fauna of Lakes, 258.
Flagellate Infusorian parasitic on Trout, 82.
Flahault, C., 746.
——, Aulosira, 692.
——, Lithoderma fontanum, a New Fresh-water Phæospore, 285.
Flask-animalcule, 818.
Flax and Sweet Almond, Germination of, 271.
Fleischer, E., Protection of Leaves from excessive Transpiration, 1025.
Fleischl, E. v., 1079.
Fleischmann, A., Movement of the Foot in Lamellibranchs, 437.
Flemming, W., 364.
——, Division of the Nucleus, 86.
——, Formation of Spindles in Mammalian Ova during the Degeneration of the Graafian Follicle, 975.
——, Staining Technique, 554.
Flesch, M., 140, 162.
——, Application of the Colouring Matter of Red Cabbage in Histology, 558.
Flies, Movement of, on Smooth Surfaces, 636.
Flight of Insects, 988.
——, Size of the Surfaces of Organs of, 221.
Floral Envelopes, Homology of, in Gramineæ and Cyperaceæ, 676.
Floridea, New Epiphytic, 842.
Florideæ of the Mediterranean, 102.
Floscularia, Four new Species of, 608.
——, New, 250.
Flowers, Colouring-matters of, 264.
—— of Desmodium sessilifolium, Opening of, 1026.
Fluorescence of Chlorophyll in Leaves, 88.
Focal Depth with the Binocular, 726.
Foci, Actinic and Visual, 331.
——, —— ——, in Photo-micrography with High Powers, 1070.
Foerste, A. F., Nectar-Glands of Apios tuberosa, 269.
——, Fertilization of the Wild Onion, 1028.
Fœtal Appendages of Mammals, 423.
Fœttinger, A., 1109.
——, Histriobdella homari, 456.
Fœtus of Gibbon and its Placenta, 783.
——, Passage of Pathogenous Microbes from the Mother to, 296, 1051.
Foex, G., and P. Viala, "Pourridié" of the Vine, 107.

Fol, H., 141, 746.
——, Cell-continuity, 426.
——, Chromatine in Cell-division, 263.
——, Determination of the Number of Germs in Air, 561.
——, Injection-table, 1092.
——, Microscopic Anatomy of Dentalium, 623.
——, New Method for the Transfer of Sterilized Broths, and the Determination of the Number of Living Germs in Water, 359.
——, Parabolic Mirror for Correction of too hard or too soft Paraffin, 344.
——, Ribesin and Eosin, 342.
——, Tail of Human Embryo, 781.
—— and P. L. Durrant, Effect of Prolonged Repose and Filtration through Porcelain on the Purity of Water, 561.
Foliage, Autumnal, 272.
——, ——, Tints of, 97.
Folin, de, New Condition of Reticular Rhizopods, 1017.
—— Structure of Reticular Rhizopods, 471.
Food, Essential, of Plants, 1029.
Food-Material, Circulation and Rotation of Protoplasm as a Means of Transport of, 665.
—— ——, Penetration of the Mechanical Ring for the Transport of, 479.
Foot in Lamellibranchs, Movement of, 437.
Foot-glands of Insects, 989.
Foraminifera Slides, Balkwill's, 1084.
Fore-gut of Arachnida, Structure of, 56.
Forel, A., Sensorial Organs of the Antennæ of Ants, 441.
——, F. A., Deep Fauna of Swiss Lakes, 238.
Forestry, Spiders in Relation to, 450.
Formative Force of Organisms, 780.
Forssell, K. B. J., Anatomy and Development of Lecanora granatina, 1043.
Foslie, M., Laminariaccæ of Norway, 1039.
Fossil Marine Diatoms, 1042.
Foucault's and Ahrens' Polarizing Prisms, Madan's Modification of, 328.
Foul Brood, Bacillus alvei the cause of, 581
Foulerton, J., 726.
Fourment, L., New Nematoid from Merlangus, 646.
Fourot, Adamsia palliata, 816.
Fowke, F., First Discovery of Comma-bacillus of Cholera, 383.
Fraipont, J., Nervous System of Archiannelides, 62.
Fraisse, Chromatine in Cell-division, 263.
France, Mosses of, 281.
Franchet, A., South American Isoetes, 279.
Francotte, P., 336, 364, 565.
——, Finder, 325.
——, Imbedding in Paraffin by Means of a Vacuum, 149.
——, Improvements in Microtomes and Knives, 347.
——, Paraffin Filter, 343.
Frank, B., Formation of Gum in Wood, 88.
—— and M. Woronin, Nutrition of Trees by Means of Underground Fungi, 844.
Frankel, B., Staining of Koch's Bacillus, 557.
Frankland, P. F., Removal of Micro-organisms from Water, 923.
Fraser, A. T., Autumnal Foliage, 272.
Frazer, P., 746.
Freia Ampulla, 818.
Freire, D., and Rebourgeon, Microbe of Yellow Fever. 694.
Freud, S., Method for Displaying the Course of the Fibres in the Central Nervous System, 159.
Frenzel, J., Alimentary Canal of Crustacea, 994.
——, Enteric Glands in the Crustacea, 61.
——, Marine Gregarinidæ, 471.
——, Mid-gut Gland (Liver) of the Mollusca, 792.
——, Temperature Maxima for Marine Animals, 791.
Fresh Tissues, Sources of Error in the Examination of, 896.
Freudenreich, de, Purity of Air in Alpine Regions. Resistance of Aerial Bacteria to Cold, 511.
Frey, J., death of, 336.
Friedrich, K., 336, 1079.
Fries' Nomenclature of Colours in the Agaricini, 105.
Fritsch, G., Anatomy of Bilharzia hæmatobia, 1003.
——, Monocular Stereoscopic Vision, 332.
Frog, Apparatus for comparing symmetrical parts of the Webs of the right and left Feet of, 879.
——, Ova of, Demonstrating Spindle-shaped Bodies in the Yolk of, 895.
Frogs, Spindle-shaped Bodies in the Yolk of Young Ova of, 213.
Frommann, C., Changes in the Cell-walls of Epidermal Cells and in the Hairs of Pelargonium zonale, 668.
——, Structure, Vital Phenomena, and Reactions of the Cell, 86.

Fructification of Phycomyces, Law of Growth of, 288.
—— of Sigillaria, 493.
Fruit of Cactaceæ, Elasticity in, 1027.
—— of Ranunculaceæ, Anatomy of, 831.
Fruits, Bursting of ripe, 481.
——, Colouring-matters of, 264.
Frullania, Development of the Sporangium of, 840.
Fucaceæ, Chlorophyll of, 282.
——, Chlorophyll-green of, 1038.
——, Protoplasmic Continuity in, 682.
Fünfstück, M., Development of the Apothecia of Lichens, 499.
——, Formation of Thalli on the Apothecia of Peltidea aphthosa, 843.
Fulgur perversus, Spawning of, 986.
Fungi. See Contents, xxix.
Fur Fibres, Construction of, 173.

G.

G., E. P., 1079.
Gadinia garnotii, Nervous System and Embryonic Forms of, 224.
Gaffky, Artificial Attenuation of Bacillus anthracis, 696.
Gage, S. H., 365, 925.
Galeodes, Presence of Coxal Gland in, 236.
Galloway, D. H., Spores of Lycopodium, 839.
Galls, Cecidomyia, on Poa, 1026.
——, Tannin and Lignin in, 1020.
Galvanotropism, 1032.
—— of Roots, 836.
"Gamma Sigma," 336.
Gannett's (W. W.) Dripping Apparatus, 900.
Garbini, A., 141.
Garrison, F. L., 1109.
Gärtner, G., 727.
Gas Chambers, Pringsheim's, 720.
Gases, Deviation of Roots from their Normal Direction through the influence of, 96.
Gasteromycetes, Development of, 501.
Gastropoda, Epipodium of, 223.
——, Eye of, 222.
——, ——, Preparing, 895.
Gautier, A., Sterilization of Fermentable Liquids in the Cold, 562.
Geissler Tube, Microscopic, 367.
Gelsemium sempervirens, Internal Cambium Ring in, 478.
Geminella interrupta, 285.
Gems, Cut, and Diamonds, Examining, 1108.
Gendre, A. v., Electromotive Functions of the Fowl's Egg, 34.
Generative Organs of Pulmonata, Development of, 623.
Genoa, Protozoa of the Gulf of, 256.
Geology, the Microscope in, 921.
George, C. F., 141.
Geotropic and Heliotropic Torsion, 95.
—— Phenomena, Secondary, 273.
—— Sensitiveness of the Apex of Root, 96.
Geotropism, Influence of Light on, 491.
Gerlach, L., Hatching of Birds' Eggs after Lesion of the Shell, 784.
——, Imbedding Small Objects, 541.
Germinal Vesicle, Staining the Nucleus of, in Arthropoda, 905.
Germination and Genetic Cycle of Anchinia, 630.
—— and Growth of Plants, Effect of Depth of Sowing on, 93.
—— and Spore-coats of Hepaticæ, 101.
——, Behaviour of Tannin in, 272.
—— of Flax and Sweet Almond, 271.
—— of Seeds, Influence of Light on, 93.
—— of Spores of Merulius lacrymans, 845.
Germs in Air, Determination of the Number of, 561.
——, Influence of Sunlight on the Vitality of, 508.
——, Living, Determination of the Number of, in Water, 359.
Giacomini, C., 162.
——, Microscope with Large Stage, 515.
——, Modified Hardening Process for the Central Nervous System, 340.
Gibbes, H., 1109.
Gibbon, Fœtus of, and its Placenta, 783.
Gierke, H., 565, 925, 1109.
——, Staining for Microscopical Purposes, 554, 900.
Gilbert, J. H., and W. J. Russell, Conditions of the Development and of the Activity of Chlorophyll, 1020.
Giles, G. M., 162.
——, Live-cell, 135.
Gill, T., Oviparous Reproduction in the Monotremes, 33.
Gill in Neptunea, 226.
Gill-book of Limulus, New Hypothesis as to the Relationship of the Lung-book of Scorpio to, 639.
Gillo, R., Mounting Insects without Pressure, 732.
Giltay, E., 141.
——, Peculiar Structure of Protoplasm in Paratracheal Parenchyma 1020.
——, Remarks on Prof. Abbe's "Note on the proper Definition of the Amplifying Power of a Lens or Lens-system," 960.
Girard, A., Nutritive Properties of the Various Portions of the Grain of Wheat, 671.

Girod, P., Integument of Cephalopods, 40.
Gizzard of Larvæ of Corethra plumicornis, Uses and Construction of, 991.
Gland, Coxal, in the Phalangida, 58.
——, ——, Presence of, in Galeodes, 236.
——, Green, of Astacus fluviatilis, Extraction of Uric Acid Crystals from, 805.
——, Mid-gut (Liver) of the Mollusca, 792.
Glands, Byssogenous, in Lamellibranchs, 227.
——, Calcareous, of Plumbagineæ, 92.
——, Coxal, of Mygale, 639.
——, Enteric, in the Crustacea, 61.
——, Honey, Distribution of, in Pitchered Insectivorous Plants, 269.
——, Nectar, of Apios tuberosa, 269.
——, Spinning, of Saw-flies, 442.
——, Staining Salivary, 1095.
——, Unicellular, in the Cloaca of Rays, 221.
——, Vascular Development of, 787.
Glass, Erosion of the Surface of, when exposed to the Joint Action of Carbonate of Lime and Colloids, 381, 761.
——, Melted, and Water Lenses, 890.
—— Slips for Collecting, 364.
—— ——, Standard Thickness of, 329.
Glowworm, Luminosity of, 50.
Glycerin and Balsam Mounts, 353.
—— and Litharge as a Cement, 743.
Glycogen, Comparative Histo-chemical Observations on, 981.
—— in the Basidiomycetes, 503.
—— in "Vesicular Cells" of Molluscs, 986.
Gobi, C., Amœboideæ, 506.
Godfrin, J., Comparative Anatomy of the Cotyledons and Endosperm, 481.
Godlewski, E., Movement of Water in Plants, 490.
Goebel, K., Tetramyxa parasitica, 292.
Göthe, R., "Cancer" of Apple-trees, 106.
Götte, A., Development of Spongilla, 254, 817.
Golgi, C., Preserving Sections of the Nervous System treated with Bichromate of Potash and Nitrate of Silver, 731.
Gongrosira, 103.
Goniometer and Analysing Prism, Böcker's Holder for, 705.
Goodale, G. L., 1110.
Goodwin, W., 746.
Gordius verrucosus, 1002.
Gosse, P. H., 163.
Gottschau, M., Advantages and Disadvantages of Different Forms of Microtome, 541.
Govi, Discovery of Pseudoscopy, 722.
Gowen's (F. H.) Microtome, 899.
Graafian Follicle, Formation of Spindles in Mammalian Ova during the Degeneration of, 975.
Graber, V., Preparing Eyes of Annelids, 1110.
——, Sense of Colour and of Brightness in Animals, 38.
Graff, L. v., 'Challenger' Myzostomida, 68.
——, New Species of Myzostoma, 814.
Gram, C., 163.
Gramineæ and Cyperaceæ, Homology of Floral Envelopes in, 676.
Grant, F., 565, 747, 889.
Gravis, A., Cutting Ribbons of Sections, 157.
——, Vegetative Organs of Urtica dioica, 833.
Gravitation, Influence of, on the Movements of Stamens, 272.
Gravity, Influence of, on Cell-division, 426.
Gray, A., Movements of Androecium in Sunflowers, 268.
Gray, S., 889.
——, Water Microscopes, 1079.
——, W. J., Balsam of Tolu for Mounting, 160.
Greely Arctic Expedition, 1115.
Green Plants, Formation of Albumen in, 274.
Gregarine, New, 471.
Gregarines, Development of Monocystid, 665.
Gregarinidæ, Marine, 471.
Gregory, J. W., 747.
Grenacher, H., Retina of Cephalopoda, 41.
Griesbach, H., Inception of Water among Mollusca, 794.
Griffin, F. W., 141.
Griffith, E. H., 141, 336, 365, 727.
——, A beautiful Slide, 163.
——, Mechanical Finger Objective, 709.
——, Microscopist's Working Cabinet, 365.
Griffiths, A. B., Extraction of Uric Acid Crystals from the Green Gland of Astacus fluviatilis, 805.
——, Pancreatic Function of the Cephalopod Liver, 622.
——, Physiology of the Alimentary Canal of Blatta periplaneta, 991.
—— and H. Fellows, Organs of Bojanus in Anodonta, 795.
Grosglik, S., Influence of Light on the Development of the Assimilating Tissue of Leaves, 266.
Grove, W. B., Pilobolidæ, 292.

Growing Point of Dorsiventral Ferns, Development of Organs and Growth at, 276.
—— Slide, 335.
—— the Spores of Botrychium ternatum, 1109.
Growth and Germination of Plants, Effect of Depth of Sowing on, 93.
——, Annual Zones of, and Medullary Rays in Conifers, Comparative Anatomy of Tissue of, 826.
——, Apical, of Phanerogams, 487.
——, ——, of Root of Todea, 839.
—— of Plants, Influence of Electricity on, 835.
—— ——, Influence of Water on, 93.
—— of the Fructification of Phycomyces, Law of, 288.
—— of Vegetable Organs, Laws of: Roots, 272.
——, Plant-, Influence of Moisture in Soils on, 486.
Gruber, A., Artificial Division of Infusoria, 472, 658.
——, Multinucleated Protozoa, 467.
——, Protozoa of Gulf of Genoa, 256.
——, Studies in Amœbæ, 260.
Grunow, J., Abbe Condenser, 1065.
Gryllotalpa, Development of, 798.
Guébhardt, A., 141.
Guignard, L., Division of the Cell-nucleus in Plants and Animals, 666.
——, Structure and Division of the Cell-nucleus, 262, 474.
Guignet, Chlorophyll and its Combinations, 822.
Guillebeau, A., Fungus-disease in Daphnia, 1046.
Guinea-pigs, Inoculation of, with Comma Bacillus, 509.
—— ——, Vesiculæ seminales of, 35.
Gum, Formation of, in Wood, 88, 89.
Gümbel, v., Shells of Molluscs, 228.
Gum-canals of the Sterculiaceæ, 827.
Gummosis of Figs, 1053.
Gundlach, E., 141, 531, 727.
——, "An Improvement in Objectives," 705, 863.
Gunning, J.W., Examination of Potable Waters, 923.
Gymnosperms, Pollen of, 484.

## H.

Haacke, W., 747, 926.
——, Dehydrating Apparatus, 148.
——, Morphology of Echinoids, 1008.
——, Oviparous Reproduction in the Monotremes, 33.
——, Pseudorhiza Haeckelii, 71.
Haberlandt, G., Conduction of Water in the Stem of Mosses, 681.
Haberlandt, G., Physiological Anatomy of Plants, 677.
Häckel, E., Origin and Development of Animal Tissues, 426.
Haddon, A. C., Generative and Urinary Ducts in some Chitons, 42.
Hæmatoxylin, New Application of, 158.
—— Staining Fluid, Method of Preparing, 741.
——, Staining with, 1095.
Hæmatozoa in Cold-blooded Animals, 472.
Hailes, H. F., 365.
Hairs, Formation of Centrifugal Thickenings in the Walls of, 267.
——, Histology of, 35.
——, Microscopically examined and Medico-legally considered, 429.
—— of Pelargonium zonale, Changes in, and in the Cell-walls of Epidermal Cells, 668.
Halia priamus Risso, Anatomy and Systematic Position of, 624.
Halicryptus, Skin and Nervous System of, 645.
Haliotis, Natural History of, 43.
Halisarca lobularis, Development of, 73.
Haller, B., Renal Organ of Prosobranchiata, 793.
——, G., Descriptions of New Acarina, 449.
Hallez, P., Development of Nematodes, 809.
——, Orientation of the Embryo and Formation of the Cocoon of Periplaneta orientalis, 991.
Halliburton, W. D., Chemical Composition of Zooeytium versatile, 818.
——, Chitin as a Constituent of the Cartilages of Limulus and Sepia, 222.
Hallier, E., Apparatus for Botanical Lectures, 312.
Halteres of Diptera, Structure of, 636.
Hamann, O., Histology of Asterida, 652.
——, New Carmine Solution, 740.
Hamlin's (F. M.) Ideal Slide, 743.
Hanaman, C. E.,White Zinc for Mounting, 163.
Hand-Lens, Test for, 720.
Handle for Cover-glasses, 1115.
Hanks, H. G., New Diatomaceous Deposit at Santa Monica, 173.
Hansen, A., Chlorophyll, 87.
——, Chlorophyll of Fucaceæ, 282.
——, Chlorophyll-green of Fucaceæ, 1038.
——, Colouring-matters of Flowers and Fruits, 264.

Hansen, A., Ferments and Enzyma, 1031.
——, Peptonizing Ferments in Secretions, 491.
——, Supply of Air to the Roots and Root-pressure, 490.
——, Transpiration-currents, 1032.
——, E. C., Counting of Microscopic Objects for Botanical purposes, 744.
——, Ferments, 849.
——, New Fermenting Fungus, 292.
——, G. A., Sponges of the Norwegian North Sea Expedition, 658.
Hansgirg, A., Algæ of Bohemia, 684.
——, Classification of the Lower Algæ, 495.
——, Distribution of Chromatophores and Nuclei in the Schizophyceæ, 691.
——, Polymorphism of Algæ, 1037.
Hard Organized Substances, Rapid Method of making Sections of, 553.
Hardening Process, Modified, for the Central Nervous System, 340.
—— Solution, Erlicki's, 341.
Hard-rubber Cells, 925.
Hardy, J. D., 365, 727.
——, Direct Vision Camera, 336.
——, Improved Collecting-bottle, 145.
Hare, A. W., 747.
Harker, A., Coloration of the Anterior Segments of the Maldanidæ, 999.
Harmer, S. F., Method for the Silver Staining of Marine Objects, 160.
——, Structure and Development of Loxosoma, 631.
Harris, V. D., Method of Preparing Permanent Specimens of Stained Human Blood, 537.
Harrison, W. J., 565.
Hart, C. P., 1110.
——, Microtome-Microscope, 861.
Hartig, R., Dry-rot, 505.
——, Germination of the Spores of Merulius lacrymans, 845.
Harting's Electrical Apparatus, 871.
Hartwich, C., Tannin and Lignin in Galls, 1020.
Hartlaub, C., Origin of Sexual Cells in Obelia, 250.
Hartog, M. M., Morphology of Cyclops and Relations of the Copepoda, 452.
——, Nature of Lichens, 500.
Hastings, C. S., 889.
Haswell, W. A., 163, 1110.
——, Anatomy of the Serpulea, with Characteristics of Australian Species, 241.
——, Australian Pycnogonida, 994.
——, —— Crustacea, 998
——, Crustacean Inhabiting the Tubes of Vermilia, 238.
Haswell, W. A., Imbedding in Paraffin, 1096.
——, Parasite of the Rock Oyster, 1000.
——, Segmental Organs of Serpula, 458.
——, Staining with Hæmatoxylin, 1095.
——, Symbiosis of Worms and Sea Anemones, 982.
Hatfield's (J. J. B.) Rotary Section-cutter, 735.
Hatschek, B., Development of the Head of Polygordius, 808.
Hauser, G., Development and Pathogenous Properties of a Bacterium, 852.
——, Pleomorphy of Pathogenic Bacteria, 1049.
Haushofer, K., 365, 926.
——, Filtering Minute Quantities, 1103.
——, Microscopical Reactions, 1106.
Haustoria of Parasitic Phanerogams, 268.
Hawkins' (R.) Observatory Trough, 719.
Hay, O. P., 565.
——, Double Injections for Dissecting Purposes, 905.
——, —— —— for Histological Purposes, 906.
——, Modification of Semper's Method of making Dry Preparations, 898.
Hays, J. E., Finish for Slides, 744.
Head and Mouth of the Larva of Insects, 441.
Healing Substances, Excretion of, into Wounds, 476.
Heart, Development of, in Vertebrates and Invertebrates, 212.
Heat and Light, Influence of, on Plant Development, 485.
Heckel, E., Formation of Secondary Cortex, 673.
——, Mycological Monstrosities, 847.
—— and J. Chareyre, Anatomy of Pitcher-plants, 1024.
Hegelmaier, F., Wolffia microscopica, 834.
Heidenhain, R., New Application of Hæmatoxylin, 158.
Heinricher, E., Idioblasts containing Albuminoids in some Cruciferæ, 672.
——, Reduced Organ in Campanula, 675.
Helianthus, Elasticity in Filaments of, 268.
Helicinæ, Uropneustic Apparatus of, 225.
Helicobasidium, a new Genus of Hymenomycetes, 1045.
Heliotropic and Geotropic Torsion, 95.

Heller, Sources of Error in the Examination of Fresh Tissues, 896.
Hellriegel, H., Evaporative Surfaces of Plants and Influence of Moisture in Soils on Plant Growth, 486.
——, Influence of Light and Heat on Plant Development, 485.
——, —— —— Water on Growth of Plants, 93.
Helmholtz, H. L. F., 1079.
Hélot-Trouvé Apparatus for Electrical Illumination, 864.
Henking, H., 163, 1110.
Henneguy, L. F., Flagellate Infusorian parasitic on Trout, 82.
——, New Ciliated Infusorian, 79.
——, Primitive Streak in Osseous Fishes, 425.
Hennum, J. O., Forms of Cells, 820.
Hénocque, 889.
——, Illumination for Projection Microscopes, 866.
Henshall, W., 365.
Hepaticæ, Elaters of, 682.
——, Spore-coats and Germination of, 101.
Hepworth, T. C., 141.
Hérail, J., Structure of Stem of Strychnos, 828.
Herdman, W. A., Evolution of the Blood-vessels of the Test in Tunicata, 230.
——, Phylogenetic Classification of Animals, 221.
——, Structure of Sarcodictyon, 253.
Heredity, Significance of Cell-nuclei in the Processes of, 975.
Hericourt, J., Curved Bacilli in Air and Water, 697.
Hermann, L., Electromotive Function of the Fowl's Egg, 34.
Hermaphroditism of the Male of Trombidium, 58.
Hertwig, O., Demonstrating Spindle-shaped Bodies in the Yolk of Frog's Ova, 895.
——, Influence of Gravity on Cell-division, 426.
——, Problem of Fertilization and of the Isotropy of the Ovum, 421.
——, Spindle-shaped Bodies in Yolk of Young Ova of Frogs, 213.
——, R., Erythropsis agilis, a New Protozoon, 77, 255.
Hervey, A. B., 727.
Hesse, R., Cryptica, a New Genus of Tuberaceæ, 105.
——, Hysterangium rubricatum, a New Hymenogaster, 505.
——, New or Rare Crustacea, 453.
Heterophylly of Eucalyptus globulus, 1025.
Heteropods, Histology of, 42.
Heurck, H. van, 141, 336, 531, 747, 890, 1080.
——, Amphipleura pellucida resolved into "Beads."—Nature of the Striæ of Diatoms, 169, 173.
——, Beads of Amphipleura, 380.
——, Hélot-Trouvé Apparatus for Electrical Illumination, 864.
——, Oblique Illuminators, 129.
——, Small Camera, 529.
——, Structure of the Diatom-valve, 498.
——, Synopsis of the Diatoms of Belgium, 686.
Hibernation of Zygnemaceæ, 284.
Hick, T., Methods for observing Protoplasmic Continuity, 540.
——, Protoplasmic Continuity in Fucaceæ, 682.
Hickson, S. J., Compound Vision and Morphology of the Eye in Insects, 234.
——, Eye and Optic Tract of Insects, 633.
——, Method of Preparing Hæmatoxylin Staining Fluid, 741.
Hieronymus, G., Stephanosphæra pluvialis, 495.
Hildebrand, F., Protective Contrivances in the Bulbs of Oxalis, 92.
Hilgendorf, F., 747.
Hilger, C., Eye of Gastropoda, 222.
——, Preparing Eyes of Gasteropods, 895.
Hiller, G. H., Epidermis of Petals, 481.
Hillhouse, W., Intercellular Relations of Protoplasts, 84.
Hincks, T., New Polyzoa, 439.
Hinton, E., 747.
Hippisley, J., A Pocket Field Microscope, 890.
——, Water and Melted Glass Lenses, 890.
Hircinidæ, Fibres of certain Australian, 254.
Hirst, G. D., 141.
Hirudinea, Organization of, 807.
Histology of Vertebrata. See Contents, viii.
Histriobdella homari, 456.
Hitchcock, R., 142, 163, 337, 338, 365, 531, 727, 747, 890, 926, 1080.
——, Microscopical Exhibitions, 926.
——, —— Societies, 332.
——, Mounting in Phosphorus, 353.
——, Multiplying Drawings, 527.
——, Optical Arrangements for Photo-Micrography, and Remarks on Magnification, 1070.
——, Schröder's Camera Lucida, 140.
—— Simple Culture-chamber, 163.

Hitchcock, R., White Zinc Cement, 163, 363.
Hoek, P. P. C., Anatomy of Cirripedia, 641.
——, 'Challenger' Cirripedia, 61.
——, Development of the Oyster, 226.
Hoffman, H., Production of Male and Female Plants, 677.
Hogg, J., 1080.
——, Indestructible Infusorial Life, 39.
Höhnel, F. v., Influence of Cortical Pressure on the Bast-fibre, 89.
——, Rapid Method of making Sections of hard Organized Substances, 553.
——, Striated Woody Tissue, 828.
Holdefleiss, Influence of Electricity on the Growth of Plants, 835.
Holl, M., Tolu instead of Chloroform for Imbedding in Paraffin, 541.
Holmes, E. A., 727.
——, O. W., 531.
Holothurians, Variations in, 1007.
Holzner, G., Contribution to the History of Staining, 553.
Homing Faculty of Hymenoptera, 990.
Homologous Sections, Electric Light, and Molecules, 337.
Honey-Glands, Distribution of, in Pitchered Insectivorous Plants, 269.
Hordeum, Development of Endosperm in, 485.
Horner, J., 747, 1110.
Horst, R., Development of the Viviparous Edible Oyster, 436.
——, Problematical Organ in Chloræmidæ, 457.
Hour of the Day, Recognition of, by Marine Animals, 431.
Howes, G. B., Atlas of Practical Elementary Biology, 787.
Hoyle, W. E., Loligopsis and Allied Genera, 984.
——, New Cephalopoda, 984.
——, New 'Challenger' Cephalopoda, 435.
——, Preserving Eggs of Cephalopoda and Preparing Blastoderms, 1083.
Hübrecht, A. W., Development of Nemertines, 1004.
——, Excretory Organs of Nemertines, 244.
Hudson, C. T., New Floscularia, 250.
——, On Four New Species of the Genus Floscularia, and Five other New Species of Rotifera, 608.
Hunt, A. R., Influence of Wave-currents on Fauna of Shallow Seas, 38.
——, G., 337.
——, Right-angled Prism instead of a Plane Mirror, 709.
Hunter, J. J., 727.
Hüppe, F., 365.
Hüppe, F., Decomposition and Fermentation of Milk, 1048.
Hussak, E., 365.
Hy, L'Abbé, Archegonium and Sporogonium of Muscineæ, 279.
Hyatt, J. D., Compound Eyes and Multiple Images, 356.
——, Hydrogen Peroxide as a Bleaching Agent, 340.
Hybridization and Cross-breeding of Plants, 1028.
Hybrids, Fertility of, 271.
Hyde, H. C., The Electric Light in Microscopy, 1080.
Hydrachnæ, Preserving, 364.
Hydrocarbon Reserve-products of Mushrooms, 1044.
Hydrochloric Acid, Formation of, in Plants, 274.
Hydrocyanic Acid, Production of, by Plants, 97.
Hydrogen Peroxide as a Bleaching Agent, 340.
Hydroid Zoophytes, Australian, 656.
—— —— of the 'Willem Barents' Expedition, 1881, 73.
Hydroids, Development of Male Germinal Cells in, 462.
Hydromedusæ, Australian, 252, 1011.
Hydrophobia, Bacilli of, 573.
Hymenogaster, Hysterangium rubricatum, A New, 505.
Hymenomycetes, Helicobasidium, a New Genus of, 1045.
Hymenoptera, Cameron's British Phytophagous, 440.
——, Homing Faculty of, 990.
——, Morphology of Mouth-organs of, 989.
——, Wings of, 234.
Hypertrophy of the Bud-cones of the Carob, 675.
Hypoblast, Origin of, in Pelagic Teleostean Ova, 214.
Hysterangium rubricatum, a New Hymenogaster, 505.

## I.

Ibiza, L. é, 565.
Ice, Organisms in, 40.
Idioblasts containing Albuminoids in some Cruciferæ, 672.
Idotea, New Species of, 454.
Ihering, H. v., Uropneustic Apparatus of Helicinæ, 225.
Ihl, A., 747.
——, Sensitive Tests for Wood-fibre and Cellulose, 897.
Illuminating Apparatus, Töpler's, 710.
—— Beam, Centering, 524.
Illumination, 713.

Illumination, Electrical, Hélot-Trouvé Apparatus for, 864.
—— for Projection Microscopes, 866.
—— of Microscopes and Balances, 328.
Illuminator, Beck's Vertical, Diaphragms for, 522.
——, Modified Wenham Disc, 128.
——, Stephenson's Cata-dioptric Immersion, 207, 523.
——, Ward's Iris, 326.
——, West's Adjustable Dark-ground, 523.
Illuminators Oblique, 129, 130.
Images in the Binocular Microscope, 1073.
Imbedding and Examining Trematodes, 735.
——, Bayberry Tallow for, 735.
—— in Paraffin, 1086, 1096.
—— —— by Means of a Vacuum, 149.
—— ——, Tolu instead of Chloroform for, 541.
——, Rapid, 150.
—— Small Objects, 541.
Imhof, O. E., Deep-water Turbellarians of Lakes, 1004.
——, Difflugia cratera, 819.
——, Flagellata (Dinobryon) as Members of the Pelagic Fauna of Lakes, 258.
——, Pelagic and Fresh-water Rotatoria, 814.
——, Sense-organs of Calanidæ, 997.
Immortality of Unicellular Organisms, 466.
Impressions of Plants, Tracks of Insects resembling, 635.
Indian Corn, Styles of, for Examining Movement of Protoplasm, 1106.
Inflorescence, Female, of Dion edule, Anatomy of, 832.
—— of Cuscuta glomerata, 1026.
Infusoria, Artificial Division of, 472, 658.
——, Fixing, Staining, and Preserving, 538.
——, Living, Employment of Colouring Matters in the Study of, 555.
——, New, 470.
——, —— Fresh-water, 80, 257, 659.
——, —— Parasitic, 81.
—— of the Gulf of Naples, 80.
Infusorial Life, Indestructible, 39.
—— Parasites of the Tasmanian White Ant, 662.
Infusorian, Flagellate, Parasitic on Trout, 82.
——, New Ciliated, 79.
—— Parasite, New, 81.
——, Supposed New, 1015.
Injecting the Arteries and Veins in Small Animals, Simple Method of, 1093.
Injection-table, Fol's, 1092.
Injections, Double, for Dissecting Purposes, 905.
——, ——, for Histological Purposes, 906.
Inostranzeff's Double Microscope, 1058.
Insecta. See Contents, xiii.
Insectivorous Plants, Pitchered, Distribution of Honey-glands in, 269.
Insects. See Insecta.
Instruments, Accessories, &c. See Contents, xxxiii.
Integument of Cephalopoda, 40.
Intercellular Spaces and Bridges in Epithelium, 221.
—— —— of Epithelium, and their Significance in Pulmonate Mollusca, 435.
—— ——, Protoplasm in, 820.
Inventions Exhibition, International, 890.
—— ——, Microscopes at, 1076.
Invertebrata. See Contents, x.
"Invicta," 142, 337.
Ishikawa, C., Development of Atyephira compressa, 996.
Isoetes, South American, 279.
Isopoda of the 'Willem Barents' Expedition, 450.
Israel, O., Cultivation of Actinomyces, 534.
Italian Microscope, Old, 518.

J.

Jackson, E. E., 747.
Jacobs' (F. O.) Freezing Microtome, 899.
Jadanza, N., 727, 1080.
James, F. L., 164, 337, 365, 890, 926, 1110.
——, Cement, 1110.
—— Cover-glass Cleaner, 354.
——, Examining Diamonds and Cut Gems, 1108.
——, Leakage of Cells, 1102.
——, Preparing Slides with Shellac, 164.
——, White Zinc Cement, 365, 1101.
Jamieson, T., Essential Food of Plants, 1209.
Jannettaz, E., 142.
Janney's (R.) Simple Solar (or Projection) Microscope, 309.
Janse, J. M., Movement of Water in Plants, 836.
Japanese Echinoidea, 1009.
Jaubert, L., 1080.
Jaw of Mandibulato Insects, Appendages of, 50.
Jendrássik and Mezey's Electrical Apparatus, 868.
Jenkins, A. E., 565, 747.

Jickeli, C. F., Process resembling Copulation in Comatula mediterranea, 70.
Johannsen, W., Development of the Endosperm in Hordeum, 485.
Johne, Cholera Bacillus, 509, 747.
Johow, F., Adaptation of Leaves to their Environment, 91.
Joliet, L., Development of Sphærularia bombi, 646.
Joly's (J.) Meldometer, 1068.
——, Microscopical Examination of Volcanic Ash from Krakatoa, 923.
Jönsson, B., Fertilization of Naias and Callitriche, 677.
Jorissen, A., Germination of Flax and Sweet Almoud, 271.
——, Production of Hydrocyanic Acid by Plants, 97.
——, Reducing Properties of Seeds and Formation of Diastase, 276.
Joseph, R. E., 142.
Joubin, Anatomy of Crania, 633.
——, Digestive and Reproductive Organs of Crania, 233.
Jourdain, S., Nervous System of Embryos of Limacina and the Relations of the Otocyst, 228.
——, The Synascidian Diplosomidæ, 796.
Jourdan, E., Elytra of some Polyneina, 456.
Journal of Mycology, 293.
—— of New York Microscopical Society, 332.
—— of R. Microscopical Society, 337, 366.
Julien, A. A., 926.
Julin, C., Fœtal Appendages of Mammals, 423.
——, Postembryonal Development of Phallusia scabroides, 795.
Juncus bufonius, Fungus of Root-swellings of, 107.
Jung's (H.) Compressorium, 136.
——, R., Strop for Knives, 157.
Juranyi, L., Pollen of Gymnosperms, 484.
Jutland "Cementstein," Sections of Diatoms from, 843.

K.

K., 142.
Kaatzer, P., 565.
Kain, C. H., Balsam of Tolu, 1117.
——, Schmidt's Atlas der Diatomaceenkunde, 103.
Kaiser, W., Luminosity of the Glow-worm, 50.
Kalchbrenner, K., Müller's Methylized Alcohol for Fungi and other Plants, 164.
Kamienski, F., Vegetative Organs of Monotropa, 1025.
Karop, G. C., Bacilli of Hydrophobia, 573.
Karsch, F., Seasonal Dimorphism in Spiders, 993.
Karyokinesis, Demonstration of, in Epithelial Tissues, 730.
—— in Segmentation of Axolotl Ovum, 976.
Karyokinetic Figures, Staining Method for, 341.
Keller, C., Spiders in Relation to Forestry, 450.
Kellicott, D. S., New Infusoria, 470.
——, New Vorticellid, 78.
Kennel, J. v., Development of Peripatus 56.
——, Preparing Embryo of Peripatus Edwardsii and P. torquatus, 734.
Kent, W. S., Infusorial Parasites of the Tasmanian White Ant, 662.
Kerbert, C., New Infusorian Parasite, 81.
Kerremans, 164.
Kerville, H. G. de, New Entomogenous Fungus, 505.
King, J. D., 366.
Kingsley, J. S., Glycerin and Balsam Mounts, 353.
——, Rapid Imbedding, 150.
Kinne, C. M., 531.
Kirchner, 565.
Kjellman, F. R., Algal-flora of the Arctic Ocean, 1039.
Kitton, F., Balsam of Tolu, 1116.
——, —— —— as a Medium for Mounting, 352.
——, Diatoms and Bladderwort, 685.
——, Mysterious Appearance of a Diatom, 1041.
——, Navicula Durrandii n. sp., 1042.
——, New Diatoms from the "Saugschiefer" of Dubrávica, 497.
——, Osteromphalus flabellatus, 380.
Klebs, G., Movement and Formation of Mucilage by the Desmidieæ, 1040.
——, Peridiniæ, 468.
——, Preparing Euglena, 539.
——, Structure of Chromatophores, 109.
Klein, C., 890.
——, Mineralogical and Petrological Microscopes, 856.
——, E., 565, 747.
——, Relations of Bacteria to Asiatic Cholera, 299.
——, L., Development of Organs and Growth at the Growing Point of Dorsiventral Ferns, 276.
——, Nocturnal Spore-formation in Botrytis cinerea, 690.

Klercker, J. E. F. af, Anatomical Structure and Development of Ceratophyllum, 825.
——, Mechanical Function of the Epidermis, 91.
Klönne and Müller's Dissecting Microscopes with Brücke Lens, 319.
—— —— Pocket Microscope, 309.
Knives and Microtomes, Improvements in, 347.
——, Strop for, 157.
Knop, W., Absorption by the Plant of Non-nutrient Substances, 1032.
Kny, L., 366.
—— and A. Zimmermann, Spiral Cells of Nepenthes, 1023.
Koch, A., Course and Termination of the Sieve-tubes in the Leaves, 90.
——, Gaffky, and Löffler, Artificial Attenuation of Bacillus anthracis, 696.
——, R., Cholera-bacillus, 113.
——, Etiology of Tuberculosis, 851.
Köhler, R., Marine Hemipterous Insect, Æpophilus Bonnairei, 448.
Kölliker, A., Epidermic Cells of Tadpoles, 977.
——, Significance of Cell-nuclei in the Processes of Heredity, 975.
Koninck, L. de, 565.
Koristka, T., 531.
Korotneff, A., Development of Gryllotalpa, 798.
Korschelt, P., Apical Growth of Phanerogams, 487.
Köstler, M., Preparing the Sympathetic Nervous System of Periplaneta orientalis, 538.
Koubassoff, Passage of Microbes by means of Milk, 1052.
——, Passage of Pathogenous Microbes from the Mother to the Fœtus, 296, 1051.
Kowalevsky, N., Development of Lucernaria, 253.
Krabbe, G., Growth of the Thickening-ring in Exogens, 478.
Krakatoa, Microscopical Examination of Volcanic Ash from, 923.
Krasan, F., Malformations caused by Insects, 484.
Kraus, C., "Bleeding" Parenchymatous Tissues, 837.
——, Excretion of Healing Substances into Wounds, 476.
——, G., Blooming of Arum italicum, 835.
Krause, F., Micrococcus in Acute Infectious Osteomyelitis, 508.
Krukenberg, C. F. W., Distribution of Chitin, 984.
Kruttschnitt, J., Fecundation of Ovules in Angiosperms, 270.
Kühne's Electrical Apparatus, 868.
Kükenthal, W., 926.
——, Lymphoid Cells of Annelids, 454.
Kultschizky, N., Staining Salivary Glands, 1095.
Künckel d'Herculais, J., 337.
Künstler, J., Bacterioidomonas undulans, 300.
——, New Rhizopod, 82.
——, Psorosperm in the Human Pleural Cavity, 261.
——, Systematic Position of the Bacteriaceæ, 1048.
Kupffer, C., Preparing Meroblastic Ova, 340.
——, Staining the Axis-cylinder of Medullated Nerve-fibres, 742.

L.

Laborie, E., Anatomy of Peduncles compared with that of the Primary Axes and of Petioles, 833.
Laboulbène, A., and P. Mégnin, Sphærogyra ventricosa, 449.
Lacaze-Duthiers, H. de, 891.
——, Anatomy of Dentalium, 984.
——, Epipodium of Gastropoda, 223.
——, Microscopic Elements serving for the Determination of the Cynthiidæ, 230.
——, Nervous System and Embryonic Forms of Gadinia garnotii, 224.
——, Phœnicurus, 1005.
Laccopteris, Affinities of, 681.
Lacerta viridis, Embryology of, 212.
Lachmann, P., Apical Growth of the Root of Todea, 839.
——, Root-organs of Nephrolepis, 1033.
Lacy, W. A., Treatment of the Eggs of the Spider, 1083.
Ladowsky, M., Demonstrating the Nuclei in Blood-corpuscles, 730.
Ladureau, A., Ammoniacal Ferment, 680.
Lagerheim, G., Occurrence of Chromatophores in the Phycochromaceæ, 102.
Lagerstedt, N. G. W., Diatomsynonymy, 287.
Lagoa, Unusual Number of Legs in Caterpillar of, 990.
Lakes, Alkaline, Edible Dipterous Larvæ from, 53.
——, Deep-water, Turbellarians of, 1004.
——, Flagellata (Dinobryon) as Members of the Pelagic Fauna of, 258.
——, Swiss, Deep Fauna of, 238.
Lamellibranchs, Aquiferous Pores in, 227.

Lamellibranchs, Classification of, 625.
——, Manner in which they attach themselves to Foreign Objects, 626.
——, Movement of the Foot in, 437.
——, Shell of, 230.
——, Structure and Formation of Shell of, 44.
Laminariaceæ of Norway, 1039.
Lamp, Bulloch's New, 133.
——, "Complete," Modification of, 380.
——, New Electric, 339.
Lampert, K., Variation in Holothurians, 1007.
Lamps, Small Incandescence, Beck's Portable Battery for, 172.
Landolt, T., 142.
Lang, A., Excretory Organs of Worms, 243.
——, Polycladidea, 245.
Lange, J., Oil-receptacles in the Fruit of Umbelliferæ, 89.
Langton, W., 926.
Lankester, E., 531, 1080.
——, E. R., Archerina Boltoni, 259.
——, Cholera Bacillus, 113.
——, New Hypothesis as to the Relationship of the Lung-book of Scorpio to the Gill-book of Limulus, 639.
——, Polyzoa, 797.
——, Protozoa, 817.
——, Rhabdopleura, 46.
——, W. B. S. Benham, and E. J. Beck, Muscular and Endoskeletal Systems of Limulus and Scorpio, 992.
Lantern Transparencies, 866.
Lanzi, M., Diatoms from Lago Trajano, 103.
Larches and Pines, Organs of Secretion in, 269.
Larva of Insects, Head and Mouth of the, 441.
Larvæ and Larva-cases of some Australian Aphrophoridæ, 992.
——, Edible Dipterous, from Alkaline Lakes, 53.
——, Marine, their Relation to Adults, 788.
—— of Corethra plumicornis, Uses and Construction of Gizzard of, 991.
——, Phytophagous, Nature of the Colouring of, 801.
Larval Form of Dorocidaris papillata, 1008.
—— Forms of Spirorbis borealis, 644.
Laschenberg, O., Colours of Bird's Eggs, 618.
"Latent period" of Unstriped Muscle in Invertebrates, 982.
Latex, Function of, in the Compositæ, 266.
Latham, V. A., 142, 164, 747, 926, 1110.
Laticiferous Vessels, 1022.
Latzel's (K.) Myriopods of Austria, 638.
Laulainé, F., Development of Sexuality, 974.
——, Nature of the Placental Neoformation and the Unity of Composition of the Placenta, 783.
——, Unity of the Process of Spermatogenesis in Mammalia, 615.
Laurent's (L.) Apparatus for Registering the Curvature and Refraction of Lenses, 862.
Lawes, J. B., Source of the Nitrogen in Plants, 275.
Leaf, Anatomy of, in Vismieæ, 675.
Leaf-trace-bundles of Evergreen Plants, Behaviour of, as the stem increases in thickness, 826.
Leakage of Cells, 1102.
Leaves, Adaptation of, to their environment, 91.
——, Course and Termination of the Sieve-tubes in, 90.
——, Fluorescence of Chlorophyll in, 88.
——, Green, Spectra of Pigments of, and their Derivatives, 670.
——, Identity of the Orange-red Colouring Matter of, with Carotine, 670.
——, Influence of Light on the Development of the Assimilating Tissue of, 266.
—— kept in Darkness, Absorption of Oxygen and Evolution of Carbon dioxide in, 678.
——, Nyctitropic Movements of, 273.
—— of Aquatic Plants, Epidermis of, 674.
—— of Chrysoplenium, Comparative Anatomy of, 91.
—— of Dicotyledons, Sieve-tubes in, 1020.
—— of Leguminosæ, Crystals in, 823.
—— of Statice monopetala, 829.
—— of the Vine, Formation of Starch in, 670.
——, Pericycle of, 673.
——, Preparing, to show Starch-grains, 1084.
——, Presence of Amylase in, 97.
——, Protection of, from excessive Transpiration, 1025.
——, Respiration of, in Darkness, 488.
Leblois, A., Function of Latex in the Compositæ, 266.
Leboucq, H., 164.
Lecanora granatina, Anatomy and Development of, 1043.
Leckenby's (A. B.) Microscope Pencil-case, 1065.

Lee, A. B., 366, 1110.
—— Microtomist's Vade Mecum, 355.
——, "Ribbon" Section-cutting, 552.
——, Structure of the Halteres of Diptera, 636.
Leech, New Parasitic, 643.
Legs, Unusual Number of, in Caterpillar of Lagoa, 990.
Leguminosæ, Crystals in Leaves of, 823.
——, Source of the Nitrogen of, 680.
——, Structure and Functions of the Aril in certain, 829.
Lehmann's (O.) Crystallization Microscope, 117.
Leidy, J., New Bothriocephalus, 810.
——, New Parasitic Leech, 643.
——, Organisms in Ice, 40.
——, Urnatella gracilis, 439.
Leitgeb, H., Exudation of Water from the Female Receptacle of Corsinia, 1035.
——, Spore-coats and Germination of Hepaticæ, 101.
Lendenfeld, R. v., 926.
——, Amœba infesting Sheep, 1018.
——, Australian Hydromedusæ, 252, 1011.
——, —— Sponges, 76, 1014.
——, Beroid of Port Jackson, 1011.
——, Cœlenterates of the Southern Seas, 656.
——, Development of the Versuridæ, 72.
——, Fibres of certain Australian Hircinidæ, 254.
——, Flexor Muscle of the Hydroid Polyp of Sarsia radiata, 72.
——, Flight of Insects, 988.
——, Histology and Nervous System of Calcareous Sponges, 1011.
——, Local Colour-varieties of Scyphomedusæ, 71.
——, Metamorphosis of Bolina Chuni, 1010.
——, Mode of Digestion in Sponges, 74.
——, Nervous System of Sponges, 253.
——, New Sponges from South Australia, 1013.
——, Occurrence of Flesh-spicules in Sponges, 254.
——, Scyphomedusæ of the Southern Hemisphere, 71.
——, Series of Sections. Thickness of Sections, 1092.
——, Slimy Coatings of certain Boltenias, 233.
——, The Phoriospongiæ, 1012.
Lens, Crystalline, Homologies of the Vertebrate, 430.
——, Glory of, 337.
Lens or Lens-system, Remarks on Prof. Abbe's Note on the proper Definition of the Amplifying Power of, 960.
Lens-holder, Ward's and Queen's, 317.
—— ——, Westien's Universal, 316.
Lenses, Laurent's Apparatus for registering the Curvature and Refraction of, 862.
——, Water and Melted Glass, 890.
Lenticels, 825.
Leone T., 1110.
Lepidoptera, Malpighian Vessels of, 51.
——, Morphology of, 635.
——, Testes of, 51.
Lepidopterous Larvæ, Number of Abdominal Segments in, 636.
—— Pigments, Action of Ammonia upon, 52.
Lépinay, M. de, 727.
Lépine, R., and G. Roux, Cystitis and Nephritis produced by Micrococcus ureæ, 1047.
Lett, H. W., Cloudy Mounts, 366.
Leuckart, R., 926.
——, Development of Sphærularia bombi, 810.
Lewis, R. T., 1080.
——, Electrical Apparatus, 875.
——, W. J., Hair microscopically examined and Medico-legally considered, 429.
Lichenes. See Contents, xxviii.
Life-Box, Whitney's, 330.
Light, Action of, on Objects hardened in Chromic Acid, 148.
—— and Heat, Influence of, on Plant Development, 485.
——, Chemical and Physiological Action of, on Chlorophyll, 837.
——, Decomposition of Solutions of Chlorophyll by, 669.
——, Influence of, on Geotropism, 491.
——, ——, on the Development of the Assimilating Tissue of Leaves, 266.
——, ——, on the Germination of Seeds, 93.
——, ——, on the Vegetation and on the Pathogenous Properties of Bacillus anthracis, 297.
Lignin and Tannin in Galls, 1020.
Limacina, Nervous System of Embryos of, 228.
——, Relations of Otocyst in, 228.
Lime, Carbonate of, and Colloids, On Erosion on the Surface of Glass, when exposed to the Joint Action of, 761.
Limit of Angular Vision, 339.
Limnocodium Sowerbii, Hydroid Phase of, 72, 168, 251.
Limpet, Habits of, 225.

Limulus and Sepia, Chitin as a Constituent of the Cartilages of, 222.
—— ——, Muscular and Endoskeletal Systems of, 992.
——, New Hypothesis as to the Relationship of the Lung-book of Scorpio to the Gill-book of, 639.
—— polyphemus, Embryology of, 806.
Linck, G., 164.
Lindt, O., Micro-chemical Test for Brucin and Strychnin, 920.
Linstow, O. v., Angiostomum, 1001.
Lissauer, 164.
List, J. H., Anilin-green, 903.
——, Preparing the Cloacal Epithelium of Scyllium Canicula, 731.
——, Staining Methods, 902.
——, Unicellular Glands in the Cloaca of Rays, 221.
——, Wandering Cells in Epithelium, 980.
Litharge and Glycerin as a Cement, 743.
Lithoderma fontanum, a New Freshwater Phæospore, 285.
Live-Cell, 134.
—— ——, Giles', 135.
Liver, Cephalopod, Pancreatic Function of, 622.
—— of the Mollusca, 792.
Lockwood, S., Pseudo-cyclosis, 663.
Löffler, Artificial Attenuation of Bacillus anthracis, 696.
——, Micro-organisms as a Cause of Diphtheria in Man, Pigeons, and Calves, 694.
Lofthouse, T. W., Dry Mounting, 1100.
Loligopsis and Allied Genera, 984.
Lommel, E., 532, 727.
Looss, A., Anatomy of the Trematoda, 460.
——, Method of Softening Chitin, 896.
Loriol, P. de, Asteroidea of Mauritius, 1009.
Loudon, J., 532.
Löw, E., Insects as Fertilizers, 990.
——, O., Protoplasm and its Powers of Resistance, 421.
——, Various Degrees of Resistance in Protoplasm, 1019.
—— and T. Bokorny, Silver-reducing Animal Organs, 619.
Löwe, L., Preparing Embryos, 729.
Löwit, M., 337.
——, Formation of Red and White Blood-corpuscles, 220.
Lowne, B. T., Compound Vision and the Morphology of the Eye in Insects, 234.
Loxosoma, Structure and Development of, 631.
Lubbock, Sir J., Homing Faculty of Hymenoptera, 990.
Lucernaria, Development of, 253.
Luciola italica, Preparing, 733.
Ludwig, F., Spectroscopic Examination of Photogenic Fungi, 504.
Lumbricus terrestris, Tenacity of Life and Regeneration of Excised Parts in, 455.
Lung-book of Scorpio, New Hypothesis as to the Relationship of, to the Gill-book of Limulus, 639.
Lungs, Human, Method for showing the Distribution and Termination of Nerves in, 894.
Lustgarten, S., Preparing the Bacillus of Syphilis, 539.
Lwoff, W., Histology of Hairs, Setæ, Spines, and Feathers, 35.
Lycopodium, Prothallium of, 277, 839.
——, Spores of, 839.
Lymphoid Cells of Annelids, 454.

M.

M., 727.
M. D., 164.
M. Q. M. C., 337.
Macadam, W. T., Diatomaceous Deposits in Scotland, 287.
M'Allister, Slide showing path of Electric Spark, 727.
M'Calla, A., 366, 565, 748.
M'Connel, J. C., 891.
McCook, H. C., Hibernation and Winter Habits of Spiders, 640.
Macdonald, J. D., General Characters of Cymbulia, 627.
Macfarlane, J. M., Distribution of Honey-Glands in Pitchered Insectivorous Plants, 269.
MacGillivray, J. H., Australian Bryozoa, 633.
M'Intosh, W. C., Identity of the two British Species of Cyanea, 464.
——, Phosphorescence of Marine Animals, 981.
——, Reproduction of Mytilus edulis, 437.
M'Kendrick, J. G., and J. J. Coleman, Action of Ozonized Air upon Micro-organisms and Albumen in Solution, 1053.
——, ——, Effects of very Low Temperatures on Living Organisms, 619.
MacLeod, J., Coxal Gland in the Phalangida, 58.
——, Hermaphroditism of the Male of Trombidium, 58.
——, Presence of a Coxal Gland in Galeodes, 236.
——, Structure of the Fore-gut of Arachnida, 56.

MacMunn, C. A., Arrangement of the Micro-spectroscope, 527.
——, Chromatology of Actiniæ, 464, 656.
——, Enterochlorophyll and Allied Pigments, 621.
——, New Organic Spectra, 429.
McMurrich, J. P., Structure and Affinities of Phytopus, 236.
Macrocystis, Anatomy of, 284.
Macrotoma plumbea, 637.
Madan's (H. G.) Method of Isolating Blue Rays for Optical Work, 327.
——, Modification of Foucault's and Ahrens's Polarizing Prisms, 328.
Maddox, R. L., Experiments on Feeding some Insects with the Curved or "Comma" Bacillus, and also with another Bacillus (B. subtilis), 602.
——, Further Experiments on Feeding Insects with the Curved or "Comma" Bacillus, 941.
——, On Some unusual Forms of Lactic Ferment—Bacterium lactis, 205.
Madreporaria (Astrangiaceæ) Structures liable to Variation in, 73.
Mæna vulgaris, Parasites of, 805.
Mäggi, L., 164.
Magnetism, Influence of, upon Insect Development, 988.
Magnification, Remarks on, 1070.
Magnifying Power of Objectives, 335.
Malaria, Bacilli of, 1052.
Malassez, Illumination for Projection Microscopes, 866.
Malcolm, E. D., Adjusting the Eyepieces of Binoculars to eyes of unequal focal length, 1065.
Maldanidæ, Coloration of the Anterior Segments of, 999.
Male and Female Plants, Production of, 677.
Malformations caused by Insects, 484.
Malley, A. C., 338.
——, Illumination, 719.
Malpighian Vessels of Lepidoptera, 51.
Mammalia, Unity of Process of Spermatogenesis in, 615.
Mammals, Fœtal Appendages of, 423.
Manchester Microscopical Society, 143.
Mandibulate Insects, Appendages of Jaw of, 50.
Manganese, Presence of, in Plants, 671.
Mangin, L., Absorption of Oxygen and Evolution of Carbon dioxide in Leaves kept in Darkness, 679.
——, Respiration of Germinating Seeds, 272.
——, —— of Leaves in Darkness, 488.
——, —— of Plants, 835.
——, —— of Plants at different Seasons, 836.
Mangin, L., and G. Bonnier, Respiration and Transpiration of Fungi, 104.
—— ——, Respiration of Tissues not containing Chlorophyll, 94.
Manson, P., Metamorphosis of Filaria sanguinis hominis in the Mosquito, 65.
Manton, W. P., 143.
Maquenne, L., Absorption of Oxygen and Evolution of Carbon dioxide in Leaves kept in Darkness, 678.
Marchantia, Stomata of, 1036.
Marchesetti, C. di, New Instance of Symbiosis, 282.
Marié, P., Structure of Ranunculaceæ, 674.
Marine Animals, Recognition by, of the Hour of the Day, 431.
—— Hemipterous Insect, Æpophilus Bonnairei, 448.
Mark, E. L., 1111.
——, Notes on Section-cutting, 737.
——, Uses of Collodion, 908.
Markfeldt, O., Behaviour of the Leaf-trace-bundles of Evergreen Plants as the Stem increases in Thickness, 826.
Marking Preparations, Coloured Crayons for, 1103.
Marseilles, Gulf of, Tectibranchiata of, 624.
Marshall, W., Cœlenterate Nature of Sponges, 816.
——, Reproduction of Spongilla lacustris, 1011.
——, W. P., 748.
Marsupials, Embryonic Membranes of, 34.
Martin, S., Digestion of Proteids in Plants, 1030.
Martinotti, G., 164.
Massee, G., New British Micro-Fungi, 757.
Masters, M. T., Petalody of Ovules, 676.
Matthews, J., 162, 564.
Maumene, E. J., Presence of Manganese in Plants, 671.
Maupas, E., Coleps hirtus, 1015.
Maurice, C., and A. Schulgin, Development of Amarœcium proliferum, 437.
—— ——, Preparing Embryos of Amarœcium proliferum, 731.
Mauritius, Asteroidea of, 1009.
Maxon, E. R., 366.
Mayall, J. jun., 532, 727.
——, Mechanical Stage, 122.
——, Nobert's Ruling Machine, 377.
Mayer's (P.) Carbolic Acid Shellac, 909.
Mayr, H., Organs of Secretion in Pines and Larches, 269.
Mays, K., Staining Nerves in Muscle, 903.

Measurement of Blood - corpuscles, 1105.
—— of Power and Aperture of Microscopic Objectives, 1082.
Mechanical Finger Objective, Griffith's, 709.
—— Injury to Trees by Cold, 1029.
—— Tissue System, 828.
"Medicinæ Doctor," 565.
Medico-legal and Chemical Microscopy, 1108.
Mediterranean, Florideæ of, 102.
Medullary Rays and Annual Zones of Growth in Conifers, Comparative Anatomy of Tissue of, 826.
Meehan, T., Elasticity in the Filaments of Helianthus, 268.
——, —— in the Fruit of Cactaceæ, 1027.
——, Fertility of Hybrids, 271.
——, Sexual Characters in Zinnia, 267.
——, Use of Spines in Cactuses, 1027.
Megaloscopy, 1061.
Mégnin, P., Sclerostoma boularti, 244.
Meldometer, Joly's, 1068.
Melibe, the Genus, 226.
Melland, B., Simplified View of Histology of Striped Muscle-fibre, 787.
Melosira, Cell-Division in, 497.
Mer, E., Nyctitropic Movements of Leaves, 273.
Mercer, A. C., 366.
Mercury, Mounting Proboscis of Blow-fly in Biniodide of, 733.
——, Perchloride of, in the Study of the Central Nervous System, 904.
Merian, A., 164.
Merlangus, New Nematoid from, 646.
Merulius lacrymans, Composition and Spore-cultivation of, 845.
—— ——, Germination of the Spores of, 845.
Mesoderm in Phoronis, 242.
Metacrinus, New Species of, 815.
Metameric Segmentation in Phoronis, 242.
Metamorphosis of Cyphonautes, 798.
—— of the Blow-fly, Influence of some Conditions on, 441.
Metschnikow, E., Erythropsis agilis, 1016.
Metzdorf, Bacillus of Cattle Plague, 114.
Mexico, Fresh-water Sponge from, 1014.
Meyenia fluviatilis, New Variety of, 658.
Meyer, A., 565.
——, Examining Vegetable Powders, 562.
——, Formation of Gum in Wood, 89.
——, Microtome Clamp, 156.
Mezey and Jendrássik's Electrical Apparatus, 868.
Michael, A. D., 338.
——, New British Oribatidæ, 385.
——, Notes on the Life-Histories of some of the little-known Tyroglyphidæ, 19.
——, Standard Thickness of Glass Slips, 329.
Michaelsen, W., Archenchytræus Möbii, 643.
Michelson, P., 566.
Microbe of Human Typhoid Fever, 299.
—— of Typhoid Fever in Man, 1052.
—— of Yellow Fever, 694.
——, On a Septic, from a high altitude, 769.
Microbes in the Soil, 693.
——, Passage of, by means of Milk, 1052.
——, Pathogenous, Passage of, from the Mother to the Fœtus, 296, 1051.
——, Removal of, by Filtering, 561.
——, Vitality of Germs of, 296.
Micro-chemical Examination, Isolating Minerals in Sections for, 921.
—— —— Examination of Minerals, 920.
—— —— Test for Brucin and Strychnin, 920.
Micrococcus, Effect of Sunlight on, 1047.
—— in Acute Infectious Osteomyelitis, 508.
—— ureæ, Cystitis and Nephritis produced by, 1047.
Microcystis, 692.
Micro-Fungi, New British, 757.
Microgoniometer, Pfaff's, 702.
Micrometer, Screw Stage-, Schieck's Microscope with, 861.
——, Standard, 338.
Micrometers, Eye-piece, 704.
—— mounted in Media of High Refractive Index, 330.
Micro-organisms, Action of Ozonized Air upon, and Albumen in Solution, 1053.
—— —— as a cause of Diphtheria in Man, Pigeons, and Calves, 694.
—— ——, Examination of Water for the Development of, 560.
—— ——, Removal of, from Water, 923.
—— ——, Saprogenous and Pathogenous, Plaut's Staining Process for the Demonstration of, 342.
Microphytes of Normal Human Epidermis, 849.
Microscope, Amici's, 531.
——, Application of, to Practical Mineralogical Questions, 922.

Microscope, Beck's Portable, 115.
——, —— —— "Star," 1121.
——, —— "Star," 512.
——, Binocular, Images shown by, 1073.
——, Box, 701.
——, Cantor Lectures on, 1124.
——, Collins's Portable, 701.
——, D'Arsonval's Water, 1054.
——, Deby's Twin, 854.
——, Direct Vision, 1056.
——, Dissecting, with Brücke Lens, 319.
——, Double-Drum, 703.
——, Duboscq's Projection, 861.
——, Electric Spark under, 888.
——, Giacomini's, with large Stage, 515.
——, Gray's Water, 1079.
——, in Geology, 921.
—— in the Schoolroom, 728.
——, Inostranzeff's Double, 1058.
—— is always ready, 143.
——, Janney's Simple Solar (or Projection), 309.
——, Klein's Mineralogical and Petrological, 856.
——, Klönne and Müller's Pocket, 309.
——, Lehmann's Crystallization, 117.
——, Microtome-, 861.
——, Müller's Insect-catcher with Lens, 519.
——, Murray and Heath's Class, 515.
——, Nachet's Class, 514.
——, —— Pocket and Portable, 700.
——, Old Italian, 518.
—— Pencil-case, Leckenby's, 1065.
——, Perfect Laboratory, 891.
——, Pocket Field, 890.
——, Queen and Co.'s Class, 119.
——, Riddell's Binocular Compound, 1059.
——, Reichert's Mineralogical-Geological, 858.
——, —— No. VII., 302.
——, Schieck's, with Screw Stage-Micrometer, 861.
——, —— Bacteria, 301.
——, Stein's, for use with the Electric Light, 303.
——, Swift's Sheep-Scab, 307.
——, Swift-Wale, 119.
——," Theiler and Sons' "Universal (Achromatic) Pocket, 704.
——, Thompson's Projection, 310.
——, "Times" on, 883.
——, Tolles' Clinical, 308.
——, "Twin" Simple, 862.
——, Védy's Revolving Stage, 699.
——, Watson's Camera or Lantern.1064.
——, —— Swinging Substage, 1062.
——, Watson-Wale, 860.
Microscope, Winkel's Demonstration, 308.
—— with Catgut Focusing Adjustment, 1057.
——, Wright's Lantern, 196.
Microscopes at the Inventions Exhibition, 1076.
——, Illumination of, and Balances, 328.
——, Projection, Illumination for, 866.
—— with Accessory Stages, 1058.
—— with Bent Body-tube, 517.
Microscopist ?", "What is a, 333.
Microscopy, Medico-legal and Chemical, 1108.
Micro-spectroscope, Arrangement of, 527.
Microstoma lineare, Nephridia of, 813.
Microtome, Advantages and Disadvantages of Different Forms of, 541.
——, Barrett's New, 1089.
——, Beck's Automatic, 153.
——, —— Universal, 344.
——, Bulloch's Combination, 548.
——, Caldwell's Automatic, 150.
——, Cambridge Rocking, 549, 1091.
——, Eternod's, with Triple Pincers, 900.
——, Gowen's, 899.
——, Hatfield's Rotary, 735.
——, Jacob's Freezing, 899.
—— Object-clamp, Reichert's, 347.
——, Reichert's Simple Hand-, 346.
——, Schanze's, 547.
——, Seiler's Attachment, 1091.
——, Thoma's, 153.
Microtome-Clamp, Meyer's, 156.
—— -Microscope, 861.
Microtomes and Knives, Improvements in, 347.
——, Bausch and Lomb Optical Co.'s Laboratory and Student's, 1089.
Microtomist's Vade Mecum, Lee's, 355.
Microzymes and Vibrios of Air, Water, and Soil, Origin of, 295.
Miles, J. L. W., Dry Mounting, 1100.
Milk, Decomposition and Fermentation of, 1048.
——, Passage of Microbes by means of, 1052.
Miller, M. N., 727.
Mills, H., Filamentous projections on Diatoms, 571.
——, New American Fresh-water Sponges, 464.
Milne, W., New Rotifer, 1007.
Mimicry among Marine Mollusca, 795.
Mineralogical Questions, Practical, Application of Microscope to, 922.
Minerals, Isolating, in Sections for Micro-chemical Examination, 921.
——, Micro-chemical Examination of, 920.

Minot, C. S., 927.
——, Dripping Apparatus, 900.
——, Formative Force of Organisms, 780.
——, Vesiculæ seminales of Guinea-pigs, 35.
Minyas, New, 1010.
Miquel, P., Hourly Variations in Aerial Bacteria, 111.
——, Nutritive Paper, 111.
Mirror Diaphragms, 523.
——, Parabolic, for Correction of too hard or too soft Paraffin, 344.
——, Plane, Right-angled Prism instead of, 709, 864.
Mitrophanow, P., Intercellular Spaces and Bridges in Epithelium, 221.
Möbius, K., Freia Ampulla O. F. Müll., the Flask-animalcule, 818.
——, Mechanical Sheaths to Secretion receptacles, 267.
——, New Epiphytic Floridea, 842.
Moist Chamber, 526.
Moisture in Soils, Influence of, on Plant Growth, 486.
——, Influence of Want of, on the Growth of the Chinese Yam, 1029.
Mojsisovics v. Mojsvár, A., 566.
Molecules, Homologous Sections and Electric Light, 337.
Molisch, H., Deviation of Roots from their Normal Direction through the Influences of Gases, 96.
——, Micro-chemical Detection of Nitrates and Nitrites in Plants, 359.
Moller, H., Plasmodiophora Alni, 844.
——, Respiration of Plants, 94.
——, J., 143, 927, 1080.
Mollusca. See Contents, xi.
Molluscoida. See Contents, xii.
Monascus, a New Genus of Ascomycetes, 291.
Mondino, C., Perchloride of Mercury in the Study of the Central Nervous System, 904.
Monopora vivipara, Development of, 811.
Monotidæ, Fresh-water, 813.
Monotremes, Oviparous Reproduction in, 33.
Monotropa, Vegetative Organs of, 1025.
Monoyer, M. F., 728.
Monstrosities, Mycological, 847.
Moore, A. Y., 728.
——, S. Le M., Identity of Bacterium fœtidum (Thin) with Soil Cocci, 696.
Morini, E., Parasitic Fungi, 105.
——, F., New Ustilaginea, 288.
Morot, L., Fibrovascular Bundles of Cycadeæ, 1023.
——, Pericycle of the Root, Stem, and Leaves, 673.
Morris, W., 1080.
Moseley, H. N., Eyes of Chitonidæ, 224.
Mosquito, Metamorphosis of Filaria sanguinis hominis in, 65.
Mosses. See Muscineæ.
Motella mustela, Development of, 785.
Mother to Fœtus, Passage of Pathogenous Microbes from, 296, 1051.
Mould for Cells, Chapman's, 911.
Mould-fungi as Ferments, 1045.
Moulds, Some Remarkable, 848.
Mounting Media for Nematodes, 897.
—— ——, Smith's (H. L.) of High Refractive Index, 352, 1097.
—— Medium, New, 377.
—— Objects. See Contents, xxxviii.
Mouth and Head of the Larva of Insects, 441.
Mouth-organs of Hymenoptera, Morphology of, 989.
Movement and Formation of Mucilage by the Desmidieæ, 1040.
—— of Ascending Sap, 489.
—— of Protoplasm in the Styles of Indian Corn, Examining, 1106.
—— of Water in Mosses, 493.
—— —— in Plants, 490, 836.
—— —— ——, Direct Observation of, 359.
Movements, Nyctitropic, of Leaves, 273.
—— of Androecium in Sunflowers, 268.
—— of Stamens, Influence of Gravitation on, 272.
——, Spontaneous, of Pigment-bodies, 476.
Mucilage, Movement and Formation of, by the Desmidieæ, 1040.
Mucorini, Zygospores of, 505.
Mulberry, Fungi Parasitic on, 290.
Müllenhoff, K., Size of the Surfaces of Organs of Flight, 221.
Müller, C., Mosses of Terra-del-Fuego, 1036.
——, Stolons of Sagittaria sagittæfolia, 479.
——, F., Diagnostic Value of Tubercular Bacilli, 298.
——, J., Contributions to Lichenology, 1042.
——, K., Solmsiella, a new genus of Mosses, 101.
——, O., Cell-Division in Melosira, 497.
——, Structure of the Cell-wall of Diatoms, 685.
——, P., Insect-catcher with Lens, 519.
——, W., Shell of Lamellibranchiata, 230.
Müller's Methylized Alcohol for Fungi and other Plants, 164.
Multinucleated Protozoa, 467.

Multiple Images and Compound Eyes, 356.
Multiplying Drawings, 527.
Murdoch, J., New Arcnicola from Arctic Alaska, 456.
——, New Crustacea from Arctic Alaska, 453.
Murray and Heath's Class Microscope, 515.
——, G., "Sclerotioids" of Potato, 1022.
Muscineæ. See Contents, xxvii.
Muscle, Flexor, of Hydroid Polyp of Sarsia radiata, 72.
——, Staining Nerves in, 903.
——, Striated, Phenomena of Contraction in, 428.
——, Unstriped, "Latent period" of, in Invertebrates, 982.
Muscle-fibre, Striped, Simplified View of Histology of, 787.
Muscles of Chætopoda, 456.
—— of Invertebrates, Absolute Force of, 58.
——, Unstriated, of Invertebrata, Physiology of, 791.
Muscular and Endoskeletal Systems of Limulus and Scorpio, 992.
Mushrooms, Hydrocarbon Reserve-products of, 1044.
Mycetozoa, De Bary's, 108.
Mycoderma vini, Influence of External Conditions on the Development of, 294.
Mycological Monstrosities, 847.
Mycology, Journal of, 293.
——, Pathological, Woodhead and Hare's, 698.
Mygale, Coxal Glands of, 639.
Myriopoda. See Contents, xiv.
Mytilus edulis, Reproduction of, 437.
Myxomycetes, Cœnonia, a new Genus of, 293.
——, Zopf's, 690.
Myzostoma, New Species of, 814.
——, Preparing, 897.
——, Structure and Development of, 66.
Myzostomida, 'Challenger,' 68.

## N.

Nachet's (A.) Class Microscope, 514.
—— Pocket and Portable Microscopes, 700.
Nachtrieb, H. F., Phylogeny of Echinoderms, 651.
Naias, Fertilization of, 677.
Nalepa, A., Intercellular Spaces of Epithelium, and their significance in Pulmonate Mollusca, 435.
Naphthalin, Monobromide of, 909.
Naples, Gulf of, Infusoria of, 80.
—— Zoological Station, 1111.
Nassonow, N., Embryology of Balanus, 643.
Navicula cuspidata as a Test-object, 140.
—— Durrandii n. sp. F. K., 1012.
Nealey, E. T., Rapid Method for Making Bone and Teeth Sections, 348.
Nectar-Glands of Apios tuberosa, 269.
Neelsen and Ehlers, "Rauschbrandpilz," a parasitic cattle-disease, 390.
Negatives, Compound, 331.
——, Small, 528.
Negri, A. F., Staining the Spores of Bacillus tuberculosis, 342.
Nelson, E. M., 143, 338, 566, 728, 1080, 1081.
——, Comma Bacillus, 563.
——, Illumination, 713.
——, Images in the Binocular Microscope, 1073.
——, Keeping both Eyes open in Observation, 881.
——, Oblique Illuminators, 129.
——, Position of Objects with the Binocular, 1075.
——, Right-angled Prism instead of a Plane Mirror, 864.
——, Simple Condenser, 327.
——, Standard Thickness of Glass Slips, 329.
——, Testing the different Sectors of Objectives, 324.
Nematodes and Rotifers, Relationship of, 1006.
——, Development of, 809.
——, Mounting Media for, 897.
——, Origin of the Nervous System of, 458.
Nematoid, New, from Merlangus, 646.
Nemertea, Circulating and Nephridial Apparatus of, 810.
Nemertines, Development of, 1004.
——, Excretory Organs of, 244.
"Nemo," 533.
Nepa cinerea and Notonecta glauca, Developmental History and Morphological Value of the Ova of, 447.
Nepenthes, Spiral Cells of, 1023.
Nephelis, Metamorphosis of, 241.
Nephridia of a New Species of Earthworm, 999.
—— of Acanthodrilus sp., 813.
—— of Microstoma lineare, 813.
Nephridial and Circulatory Apparatus of the Nemertea, 810.
Nephritis and Cystitis, produced by Micrococcus ureæ, 1017.
Nephrolepis, Root-organs of, 1033.
Neptunea, Gill in, 226.

Nerve-end Organs in the Antennæ of Myriopods, Demonstrating, 896.
Nerve-fibres, Medullated, Staining the Axis-cylinder of, 742.
—— ——, Parietal Cells in, 428.
Nerve-terminations on the Antennæ of Myriopoda, 448.
Nerves in Muscle, Staining, 903.
——, Method for showing the Distribution and Termination of, in the Human Lungs, 894.
Nervous Organs, Central, Investigating the Structure of, 730.
—— System and Embryonic Forms of Gadinia garnotii, 224.
—— —— and Histology of Calcareous Sponges, 1011.
—— ——, Central, Application of Borax-methylen-blue in the Examination of, 731.
—— ——, ——, Method for Displaying the Course of the Fibres in, 159.
—— ——, ——, Modified Hardening Process for, 340.
—— ——, ——, Perchloride of Mercury in the Study of, 904.
—— ——, ——, Preparations of, for Projection, 146.
—— ——, ——, Weigert's Staining Method for, 158, 159.
—— ——, New Double Stain for, 741.
—— —— of Acœlomate Planarians, 1004.
—— —— of Apus, 805.
—— —— of Archiannelides, 62.
—— —— of Bothriocephalidæ, 646.
—— —— of Buccinidæ and Purpuridæ, 793.
—— —— of Embryos of Limacina, 228.
—— —— of Fissurella, 624.
—— —— of Gadinia garnotii, 224.
—— —— of Muzzle and Upper Lip of the Ox, Staining, 555.
—— —— of Nematodes, Origin of, 458.
—— —— of Polychætous Annelids, 644.
—— —— of Priapulus and Halicryptus, 645.
—— —— of Sponges, 253.
—— —— of Tænia, 244, 459.
—— ——, Preserving Sections of, Treated with Bichromate of Potash and Nitrate of Silver, 731.
—— ——, Sympathetic, of Periplaneta orientalis, Preparing, 538.
Net for Microscopists, 535.
Neumayr, M., Classification of the Lamellibranchs, 625.
——, Hinge of the Shells of Bivalves, 229.
Neville, J. W., 566.
New York Microscopical Society, Journal of, 332.
Nicati, W., and Rietsch, Attenuation of the Choleraic Virus, 1051.
—— ——, Odour and Poisonous Effects of the Fermentation produced by the Comma Bacillus, 298.
Nicholson, W. O., 563.
—— and H. S. Carpenter, Examination of Water for Organisms, 560.
Nicol Prism, Repairing, 891.
Niemiec, J., Morphology of Suckers of Animals, 431.
——, Nervous System of Bothriocephalidæ, 646.
——, —— —— of Tænia, 244, 459.
Nikolaides, R., Phenomena of Contraction in Striated Muscle, 428.
Nitrates and Nitrites, Microchemical Detection of, in Plants, 359.
——, Formation of, in Plants, 275.
Nitrogen, Atmospheric Absorption of, by Plants, 680.
—— of the Leguminosæ, Source of, 680.
——, Source of, in Plants, 275.
Nobert's Ruling Machine, 377.
Node of Equisetum, 840.
Noll, F., Eau de Javelle as a Medium for Clarifying and Dissolving Plasma, 893.
Norway, Laminariaceæ of, 1039.
Norwegian North Sea Expedition, Sponges of, 658.
Nose-piece, Bertrand's Adapter, 525.
Notonecta glauca, and Nepa cinerea, Developmental History and Morphological Value of the Ova of, 447.
Nowakowskia, a new Genus of Chytridiaceæ, 846.
Nuclei and Chromatophores, Distribution of, in the Schizophyceæ, 691.
——, Cell-, Significance of, in the Processes of Heredity. 975.
—— in Blood-corpuscles, Demonstrating, 730.
Nucleolus, Structure of, 821.
Nucleus, Behaviour of, after Division, 475.
——, Division of, 86.
——, ——, in Plants and Animals, 666.
——, ——, in Tradescantia, 475.
—— of the Germinal Vesicle in Arthropoda, Staining, 905.
——, Structure and Division of, 262, 474.
Nudibranchs, "Challenger," 43.
Nusbaum, J., Development of the Sexual Organs of Clepsine, 455.
Nussbaum, M., and A. Gruber, Artificial Division of Infusoria, 472.
Nutations of Seedlings, 490.
——, Spontaneous, Mechanical Explanation of, 273.

Nutrient Substances, Non-, Absorption by the Plant of, 1032.
Nutrition of Trees by means of Underground Fungi, 844.
Nutritive Properties of the Various Portions of the Grain of Wheat, 671.
Nyctitropic Movements of Leaves, 273.

O.

Obelia, Origin of Sexual Cells in, 250.
"Obituary," 143.
Objective, Griffith's Mechanical Finger, 709.
——, Supposed Increase of the Aperture of, by Using Highly Refractive Media, 1077.
Objectives, An Improvement in, 705.
—— and Oculars, Choice of, 1082.
——, Care and Use of, 708.
——, Gundlach's Improved, 863.
——, Magnifying Power of, and Position of Wollaston Camera, 335.
——, Measurement of Power and Aperture of, 1082.
—— of Large Aperture, Cost of, 325.
——, Series of, 863.
——, Testing the Different Sectors of, 324.
——, Universal Screw for, 335,
Oblique Illuminators, 129, 130.
Ocular. See Eye-piece.
Ognew, J., 1111.
Oidium, New Parasitic, 505.
Oil, Mineral, Composition of, in Relation to the Plants which have produced it, 276.
—— Receptacles in the Fruit of Umbelliferæ, 89.
Oldfield, W., 1081.
Oldham, W. P., 533.
Oleander, Development of Sclerenchymatous Fibres of, 478.
Olivier, L., Method for Observing Protoplasmic Continuity, 892.
Oltmanns, F., Conducting Water in the Stem of Mosses, 682.
——, Movement of Water in Mosses, 493.
Onion, Wild, Fertilization of, 1028.
Onoclea, Third Coat in the Spores of the Genus, 493.
Oogenesis in Branchiobdella, 643.
Opaque Dry Objects, Mounting without Cover-glass, 161.
—— Objects, Dry Mounting of, 560.
Ophioglossaceæ, Structure and Classification of, 1031.
Ophrydium versatile, Chemical Composition of Zoocytium of, 818.
Ophryocystis Bütschlii, 82.
Opossum, Development of, 976.
Optic Ganglion of Æschna, 800.
—— —— of Palinurus vulgaris, 450.
Ord, W. M., On Erosion of the Surface of Glass, when exposed to the Joint Action of Carbonate of Lime and Colloids, 381, 761.
"Orderic Vital," 891.
Oribatidæ, New British, 385.
Orley, L., Respiration of the Serpulaceæ in Relation to their Tegumentary Pigments, 64.
"Os," 533.
Osborn, H. F., Preparing Brain of Urodela, 536.
——, Simple Method of Injecting the Arteries and Veins in Small Animals, 1093.
——, H. L., Gill in Neptunea, 226.
—— and E. B. Wilson, Mimicry among Marine Mollusca, 795.
Osborne, J. A., Embryology of Botys hyalinalis, 447.
——, Lord S. G., 143.
——, ——, Diatomescope, 128.
Osmunda, Apex of the Root in, 1033.
Osseous Tissue, Decalcification and Staining of, 905.
Osten-Sacken, C. R., Comparative Chætotaxy, 52.
Osteomyelitis, Acute Infectious, Micrococcus in, 508.
—— -cocci, Development of, in the Organism, 290.
Ostroumoff, A., Metamorphosis of Cyphonautes, 798.
Otocyst, Relations of, in Limacina, 228.
Otto, J. G., 566.
Oudemans, A. C., Circulatory and Nephridial Apparatus of the Nemertea, 810.
Ova and Embryos of the Aphides, Treatment of, 147.
——, Formation of, in Pyrrhocoris, 798.
——, Frog's, Demonstrating Spindle-Bodies in Yolk of, 895.
——, Influence of External Conditions on the Development of, 423.
——, Mammalian, Formation of Spindles in, during Degeneration of the Graafian Follicle, 975.
——, Meroblastic, Preparing, 340.
—— of Bombyx, Composition of, 441.
—— of Nepa cinerea and Notonecta glauca, Developmental History and Morphological Value of, 447.
——, Pelagic Teleostean, Origin of the Hypoblast in, 214.
——, Young, of Frogs, Spindle-shaped Bodies in the Yolk of, 213.
Ovary and Perianth, Relation of, in the Development of Dicotyledons, 1026.

Oviparous Reproduction in the Monotremes, 33.
Ovules, Curvature of, 267.
——, Fecundation of, in Angiosperms, 270.
——, Petalody of, 676.
Ovum, Isotropy of, and Problem of Fertilization, 421.
—— of Axolotl, Karyokinesis in Segmentation of, 976.
Owen, D., Clearing Fluid for Vegetable Tissues, 366.
——, Mounting Sections Stained with Picro-carmine, 164.
Ox, Staining the Nervous System of the Muzzle and Upper Lip of, 555.
Oxalis, Protective Contrivances in the Bulbs of, 92.
Oxygen, Absorption of, in Leaves kept in Darkness, 678.
——, Influence of, on Fermentation by Schizomycetes, 850.
Oyster, Development of, 226.
——, Viviparous Edible, Development of, 436.
——, Rock, Parasite of, 1000.

P.

P., T., 143.
Pachydrilus enchytræoides, Organization of, 1000.
Pacific, North, Copepoda of, 454.
Packard, A. S., Brain of Asellus and Cecidotæa, 238.
——, Embryology of Limulus polyphemus, 806.
——, Number of Abdominal Segments in Lepidopterous Larvæ, 636.
——, Unusual number of Legs in the Caterpillar of Lagoa, 990.
Palinurus vulgaris, Optic Ganglion of, 450.
Paludicella, New Species of, 47.
Pancreatic Function of the Cephalopod Liver, 622.
Paneth, J., Histology of Pteropods and Heteropods, 42.
Papaver, Soluble Yellow Pigment in the Petals of, 476.
Paper, Nutritive, 111.
Paraffin, Imbedding in, 1086, 1096.
——, ——, by means of a Vacuum, 149.
——, Parabolic Mirror for Correction of too hard or too soft, 344.
Parallel Rays in Photo-micrography, 528.
Parasite, Flagellate Infusorian, on Trout, 82.
——, New Fungus, on the Rose, 847.
——, New Infusorian, 81.
—— of the Rock Oyster, 1000.
Parasite, Rhodomyces, a New Human, 1046.
Parasites, Infusorial, of the Tasmanian White Ant, 662.
—— of Fresh-water Fishes, 647.
—— of Mæna vulgaris, 805.
Parasitic Cattle-disease, "Rauschbrandpilz," 300.
—— Copepod of the Clam, 239.
—— Fungi, 105.
—— —— on Aurantiaceæ, 106.
—— —— on the Mulberry, 290.
—— Fungus on the Red-currant, 291.
—— Infusoria, New, 81.
—— Oidium, New, 505.
—— Phanerogams, Haustoria of, 268.
—— Pneumonia, Infectious, 510.
Parasitism, Change of Sarcopsylla penetrans through, 447.
Parenchyma, Paratracheal, Peculiar Structure of Protoplasm in, 1020.
Parenchymatous Tissues, "Bleeding" of, 837.
Parona, New and Little-known Protista, 261.
Parsons, F. A., Hydroid form of Limnocodium Sowerbii, 168.
Parthenogenesis in Spirogyra, 285.
Passerini, G., Fungi Parasitic on the Mulberry, 290.
Pasteur, L., Origin of Microzymes and Vibrios of Air, Water, and Soil, 295.
'Pathological Mycology,' Woodhead and Hare's, 698.
Patouillard, N., Helicobasidium, a new Genus of Hymenomycetes, 1045.
Patten, W., Artificial Fecundation of Mollusca, 623.
——, Development of Phryganids, 53.
Pax, F., Anatomy of Euphorbiaceæ, 824.
Pear Blight, 1053.
Pedley, P. R., Stupefying Active Forms of Aquatic Life, 165.
Peduncles, Anatomy of, compared with that of the Primary Axes and of Petioles, 833.
Pelagic Algæ, 684.
Pelargonium zonale, Changes in Hairs of, and in the Cell-walls of Epidermal Cells, 668.
Pelletan, J., 533, 566, 1081.
Pelley, C. le, 747.
Pelseneer, P., Coxal Glands of Mygale, 639.
——, Nervous System of Apus, 805.
Peltidea aphthosa, Formation of Thalli on the Apothecia of, 843.
Penhallow, D. P., Handle for Cover-glasses, 1115.
——, Relation of Annual Rings of Exogens to Age, 1023.

Penicillium-Ferment in Pharmaceutical Extracts, 1046.
Penny, W. G., 143.
Penzig, O., Cystoliths of Cucurbitaceæ, 87.
——, Fungi parasitic on Aurantiaceæ, 106.
——, —— —— on the Mulberry, 290.
Peragallo, H., 748.
Pereyaslawzew, S., Development of Rotifers, 1006.
——, Development of Turbellaria, 648.
Pergens's Picrocarmine, 558.
Perianth and Ovary, Relation of, in the Development of Dicotyledons, 1026.
Pericycle of the Root, Stem, and Leaves, 673.
Peridiniæ, 468.
——, Marine, 469.
Peripatus, Development of, 56.
—— capensis, Development of, 802.
—— Edwardsii, and P. torquatus, Preparing Embryo of, 734.
Periplaneta orientalis, Orientation of the Embryo and Formation of the Cocoon of, 991.
—— ——, Preparing the Sympathetic Nervous System of, 538.
Peristome of Bryaceæ, 1035.
—— of Mosses, 100.
Perravex, E., Formation of Egg-shell in Dogfish, 425.
Perrier, E., Ambulacra of Echinoderms, 815.
——, Brisingidæ of the 'Talisman' Expedition, 1009.
——, Development of Comatula, 655.
Perroncito, E., Action of Sodium Chloride on Cercariæ, 814.
Petalody of Ovules, 676.
Petals, Epidermis of, 481.
Petioles, Anatomy of Peduncles compared with that of the Primary Axes and of, 833.
Pfaff's (F.) Microgoniometer, 702.
Pfitzer, E., Assimilating Cavities in the interior of Tubers of Bolbophyllum, 671.
Pfurtscheller, P., Anatomy of the Wood of Conifers, 825.
Phæospore, Lithoderma fontanum, a New Fresh-water, 285.
Phalangida, Coxal Gland in, 58.
Phallus impudicus, Structure of, 505.
Phallusia scabroides, Postembryonal Development of, 795.
Phanerogamia, Anatomy and Physiology of. See Contents, xxi.
Pharmaceutical Extracts, Penicillium-Ferment in, 1046.
Phenol and Collodion in Microscopical Technique, 559.
Philibert, Peristome of Bryaceæ, 1035.
——, —— of Mosses, 100.
Phillips, P. A., 338.
Phlougria, Marine Species of, 239.
Phipson, T. L., Chemical Phenomena of the Respiration of Plants, 488.
Phœnicurus, 1005.
Phoriospongiæ, The, 1012.
Phoronis, Blastopore, Mesoderm, and Metameric Segmentation in, 242.
Phosphorescence of Marine Animals, 981.
Phosphorus, Diatoms in, 354.
——, Mounting in, 353.
Photogenic Fungi, Spectroscopic Examination of, 504.
Photographing, Selection and Preparation of Objects for, 911.
Photo-micrograph of Tongue of Blow-fly, 1077.
Photo-micrographic Purposes, Staining Bacteria for, 166.
Photo-micrographs, Value of, 528.
Photo-micrography, 338.
—— ——, Actinic and Visual Foci in, with High Powers, 1070.
—— ——, Atwood's Apparatus for, 330.
—— ——, Optical Arrangements for, 1070.
—— ——, Parallel Rays in, 528.
—— ——, Staining Tissues for, 559.
Phryganids, Development of, 53.
Phycochromaceæ, Occurrence of Chromatophores in, 102.
Phycomyces, Law of Growth of Fructification of, 288.
Phylloglossum Drummondii, Morphology of, 1034.
Phylogeny of Echinoderms, 651.
Physiology of the Phanerogamia. See Contents, xxi.
Phytophagous Larvæ, Nature of the Colouring of, 801.
Phytopus, Structure and Affinities of, 236
Piccone, A., Phytophagous Fishes as Disseminators of Algæ, 843.
Pick, H., Red Pigment of Phanerogams, 265.
Picrocarmine, Mounting Sections stained with, 164.
——, Pergens's, 558.
——, Staining Vegetable Tissues in, 165.
Piersol, G. A., Staining Tissues for Photo-micrography, 558.
Pigment, Red, in Flowering Plants, 670.
——, ——, of Phanerogams, 265.
——, Soluble Yellow, in the Petals of Papaver, 476.
Pigment-bodies, Spontaneous Movements of, 476.

Pigments, Enterochlorophyll and allied, 621.
——, Lepidopterous, Action of Ammonia upon, 52.
—— of Green Leaves, Spectra of, and their Derivatives, 670.
——, Tegumentary, Respiration of the Serpulaceæ in Relation to their, 64.
Pilobolidæ, 292.
Pines and Larches, Organs of Secretion in, 269.
Pirotta, R., Cystopus Capparidis, 107.
Pitcher-plants, Anatomy of, 1024.
Pitres, A., Psorosperm in the Human Pleural Cavity, 261.
Placenta, Fœtus of Gibbon and its, 783.
——, Nature of the Placental Neoformation and the Unity of Composition of, 783.
Planarians, Accelomate, Nervous System of, 1004.
Plasma, Eau de Javelle as a Medium for Clarifying and Dissolving, 893.
Plasmodiophora Alni, 844.
Plasmolysis, 84.
Plate, L., Structure of Rotatoria, 65.
Plateau, F., Absolute Force of the Muscles of Invertebrates, 58.
Plaut's Staining Process for the Demonstration of Saprogenous and Pathogenous Micro-organisms, 342.
Pleomorphy of Pathogenic Bacteria, 1049.
Pleural Cavity, Human, Psorosperm in, 261.
Pleurobranchus, Communication of the Vascular System with the Exterior in, 794.
Pleuroweisia, a New Genus of Mosses, 1036.
Plössl's Electrical Apparatus, 867.
Plowright, C. B., Life-history of certain British Hetercœcismal Uredineæ, 288.
——, Reproduction of the Heterœcious Uredineæ, 503.
Plumbagineæ, Calcareous Glands of, 92.
Pneumonia, Infectious and Parasitic, 510.
Pneumonia-cocci in Dormitories as a Cause of Pneumonia, 300.
Pneumonomycosis of Birds, 848.
Poa, Cecidomyia-galls on, 1026.
Podophrya fixa, Unstalked Variety of, 662.
Poggi, T., Fungi Parasitic on the Mulberry, 290.
Poirier, J., Anatomy and Systematic Position of Halia priamus Risso, 524.
——, Trematoda, 1002.
Polarized Light in Vegetable Histology, 357.
Polarizing Prism, Bertrand's, 133.
—— Prisms, Madan's Modifications of Foucault's and Ahrens', 328.
Poleck, Composition and Spore-cultivation of Merulius lacrymans, 845.
Poletajew, N., Spinning Glands of Sawflies, 442.
Pollen of Gymnosperms, 484.
Pollen-grains, Studying, 1085.
Pollens and Smuts, Staining and Mounting, 349.
Polycladidea, 245.
Polycystina, Cleaning and Mounting, 165.
Polygordius, Development of the Head of, 808.
Polymorphism in the Amphipoda, 997.
—— of Algæ, 1037.
Polynoina, Elytra of some, 456.
Polyphemus pediculus, Amœboid Movements of Spermatozoa of, 239.
Polyporus, Monograph of, 289.
—— sulfureus, Mycelial Conidia of, 289.
Polyzoa. See Contents, xii.
Pomatias and Cyclostoma, 436.
Pommer, G., Decalcification and Staining of Osseous Tissue, 905.
Poppe, S. A., Copepoda of the North Pacific, 454.
Porcelain, Effect of Prolonged Repose and Filtration through, on the Purity of Water, 561.
Porifera. See Contents, xix.
Porpita mediterranea, Histology of, 463.
Port Jackson, Beroid of, 1011.
Portraits of Presidents, 1121.
Position of Objects with the Binocular, 1075.
Postal Microscopical Section of Royal Society of South Australia, 891.
Postembryonal Development of Phallusia scabroides, 795.
Potash, Bichromate of, Preserving Sections of the Nervous System treated with, 731
Potato, "Sclerotioids" of, 1022.
Pottia Güssfeldti, a New Moss, 682.
——, Spores of, 1036.
Potts, E., Fresh-water Sponge from Mexico, 1014.
——, Minute Fauna of Reservoirs, 433.
——, Modification in the Form of Sponge Spicules, 75.
——, New Fresh-water Sponge, 658, 817.
—— New Species of Paludicella, 47.
——, Wide Distribution of some American Sponges, 76.
Pouchet, A. G., Cholera Bacillus, 1051.
——, Marine Peridiniæ, 469.

Poulton, E. B., Nature of the Colouring of Phytophagous Larvæ, 801.
"Pourridié" of the Vine, 107.
Powders, Examining Vegetable, 562.
Powell & Lealand's Rings for Throwing the Coarse Adjustment out of Gear, 525.
Power and Aperture of Microscopic Objectives, Measurement of, 1082.
Prantl, K., Structure and Classification of Ophioglossaceæ, 1034.
Pratt, W. F., Staining Vegetable Tissues in Picrocarmine, 165.
Prazmowski, A., History of Development and Morphology of Bacillus anthracis, 297.
President's Address, 177.
Presidents, Portraits of, 1121.
Pressure, Apparatus for Watching the Phenomena that Animals subjected to great, present, 876.
Pressures, Effect of High, on the Vitality of Ferments and on Fermentation, 693.
Priapulus, Skin and Nervous System of, 645.
Primitive Layers in Cuma Rathkii, Development of the Egg and Formation of, 238, 641.
—— Streak in Osseous Fishes, 425.
Pringsheim's (N.) Gas Chambers, 720.
Prinz, W., Sections of Diatoms from the Jutland "Cementstein," 843.
Prior, Cholera Bacillus, 1050.
Prism, Right-angled, instead of a Plane Mirror, 709, 864.
"Prismatique," 338.
Prisms, Improved Form of Stephenson's Erecting and Binocular, 959.
Problematic Organisms of the Ancient Sea, 1039.
Proceedings of the Society. See Contents, xliv.
Procella, 1081.
Production of Male and Female Plants, 677.
Projection, Preparations of the Central Nervous System for, 146.
Prosobranchiata, Renal Organ of, 793.
Proteids, Digestion of, in Plants, 1030.
Prothallium of Lycopodium, 277, 839.
Protista, New and Little-known, 261.
Protophyta. See Contents, xxxi.
Protoplasm and its Powers of Resistance, 421.
——, Circulation and Rotation of, as a means of Transport of Food-material, 665.
——, Continuity of, 473.
——, Examining Movement of, in the Styles of Indian Corn, 1106.
Protoplasm in the Intercellular Spaces, 820.
——, Intercellular, and Protoplasts, Connection of, 83.
——, Peculiar Structure of, in the Paratracheal Parenchyma, 1020.
——, Various Degrees of Resistance in, 1019.
Protoplasmic Continuity in the Fucaceæ, 682.
—— ——, Methods for Observing, 540, 892.
Protoplasts and Intercellular Protoplasm, Connection of, 83.
——, Intercellular Relations of, 84.
Prototracheata. See Contents, xiv.
Protozoa. See Contents, xx.
Prouho, Anatomy of Dorocidaris, 815.
——, Larval Form of Dorocidaris papillata, 1008.
Pruvot, G., Nervous System of Polychætous Annelids, 644.
Pseudo-cyclosis, 663.
—— —— in Amœba, 1019.
Pseudopodia, Experiments on Formation of, 1014.
Pseudorhiza haeckelii, 71.
Pseudoscopy, Discovery of, 722.
Psorosperm in the Human Pleural Cavity, 261.
Pteris aquilina and Struthiopteris germanica, Anatomy of Vegetative Organs of, 492.
Pteropods, Histology of, 42.
Puccinia Thlaspidis, 1045.
Pulmonata, Development of Generative Organs of, 623.
Pumphrey, W., 533.
——, Parallel Rays in Photo-micrography, 528.
Punches, Cheap, for Sheet Wax, 337.
Puppy, Preparing Tail of, 894.
Purpuridæ, Nervous System of, 793.
Puzzles, Aperture, 721, 882.
Pycnogonida, Australian, 994.
Pyronema confluens, Development of, 289.
Pyrrhocoris, Formation of Ova in, 798.

Q.

Queen, J. W., 728, 748.
——, Centering the Illuminating Beam, 524.
—— Lens-holders, 317.
——, Table of Colour-corrections, 1068.
——, J. W., & Co., 728, 891.
—— —— Class Microscope, 119.
—— —— Prepared Diatoms in Fluid ready for Mounting, 927.
—— —— Slide Case, 1111.

R.

R., R. D., 533.
Rabenhorst's Cryptogamic Flora of Germany (Fungi), 690.
—— —— —— —— (Marine Algæ), 685.
Rabl, C., Cell-division, 217.
——, Preparing Tissues to show Cell-division, 893.
—— Slide for Viewing Objects on both Sides, 329.
Radoszkowski, O., Copulatory Apparatus of Male Bombus, 50.
Radula, 282.
—— of Cephalophorous Molluscs, 434.
Ralph, T. S., Examining Blood in Typhoid Fever, 1104.
Rana temporaria, Early Development of, 785.
—— ——, Fate of Blastopore of, 425.
Ransom, W., Cardiac Rhythm of Invertebrates, 789.
Ranunculaceæ, Anatomy of the Fruit of, 831.
——, Structure of, 674.
Rat, Spermatogenesis in, 783.
Ratte, F., Larvæ and Larva-cases of some Australian Aphrophoridæ, 992.
Rauber and Sachsse, Influence of external conditions on the Development of Ova, 423
"Rauschbrandpilz," a parasitic cattle-disease, 300.
Rayleigh, Lord, 143.
Rays of Osseous Fishes, Development of, 213.
—— Unicellular Glands in Cloaca of, 221.
Rebourgeon, Microbe of Yellow Fever, 694.
Receptacle, Morphology of, 831,
Receptaculum Seminis of Bees and Wasps, 1.
"Rector, F.R.A.S.," 891.
Red-currant, Parasitic Fungus on, 291.
Reess, E., Systematic Position of Saccharomyces, 294.
Refracting Media, Highly, supposed increase of the Aperture of an Objective by using, 1077.
Refractive Index, Device for Testing, 1066.
—— ——, High, Micrometers mounted in Media of, 330.
—— ——, ——, Smith's Mounting Media of, 753, 1097.
Regeneration of Excised Parts and Tenacity of Life in Lumbricus terrestris, 455.
Regnard, P., Apparatus for watching the phenomena that animals subjected to great pressure present, 876.
Reichert's (C.) Microtome Object-clamp, 347.
—— Mineralogical-Geological Microscope, 858.
——, No. VII. Microscope, 302.
——, Simple Hand-Microtome, 346.
Reighard, J., Anatomy and Histology of Aulophorus vagus, 1001.
Reinhardt, L., Morphology and Classification of Black Sea Algæ, 1039.
Reinke, J., Decomposition of Solutions of Chlorophyll by Light, 669.
——, Fluorescence of Chlorophyll in Leaves, 88.
Renal Organ of Prosobranchiata, 793.
Repiachoff, M., New Turbellarian, 248.
Reproductive Organs of Crania, 233.
Reserve-products, Hydrocarbon, of Mushrooms, 1044.
Reservoirs, Minute Fauna of, 433.
Resolution, on the Limits of, in the Microscope, 968.
Respiration and Transpiration of Fungi, 104.
—— of Germinating Seeds, 272.
—— of Leaves in Darkness, 488.
—— of Plants, 94, 835.
—— —— at Different Seasons, 836.
—— ——, Chemical Phenomena of, 488.
—— of the Serpulaceæ in relation to their Tegumentary Pigments, 64.
—— of Tissues not containing Chlorophyll, 94.
—— of Truncatella, 986.
——, Variation of, with Development, 679.
Respiratory Combustion, 95.
Retina of Cephalopoda, 41.
Retterer, Development of Vascular Glands, 787.
Reynolds, R. N., 165.
Rhabdonema arcuatum, Conjugation of, 842.
Rhabdopleura, 46.
Rhizopod, New, 82.
Rhizopoda, Marine, 1016.
Rhizopods, Collecting, 534.
——, Reticular, New Condition of, 1017.
——, Reticular Structure of, 471.
Rhodomyces, a New Human Parasite, 1046.
Rhythm, Cardiac, of Invertebrates, 789.
Ribbert, M., Development of Osteomyelitis-cocci in the Organism, 290.
——, Staining Bacteria with Dahlia, 558.
Ribbons of Sections, Cutting, 157, 158, 552.
Ribesin and Eosin, 342.
Richard, J., Action of Cocain on Invertebrates, 621.

Richard, J. Cocain for Mounting Small Animals, 893.
——, O. J., 165.
Richmond Athenæum, 144.
Richter, P., Beggiatoa roseo-persecina, 508.
——, Microcystis, 692.
Riddell's (J. L.) Binocular Compound Microscope, 1059.
Ridley, S. O., Structures liable to Variation in the Astrangiaceæ (Madreporaria), 73.
Riesengebirge, Fauna of the Pieces of Water of, 433.
Rietsch, Odour and Poisonous Effects of the Fermentation produced by the Comma Bacillus, 298.
—— and W. Nicati, Attenuation of the Choleraic Virus, 1051.
Rimmer, F., Nutations of Seedlings, 490.
Ring, Internal Cambium, in Gelsemium sempervirens, 478.
——, Mechanical Penetration of, for the Transport of Food-material, 479.
——, Thickening, in Exogens, Growth of, 478.
Rings, Annual, of Exogens, Relation of to Age, 1023.
—— for Throwing the Coarse Adjustment out of Gear, 525.
Rischawi, L., Galvanotropism, 1032.
Rob. Crus., 728, 891.
Robin, C., Death of, 1118.
Robinson's Miniature Microscopic Camera, 528.
Roboz, Z. v., Calcituba polymorpha, 258.
Rocher, B. du, Megaloscopy, 1061.
Rogers, W. A., Micrometers mounted in Media of High Refractive Index, 330.
——, Mounting of Opaque Objects, 560.
—— Section-cutter, 347.
Rohde, E., Muscles of Chætopoda, 456.
Rohrbeck, H., 748.
Rollett's Electrical Apparatus, 874.
Romanes, G. J., Homing Faculty of Hymenoptera, 990.
Rombouts, J. E., Movement of Flies on Smooth Surfaces, 636.
Romiti, G., 748.
Rommier, A., Cultivated Wine-yeast, 114.
Root, Apex of, Geotropic Sensitiveness of, 96.
——, ——, in Osmunda and Todea, 1033.
—— of Todea, Apical Growth of, 839.
——, Pericycle of, 673.
Root-organs of Nephrolepis, 1033.
Root-swellings of Juncus bufonius, Fungus of, 107.
Roots, 272.
——, Deviation of, from their Normal Direction through the Influences of Gases, 96.
——, Galvanotropism of, 836.
——, Influence of the Medium on the Structure of, 832.
——, Motions of, during growth, 272.
—— of Æthalium septicum, Thermotropism of, 844.
——, Supply of Air to, and Root-pressure, 490.
——, Thermotropism of, 679.
Rose, New Fungus-parasite on, 817.
Rosenvinge, L. K., Parthenogenesis in Spirogyra, 285.
Rosseter, T. B., Uses and Construction of the Gizzard of Larvæ of Corethra plumicornis, 991.
Rössler, R., Radula of Cephalophorous Molluscs, 434.
Rotatoria, Pelagic and Fresh-water, 814.
——, Structure of, 65.
Rothrock, J. T., Internal Cambium Ring in Gelsemium sempervirens, 478.
Rotifer, New, 1007.
—— vulgaris, Reproduction and Development of, 249.
Rotifera, On Five new Species of, 608.
Rotifers and Nematodes, Relationship of, 1006.
——, Development of, 1006.
Roule, L., New Species of Simple Ascidians, 45, 631.
Roux, G., Cystitis and Nephritis produced by Micrococcus ureæ, 1047.
——, Small Negatives, 528.
Royal Microscopical Society, Deputation from, 339.
Royston-Pigott, G. W., 338, 1081.
——, Limit of Angular Vision, 339.
——, Note on the Structure of the Scales of Butterflies, 165.
Rulf, P., Behaviour of Tannin in Germination, 272.
Rusby, H. H., Opening of the Anthers in Ericaceæ, 675.
Ruschhaupt, G., Development of Monocystid Gregarines, 665.
Russell, W. J., Conditions of the Development and of the Activity of Chlorophyll, 1020.
Russow, E., Protoplasm in the Intercellular Spaces, 820.
Ryder, J. A., Cheap Bell-glass for the Laboratory Table, 1111.
——, Chlorophylloid Granules of Vorticella, 78.

Ryder, J. A., Development of the Rays of Osseous Fishes, 213.
——, —— of Salmon, 786.
——, ——of Viviparous Osseous Fishes, 978.
——, Position of the Yolk-Blastopore as determined by the Size of the Vitellus, 978.
——, Translocation forwards of the Rudiments of the Pelvic Fins in the Embryos of Physoclist Fishes, 618.

S.

S., J. T., 144.
S., W., 366.
Sabatier, A., Eggs of Ascidians, 987.
——, Follicular and Granular Cells of Tunicates, 44.
——, Spermatogenesis in Decapod Crustacea, 237.
Saccardo, P. M., Fungi Parasitic on the Mulberry, 290.
Saccharomyces, Occurrence of Variations in the Development of a, 16.
——, Systematic Independence and Position of, 294.
Sacculina, Evolution of, 454.
Sachs, J., 339.
——, Preparing Leaves to show Starch-grains, 1084.
Sachsse, Influence of external conditions on the development of Ova, 423.
Säfftigen, A., Preparing Echinorhynchi, 147.
Sagittaria sagittæfolia, Stolons of, 479.
Sahli, H., Application of Borax methylen-blue in the Examination of the Central Nervous System, 731.
——, New Double Stain for the Nervous System, 741.
St. Clair, R. W., New Electric Lamp, 339.
Saint-Loup, Organization of Pachydrilus enchytræoides, 1000.
——, —— —— the Hirudinea, 807,
——, Parasites of Mæna vulgaris, 805.
Salensky, W., Development of Monopora vivipara, 811.
Salivary Glands, Staining, 1095.
Salmon, D. E., Culture-tube, 145, 367.
——, and T. Smith, 566.
——, New Chromogenous Bacillus, B. luteus suis, 1052.
Salmon, Development of, 786.
Santa Monica, New Diatomaceous deposit at, 173.
Santalum, Embryo-sac of, 830.
Sap, Ascent of, 1031.
——, Movement of Ascending, 489.
Saporta, G. de, Problematic Organisms of the Ancient Sea, 1039.
Sarasin, P. B. and C. F., Development of Epicrium, 618.
Sarcodictyon, Structure of, 253.
Sarcopsylla penetrans, Change of, through Parasitism, 447.
Sarcopsyllidæ, New genus of, 447.
Sarcoptidæ, 803.
Sarcosporidia, New Type of, 820.
Sarsia radiata, Flexor Muscle of the Hydroid Polyp of, 72.
Satterthwaite, T. E., 566.
Saunders, W. D., 165.
Savastano, L., 927.
——, Hypertrophy of the Bud-cones of the Carob, 675.
Saw-flies, Spinning Glands of, 442.
Sazepin, B., Demonstrating Nerve-end Organs in the Antennæ of Myriopods, 896.
——, Nerve-terminations on the Antennæ of Myriopoda, 448.
Scales of Butterflies, note on Structure of, 165.
—— of Coleoptera, 442.
Schaarschmidt, G., Cell-wall-thickenings and Cellulin-grains in Chara and Vaucheria, 838.
——, Hibernation of Zygnemaceæ, 284.
——, Vegetative Changes of Form in Chlorosporeæ, 283.
——, J., Connection of Protoplasts and Intercellular Protoplasm, 83.
——, Gongrosira, 103.
——, Staining Vaucheria and Chara, 557.
Schacht's Electrical Apparatus, 868.
Schäfer, E. A., 927.
——, Electrical Apparatus, 872.
Schanze's (M.) Microtome, 547.
Scharff, R., Skin and Nervous System of Priapulus and Halicryptus, 645.
Scheit, M., Air in Water-conducting Wood, 679.
Schenck, H., Changes of Structure in Land-Plants when growing submerged, 674.
——, Formation of Centrifugal Thickenings in the Walls of Hairs and in the Epidermis, 267.
Scherrer, J., 728.
Schieck's, (J. W.), Bacteria Microscopes, 301.
——, Dissecting Microscopes with Brücke Lens, 319.
——, Microscope with Screw Stage-Micrometer, 861.
Schiefferdecker, P., 367, 927.
——, Anilin-green, 903.
Schimkewitsch, W., Change of Sarcopsylla penetrans through Parasitism, 447.
——, Development of Astacus, 805.

Schimkewitsch, W., Change of the Heart in Vertebrates and Invertebrates, 212.
——, New genus of Sarcopsyllidæ, 447.
—— and P. Bertkau, Sense-organ of Spiders, 993.
Schizomycetes, Influence of Oxygen on Fermentation by, 850.
Schizophyceæ, Distribution of Chromatophores and Nuclei in, 691.
Schizopoda, Circulation of, 60.
Schlechter, J., Causes of Sex, 215.
Schlen, v., Bacilli of Malaria, 1052.
Schliephacke, K., Pleuroweisia, a new genus of Mosses, 1036.
——, Pottia Güssfeldti, a new Moss, 682.
Schloesing, T., Absorption of Oxygen and Evolution of Carbon dioxide in Leaves kept in Darkness, 679.
Schmidt's Atlas der Diatomaceenkunde, 103.
Schmitz, F., Structure of Chromatophores, 109, 293.
Schneider, A., Anoplophyra circulans, 819.
——, Ophryocystis bütschlii, 82.
Schnetzler, J. B., Beggiatoa alba, 1046.
——, Remarkable Development of Aspergillus niger, 289.
Schoolroom, Microscope in the, 728.
Schott, 728.
Schrenk, J., Haustoria of Parasitic Phanerogams, 268.
Schröder, H., Bertrand's Polarizing Prism, 133.
—— Camera Lucida, 140.
Schrodt, J., Bursting of the Sporangium of Ferns and the Anther of Flowering Plants, 1032.
Schröller, Influence of Electricity on the Growth of Plants, 835.
Schröter, J., Classification of Fungi, 689.
Schüler, P., Relations of Cavernous Spaces in the Connective Tissue of Anodonta to the Blood-vascular System, 794.
Schulgin, A., Argiope Kowalevskii, 49.
——, Development of Amaræcium proliferum, 437.
Schultze, E. A., 339.
Schulze, C., Albuminoid Constituents of Plants, 97.
Schütz, Pneumonomycosis of Birds, 848.
Schützenberger, P., Respiratory Combustion, 95.
Schwarz, F., Behaviour of the Nucleus after Division, 475.
Schwendener, S., Firmness of Tissues, 476.
——, Laticiferous Vessels, 1022.
Science Studies, Influence of, 1081.
Sclerostoma boulardi, 244.
"Sclerotioids" of Potato, 1022.
Scorpio, Muscular and Endoskeletal Systems of, 992.
——, New Hypothesis as to the Relationship of the Lung-book of, to the Gill-book of Limulus, 639.
Scorpions, Direct Nuclear Division in the Embryonic Investments of, 448.
Scotland, Diatomaceous Deposits in, 287.
Screw, Universal, for Microscope Objectives, 335.
Scyllium Canicula, Preparing the Cloacal Epithelium of, 731.
Scyphomedusæ, Local Colour-varieties of, 71.
—— of the Southern Hemisphere, 71.
Sea, Ancient, Problematic Organisms of, 1039.
Sea-Anemones and Worms, Symbiosis of, 982.
Seaman, W. H., 533, 565, 927.
Seas, Shallow, influence of Wave-currents on Fauna of, 38.
Season Dimorphism in Spiders, 803.
Secreting Canals of Plants, 823.
Secretion, Organs of, in Pines and Larches, 269.
—— -receptacles, Mechanical Sheaths to, 267.
Secretions, Peptonizing Ferments in, 491.
Section-cutter. See Microtome.
Section-cutting, Notes on, 737.
—— ——, "Ribbon," 552.
Sections of Bone and Teeth, Rapid Method of making, 348.
—— of hard Organized Substances, Rapid Method of making, 553.
——, Series of, 740, 1092.
——, ——, Suggestions as to the Preparation and Use of, in Zootomical Instruction, 1091.
——, Thickness of, 1092.
Sedgwick, A., Development of Peripatus capensis, 802.
Sée, Infectious and Parasitic Pneumonia, 510.
Seedlings, Nutations of, 490.
Seeds, Albuminous, Absorbing Organs of, 829.
——, Germinating, Respiration of, 272.
——, Influence of Light on Germination of, 93.
——, Reducing Properties of, and Formation of Diastase, 276.
Seeliger, O., Development of Social Ascidians, 627.
Segmental Organs of Serpula, 458.

Segmentation of Axolotl Ovum, Karyokinesis in, 976.
Segments, Number of Abdominal, in Lepidopterous Larvæ, 636.
Seiler's (C.) Microtome Attachment, 1091.
Selaginella spinulosa, Development of the Vegetative Organs of, 279.
Selenka, E., Development of the Opossum, 976.
——, Imbedding in Paraffin, 1086.
Seligeriaceæ, Trochobryum, a new Genus of, 281.
Seminiferous Canals, Origin of Spermatozoids in, 979.
Semper's Method of making dry Preparations, Modification of, 898.
Sense-organ of Spiders, 993.
—— -organs of Calanidæ, 997.
—— —— of Spiders, 58.
Sensorial Organs of the Antennæ of Ants, 441.
Sepia and Limulus, Chitin as a Constituent of the Cartilages of, 222.
Series of Sections, 740, 1092.
—— ——, Suggestions as to the Preparation and Use of, in Zootomical Instruction, 1091.
Serpula, Formation of Trochosphere in, 240.
——, Segmental Organs of, 458.
Serpulaceæ, Respiration of, in Relation to their Tegumentary Pigments, 64.
Serpulea, Anatomy of, with Characteristics of Australian Species, 241.
Setæ, Histology of, 35.
Sex, Causes of, 215.
Sexes in Bees and Wasps, Apparatus for Differentiating, 1.
——, Regulation of the Proportion of, in Man, Animals, and Plants, 214.
Sexton, L. R., Obituary of, 339.
Sexual Characters in Zinnia, 267.
—— Organs of Clepsine, Development of, 455.
Sexuality, Development of, 974.
—— in the Zygnemaceæ, 285.
Seynes, J. de, Mycelial Conidia of Polyporus sulfureus, 289.
Sharp, B., Homologies of the Vertebrate Crystalline Lens, 430.
—— H., Mounting in Cells with Canada Balsam, 909.
——, Mounting the Proboscis of the Blow-fly in Biniodide of Mercury, 733.
Sheaths, Mechanical, to Secretion Receptacles, 267.
Sheep, Amœba infesting, 1018.
Shell, Hatching of Birds' Eggs after Lesion of, 784.
—— of Lamellibranchiata, 230.
Shell of Lamellibranchs, Structure and Function of, 44.
Shellac, Mayer's Carbolic Acid, 909.
——, Preparing Slides with, 164.
Shells of Bivalves, Hinge of, 229.
—— of Molluscs, 228.
——, Preparing Thin Sections of, 348.
Sieve-hyphæ in Algæ, 684.
—— -tube System of Cucurbitaceæ, 477.
—— -tubes, Course and Termination of, in Leaves, 90.
—— —— in the Leaves of Dicotyledons, 1020.
Sigillaria, Fructification of, 493.
Siliceous Films too thin to show a broken edge, 406.
—— Membrane with Properties of the Cell-wall, 263.
Silliman, W. A., Fresh-water Turbellaria of North America, 648.
Silver, Nitrate of, Preserving Sections of the Nervous System treated with, 731.
Silver-reducing Animal Organs, 619.
Simroth, H., Cyclostoma and Pomatias, 436.
Siphonophora, Cyclical Development of, 1010.
Sirodot, S., Batrachospermum, 494.
Skin of Priapulus and Halicryptus, 645.
Slack, H. J., 144, 166, 367, 566, 748, 927.
Sladen, W. P., Arbaciadæ, 652.
Slater, J. W., Influence of Magnetism upon Insect Development, 988.
Slide, a beautiful, 163.
—— Boxes, 910.
—— Case, 1111.
——, Double-sided, 908.
—— for Viewing Objects on both Sides, Rabl's, 329.
——, Hamlin's Ideal, 743.
Slides, Balkwill's Foraminifera, 1084.
——, Finish for, 744.
Slingo, W., 144.
Small Objects, Imbedding, 541.
Smith, C. V., death of, 533.
——, H. L., Device for Testing Refractive Index, 1066.
——, Influence of Science Studies, 1081.
——, Mounting Media of High Refractive Index, 352, 753, 1097.
——, New Cement, 1099.
——, S. I., New Crustacean, 807.
——, New Decapod Crustacea, 453.
——, T., 566.
——, New Chromogenous Bacillus—B. luteus suis, 1052.
Smuts and Pollens, Staining and Mounting, 349.
Societies, Microscopical, 332.

Sodium Chloride, Action of, on Cercariæ, 814.
Soils, Influence of Moisture in, on Plant Growth, 486.
Solger, B., Development of the Cœlom and Cœlomic Epithelium of Amphibia, 423.
Solla, R. F., 566.
——, Pelagic Algæ, 684.
Sollas, W. J., 1111.
——, Apparatus for Determining the Specific Gravity of Minute Objects under the Microscope, 879.
——, Development of Halisarca lobularis, 73.
——, Structure of the Skeleton in the Anomocladina, 464.
Solmsiella, a new Genus of Mosses, 101.
Sommer, A., Macrotoma plumbea, 637.
Sonsino, P., Small Rod-like Cell-contents of certain Cercariæ, 1003.
Sorby, H. C., 1082.
——, Autumnal Tints of Foliage, 97.
——, Dichroiscope, 121.
Southall, G., 339.
Southern Hemisphere, Scyphomedusæ of, 71.
—— Sea, Cœlenterates of, 656.
Southworth, E. A., Stomata of Equisetum, 99.
Sowing, Effect of Depth of, on the Germination and Growth of Plants, 93.
Spark, Electric, Stokes - Watson Apparatus, 728, 1069.
——, ——, Slide showing Path of, 727.
——, ——, under the Microscope, 888.
Spawning of Fulgur perversus, 986.
—— of the Cod, 786.
Specific Gravity of Minute Objects under the Microscope, Apparatus for Determining, 879.
Spectra, New Organic, 429.
—— of the Pigments of Green Leaves and their Derivatives, 670.
Spectroscopic Examination of Photogenic Fungi, 504.
Spectrum of Chlorophyll, Examining, 527.
Spee, F., Sections in Series, 740.
Spencer, W. B., Early Development of Rana temporaria, 785.
——, Fate of the Blastopore of Rana temporaria, 425.
——, Urinary Organs of Amphipoda, 640.
Spengel, J. W., Anatomy of Balanoglossus, 69.
Spermatogenesis in Branchiobdella, 643.
—— in Decapod Crustacea, 237.
Spermatogenesis in the Rat, 783.
——, Unity of Process of, in Mammalia, 615.
Spermatozoa of Polyphemus pediculus, Amœboid Movements of, 239.
Spermatozoids, Origin of, in the Seminiferous Canals, 979.
Sphæridia of the Echinoidea, Structure and Functions of, 1009.
Sphærogyna ventricosa, 449.
Sphærularia bombi, Development of, 646, 810.
Sphagnaceæ, European, 281.
Spicules, Flesh-, Occurrence of, in Sponges, 254.
——, Sponge-, Modification in form of, 75.
Spiders. See Arachnida.
Spinal Cord, New Method of Staining, 742.
Spindle-shaped Bodies in the Yolk of Young Ova of Frogs, 213.
Spindles, Formation of, in Mammalian Ova during the Degeneration of the Graafian Follicle, 975.
Spines, Histology of, 35.
——, Use of, in Cactuses, 1027.
Spinning Glands of Saw-flies, 442.
Spirogyra, Parthenogenesis in, 285.
Spirorbis borealis, Larval Forms of, 644.
Sponges. See Porifera.
Spongilla, Development of, 254, 817.
—— fragilis, 255.
—— lacustris, Reproduction of, 1011.
——, New Species of, 255.
Sporangia, Dehiscence of, in Vascular Cryptogams, 276.
Sporangium of Ferns, Bursting of, 1032.
—— of Frullania, Development of, 840.
—— of Trichia, Development of, 107.
Spore-coats and Germination of Hepaticæ, 101.
—— -cultivation and Composition of Merulius lacrymans, 845.
—— -formation, Internal, in Diatoms, 1041.
—— ——, Nocturnal, in Botrytis cinerea, 690.
Spores of Botrychium ternatum, Growing, 1109.
—— of Cladothrix, Formation of, 692.
—— of Lycopodium, 839.
—— of Merulius lacrymans, Germination of, 845.
—— of Pottia, 1036.
—— of the Genus Onoclea, Third Coat in, 493.
Sporocyst, Free-swimming, 648.
Sporogonium and Archegonium of Muscineæ, 279.
Spur of Cucurbitaceæ, 831.

Stage, Mayall's Mechanical, 122.
——, Tolles's Centering, 521.
Stages, Microscopes with Accessory, 1058.
Stahl, E., Influence of Light on Geotropism, 491.
Stain, New Double, for the Nervous System, 741.
Staining and Decalcification of Osseous Tissue, 905.
—— and Mounting Pollens and Smuts, 349.
—— Bacteria for Photo-micrographic purposes, 166.
—— —— with Dahlia, 558.
——, Contribution to the History of, 553.
—— Desmids, 742.
——, Double, 558.
——, ——, Bacillus subtilis, &c., 363.
—— Fluid, Method of Preparing Hæmatoxylon, 741.
—— Fluids, Carmine, New Methods of Preparing, 1094.
—— for Microscopical Purposes, 554, 900.
—— for the Study of Red Blood-corpuscles, 741.
—— Infusoria, 538.
—— Method for Karyokinetic Figures, 341.
—— —— for the Central Nervous System, Weigert's, 158, 159.
—— Methods, 902.
—— Nerves in Muscle, 903.
—— of Koch's Bacillus, 557.
—— Process, Plaut's, for the Demonstration of Saprogenous and Pathogenous Micro-organisms, 342.
—— Salivary Glands, 1095.
——, Silver, of Marine Objects, Method for, 160.
—— Technique, 554.
—— the Axis-cylinder of Medullated Nerve-fibres, 742.
—— the Nervous System of the Muzzle and Upper Lip of the Ox, 555.
—— the Nucleus of the Germinal Vesicle in Arthropoda, 905.
—— the Spinal Cord, New Method of, 742.
—— the Spores of Bacillus tuberculosis, 342.
—— Tissues for Photo-micrography, 559.
—— Vaucheria and Chara, 557.
—— Vegetable Tissues in Picrocarmine, 165.
—— with Hæmatoxylin, 1095.
Stamens, Influence of Gravitation on the Movements of, 272.
Starch, Formation of, in the Leaves of the Vine, 670.
—— in Vessels, 671.
Starch-grains, Preparing Leaves to show, 1084.
—— -meal, 265.
Statice monopetala, Leaves of, 829.
Stearn, C. H., 339.
Stebbing, T. R. R., New Amphipodous Crustacean, 238.
Stein's (S. T.) Microscopes for use with the Electric Light, 303.
Steinbrinck, C., Bursting of Ripe Fruits, 481.
Steinheil, A., 339, 533.
Stem of Aquatic Plants, Structure of, 480.
—— of Compositæ, Anatomical Structure of, 480.
—— of Strychnos, Structure of, 828.
——, Pericycle of, 673.
Stephani, F., Radula, 282.
Stephanosphæra pluvialis, 495.
Stephenson, J. W., Erecting and Binocular Prisms, Improved Form of, 959.
——, Immersion Illuminator, 523.
——, On a Cata-dioptric Immersion Illuminator, 207.
Sterculiaceæ, Gum-canals of, 827.
Stereoscopic Vision, Monocular, 332.
Sterilization of Fermentable Liquids in the Cold, 562.
Sternberg, G. M., Culture-tubes, 367.
——, Relation of Bacteria to Asiatic Cholera, 299.
——, Selection and Preparation of Objects for Photographing, 911.
Stieda, L., 367.
Stilling, J., Investigating the Structure of the Central Nervous Organs, 730.
Stillson, J. O., 367.
Stodder, J. C., Series of Objectives, 863.
Stokes, A. C., New Choano-Flagellata, 258.
——, New Fresh-water Infusoria, 80, 257, 659.
——, New Parasitic Infusoria, 81.
——, New Vorticella, 470, 819.
——, Vorticellæ with Two Contractile Vesicles, 659.
——, G. G., 892.
Stokes-Watson Electric Spark Apparatus, 728, 1069.
Stolons of Sagittaria sagittæfolia, 479.
Stomachs of Mollusca and Crustacea, Preparing Diatoms from, 734.
Stomata of Equisetum, 99.
—— of Marchantia, 1036.
Stowell, C. H., 144, 566, 748.
——, Dissecting Insects, 166.
——, Microscopic Geissler Tube, 367.

Stowell, C. H. and L. R.,144, 533, 566, 728.
Strahl, H., Embryology of Lacerta viridis, 212.
Strasburger, E., 144.
——, Coloured Crayons for Marking Preparations, 1103.
——, Development of the Sporangium of Trichia, 107.
——, Eau de Javelle for Clearing, 1097.
——, Embryo-sac of Santalum and Daphne, 830.
——, Finder, 1103.
——, Practical Botany, 332.
——, Theory of Descent, 1027.
Streng, A., Isolating Minerals in Sections for Micro-chemical Examination, 921.
Striæ of Diatoms, Nature of, 169, 173.
Striated Woody Tissue, 828.
Stricker's Electrical Apparatus, 870, 874.
—— Electrodes, 875.
Ströbelt's Electrical Apparatus, 870.
Strop for Knives, 157.
Struthiopteris germanica and Pteris aquilina, Anatomy of Vegetative Organs of, 492.
Strychnin, Micro-chemical Test for, 920.
Strychnos, Structure of Stem of, 828.
Stuhlmann, F., 1111.
Stupefying Active Forms of Aquatic Life, 165.
Sturtevant, E. L., Hybridization and Cross-breeding of Plants, 1028.
Styles of Indian Corn for Examining Movement of Protoplasm, 1106.
Styrax and Balsam, 744.
—— for Mounting Diatomaceæ, 166.
Substage Apparatus, Beck's Combined, 115.
Succulent Plants, Periodical Formation of Acids in, 97.
Suckers of Animals, Morphology of, 431.
Summary of Current Researches. See Contents, viii.–xliv.
Sun, Influence of, on the Growth and Activity of Bacillus anthracis, 1050.
Sunflowers, Movements of Androœcium in, 268.
Sunlight, Effect of, on Micrococcus, 1047.
——, Influence of direct, on Vegetation, 678.
——, ——, on the Vitality of Germs, 508.
Surfaces, flat vertical, How Insects adhere to, 801.
Swaen, A., Early Developmental Stages of Torpedo, 977.
Swelling Agent, Biniodide of Mercury and Potassium as, 341.
Swift's (J.) Cone and Achromatized Immersion Paraboloid Condenser, 126.
—— Sheep-Scab Microscope, 307.
Swift, M. J., Photo-micrograph of Tongue of Blow-fly, 1077.
Swift-Wale Microscope, 119.
Swine's-flesh, Actinomyces in, 290.
Swiss Lakes, Deep Fauna of, 238.
Symbiosis, New Instance of, 282.
—— of Worms and Sea-Anemones, 982.
Synascidian Diplosomidæ, the, 796.
Syphilis, Preparing the Bacillus of, 539.

T.

Table, Numerical Aperture, 972.
Tadpoles, Epidermic Cells of, 977.
Tænia, Nervous System of, 244, 459.
—— Echinococcus, Experimental Breeding of, 1002.
—— ——, Frequent occurrence of, in Domestic Dogs, 1002.
"Tag" of Cœlopleurus Maillardi, 815.
Tail of Human Embryo, 781.
'Talisman' Expedition, Brisingidæ of, 1009.
Tangl, E., Continuity of Protoplasm, 473.
Tannin and Lignin in Galls, 1020.
——, Behaviour of, in Germination, 272.
Tasmanian White Ant, Infusorial Parasites of, 662.
Tate, A. N., 749.
Taylor, C. J., Apparatus for Botanical Lectures, 312.
——, F. W., 367.
——, G. H., 927.
——, H., and F. Kitton, Diatoms and Bladderwort, 685.
——, T., 927.
——, Examination of Butter and Fats, 356.
——, and J. B. Betts, Discrimination of Butter and its Substitutes, 918.
Tayou, M., Microbe of Human Typhoid Fever, 299.
——, —— of Typhoid Fever in Man, 1052.
Tea, Microscopical Examination of, 749.
Technical Notes, Various, 928.
Technique, Hints on, 166.
Tectibranchiata of the Gulf of Marseilles, 624.
Teeth and Bone Sections, Rapid Method for Making, 348.
——, Preparing Thin Sections of, 348.

Temne, F., Formation of Gum in Wood, 88.
Temperature Maxima for Marine Animals, 791.
Temperatures, Effects of Very Low, on Living Organisms, 619.
Tension, Behaviour of the Optical Axes of Elasticity of Cell-walls under, 476.
Terletzki, P., Anatomy of the Vegetative Organs of Struthiopteris germanica and Pteris aquilina, 492.
Terra-del-Fuego, Mosses of, 1036.
Test for the Hand-Lens, 720.
—— in Tunicata, Evolution of the Blood-vessels of, 230.
Test-object, Navicula cuspidata as a, 140.
Testes of Lepidoptera, 51.
Testing the different Sectors of Objectives, 324.
Tests, Sensitive, for Wood-fibre and Cellulose, 897.
Tetramyxa parasitica, 292.
Tetraplatia volitans, 252.
Textile Microscopical Association, 728.
Thalli, Formation of, on the Apothecia of Peltidea aphthosa, 843.
Thallwitz, J., Development of Male Germinal Cells in Hydroids, 462.
Thanhoffer's Electrical Apparatus, 869.
Theiler and Son, 729.
—— "Universal (Achromatic) Pocket Microscope," 704.
Thermal Waters, Algæ of, 1047.
Thermotropism of Roots, 679.
—— —— of Æthalium septicum, 844.
Thickenings, Centrifugal, Formation of, in the Walls of Hairs and in the Epidermis, 267.
Thoma's (R.) Microtome, 153.
Thomas, J. D., Experimental Breeding of Tænia Echinococcus, 1002.
——, Frequent occurrence of Tænia Echinococcus in Domestic Dogs, 1002.
Thompson's (D'A. W.), Bibliography of Protozoa, Sponges, Cœlenterata, Worms, and Molluscoida, 983.
——, Hydroid Zoophytes of the 'Willem Barents' Expedition, 1881, 73.
—— (W. G.) Projection Microscope, 310.
Thore, J., Algæ of Thermal Waters, 1047.
Thoulet, J., 166.
Thudichum, J. L. W., Medico-legal and Chemical Microscopy, 1108.
Thümen, F. v., Fungi of the Vine and Willow, 291.
Thurston, E., 749.
——, Balsam for mounting Bacteria, 166.
Thurston, E., Examining Bacteria, 362.
——, Staining Bacteria for photo-micrographic purposes, 166.
Tichborne, Application of the Microscope to Practical Mineralogical Questions, 922.
Tichomirow, Composition of the Ova of Bombyx, 441.
——, W. A., Peculiar Structures in the Flesh of the Date, 824.
Tieghem, P. van, Annular and Spiral Cells of Cactaceæ, 672.
——, Cœnonia, a New Genus of Myxomycetes, 293.
——, Cortical Fibrovascular Bundles of Vicieæ, 266.
——, Curvature of Ovules, 267.
——, Development of Bacillus Amylobacter in Plants in a Normal Condition of Life, 297.
——, —— of Pyronema confluens, 289.
——, Gum-canals of the Sterculiaceæ, 827.
——, Monascus, a New Genus of Ascomycetes, 291.
——, Secreting Canals of Plants, 823.
Tiemann, Examination of Water for the Development of Micro-organisms, 560.
'Times,' The, on the Microscope, 883.
Timiriazeff, C., Chemical and Physiological Action of Light on Chlorophyll, 837.
Tindall, E. A., 533.
Tintinnodea, 470.
Tissue-system, Mechanical, 828.
Tissues, Animal, Origin and Development of, 426.
——, Firmness of, 476.
——, Susceptibility of the Different, to Colouring Matters, 554.
——, Vegetable, Cleaning Fluid for, 366.
Tizzoni, Demonstration of Karyokinesis in Epithelial Tissues, 730.
Todea, Apex of the Root in, 1033.
——, Apical Growth of the Root of, 839.
Toldt, C., 567.
Tolles, R. B., 339.
——, Centering Stage, 521.
——, Clinical Microscope, 308.
——, Memorial Fund, 380.
—— —— ——, Donation of Society to, 168.
Tolman, H. L., and M. D. Ewell, Eyepiece Micrometers, 704.
Tolu, Balsam of, as a Medium for Mounting, 352, 1116, 1117.
—— instead of Chloroform for Imbedding in Paraffin, 541.
Tongue of Blow-fly, 751.

Töpffer, A., Transitional Equisetum, 681.
Töpler's (A.) Illuminating Apparatus, 710.
Torpedo, Early Developmental Stages of, 977.
Torsion, Heliotropic and Geotropic, 95.
Townsend, F., Homology of the Floral Envelopes in Gramineæ and Cyperaceæ, 676.
Trachinus vipera, Development of, 34.
Trachsel-Crozet, 1111.
Tracks of Insects resembling the Impressions of Plants, 635.
Tradescantia, Division of Cell-nucleus in, 475.
Trajano, Lago, Diatoms from, 103.
Transactions of the Society. See Contents, xliv.
Transparencies, Lantern, 866.
Transpiration and Respiration of Fungi, 104.
——, Protection of Leaves from excessive, 1025.
Transpiration-currents, 1032.
Treasurer's Account for 1884, 373.
Trees, Mechanical Injury to, by Cold, 1029.
——, Nutrition of, by means of underground Fungi, 844.
Trelease, W., Relations of Two Cecidomyians to Fungi, 291.
Trematoda, 1002.
——, Anatomy of, 460.
Trematodes, Imbedding and Examining, 735.
Treub, M., Embryo of Barringtonia, 271.
——, —— of Cycadeæ, 270.
——, Prothallium of Lycopodium, 277.
Trichia, Development of the Sporangium of, 107.
Trochobryum, a New Genus of Seligeriaceæ, 281, 841.
Trochosphere, Formation of, in Serpula, 240.
Trombidium, Hermaphroditism of Male of, 58.
Trouessart, E. L., Acari inhabiting the Quill of Feathers, 236.
——, Sarcoptidæ, 803.
Trough, Hawkins's Observatory, 719.
Trout, Flagellate Infusorian parasitic on, 82.
Truncatella, Respiration of, 986.
Tschirch, A., Chemical Reactions of Chlorophyll, 264.
——, Chlorophyll of Fucaceæ, 282.
——, Mechanical Tissue-system, 828.
——, Morphology of Chlorophyll-grains, 88, 475.
Tschirch, Penetration of the Mechanical Ring for the Transport of Food-material, 479.
——, Starch-meal, 265.
Tuberaceæ, Cryptica, a New Genus of, 105.
Tuberculosis, Etiology of, 851.
Tunicata. See Contents, xii.
Turbellaria, Development of, 648.
——, Fresh-water, of North America, 648.
Turbellarian, New, 248.
Turbellarians, Deep-water, of Lakes, 1004.
Turner, W. B., On some new and rare Desmids, 933.
——, Staining Desmids, 742.
Turntable, Brownell's, 350.
——, Microscopical, 166.
"Twin" Simple Microscope, 862.
Tyas, W. H., 928.
Tyroglyphidæ, Notes on the Life-Histories of some of the little-known, 19.
Tyrothrix, Action of various Compounds on, 510.
Tyrrell, P., 534.

U.

Uljanin, B., Doliolum, 231.
——, Structure of Distaplia, 233.
Ulmer, J., Microscope with Catgut Focusing Adjustment, 1057.
Umbelliferæ, Oil-receptacles in the Fruit of, 89.
Unicellular Organisms, Immortality of, 466.
"Universal Accessory," Bausch and Lomb Optical Company's, 713.
Urbanovics, F., Development of Cyclops, 641.
Uredineæ, Life-history of certain British Heterœcismal, 288.
——, Reproduction of the Heterœcious, 503.
Uric Acid Crystals, Extraction of, from the Green Gland of Astacus fluviatilis, 805.
Urinary Deposits, Mounting, 365.
—— Organs of Amphipoda, 640.
Urnatella gracilis, 439.
Urodela, Preparing Brain of, 536.
Uropneustic Apparatus of Helicinæ, 225.
Urtica dioica, Vegetative Organs of, 833.
Ustilaginea, New, 288.

V.

Van Brunt, C., 534, 729, 749, 928, 1111.
——, Balsam of Tolu as a Medium for Mounting, 352.

Vandevelde, G., Chemistry of Bacillus subtilis, 508.
Variation, New Law of, 216.
Varigny, H. de, "Latent period" of Unstriped Muscle in Invertebrates, 982.
——, Physiology of the Unstriated Muscles of Invertebrata, 791.
Vascular System, Communication of, with the Exterior in Pleurobranchus, 794.
—— —— of Echinoids, 814.
Vaucheria and Chara, Staining, 557.
——, Cell-wall Thickenings and Cellulin Grains in, 838.
Vayssière, A., Respiration of Truncatella, 986.
——, Tectibranchiata of the Gulf of Marseilles, 624.
Védy's Revolving Stage Microscope, 699.
Vegetative Organs of Monotropa, 1025.
—— —— of Phanerogams and Ferns, 93.
Vejdovsky, F., Observations on some Fresh-water Sponges, 255.
Velella, Structure of, 1010.
Venturi, G., Spores of Pottia, 1036.
Vermes. See Contents, xvi.
Vermilia, Crustacean inhabiting the Tubes of, 238.
Verrall, G. H., 892.
Verrill, A. E., New Cœlenterates and Echinoderms, 432.
Versuridæ, Development of, 72.
Vertebrata, Embryology and Histology of. See Contents, viii.
Vesicating Insects, Structure of Wings of, 992.
Vesiculæ Seminales of Guinea-pigs, 35.
Vesque, J., Anatomy of the Leaf in Vismieæ, 675.
——, Ascent of Sap, 1031.
——, Movement of Ascending Sap, 489.
Vétillart, M., 567.
Viallanes, H., Optic Ganglion of Æschna, 800.
——, —— —— of Palinurus vulgaris, 450.
Vialleton, L., Buccal Membrane of Cephalopoda, 622.
——, Fecundation in Cephalopoda, 983.
Vibrios and Microzymes of Air, Water, and Soil, Origin of, 295.
Vicieæ, Cortical Fibrovascular Bundles of, 266.
Vigelius, W. J., Morphology of the Bryozoa, 438.
Viguier's (C.) Compressorium, 137.
Viguier, Lower Animals of the Bay of Algiers, 65.
——, Pelagic Annelids, 998.
——, Tetraplatia volitans, 252.
Villot, A., Host of the Larva of Echinorhyncus clavæceps, 459.
Vine, Bacillus of, 1053.
——, Formation of Starch in Leaves of, 670.
——, Fungi of, 291.
——, "Pourridié" of, 107.
Vines, S. H., and F. O. Bower, Examining the Spectrum of Chlorophyll, 527.
—— ——, Practical Botany, 484.
Virchow, H., Action of Light on Objects hardened in Chromic Acid, 148.
Vision, Compound, and the Morphology of the Eye in Insects, 234.
——, Limit of Angular, 339.
——, Monocular Stereoscopic, 332.
Vismieæ, Anatomy of the Leaf in, 675.
Vitellus, Position of the Yolk-Blastopore as determined by the Size of, 978.
Vogel, J., 144.
Vogt, C., Erythropsis agilis, 77.
Voigt, W., Oogenesis and Spermatogenesis in Branchiobdella, 643.
Volcanic Ash, Microscopical Examination of, from Krakatoa, 923.
Volkens, G., Calcareous Glands of Plumbagineæ, 92.
Vorce, C. M., 339, 367, 534, 567, 928.
——, Compound Negatives, 331.
——, Lantern Transparencies, 866.
—— and R. Hitchcock, Multiplying Drawings, 527.
Vorticella, Chlorophylloid Granules of, 78.
——, New, 470, 819.
Vorticellæ with Two Contractile Vesicles, 659.
Vorticellid, New, 78.
Vosmaer, G. C. J., Note on Sponges, 75.
——, Sponges of the 'Willem Barents' Expedition, 1013.
Vries, H. de, Circulation and Rotation of Protoplasm as a means of Transport of Food-material, 665.
——, Periodical Formation of Acids in Succulent Plants, 97.
——, Plasmolysis, 84.
Vuillemin, P., Anatomical Structure of the Stem of Compositæ, 480.
——, Puccinia Thlaspidis, 1045.

## W.

W., D. S., Freeing Objects from Air, 898.
W., E. D., Measurement of Power and Aperture of Microscopic Objectives, 1082.

Waldeyer, W., 144.
Wales, W., 534.
——, Care and Use of Objectives, 708.
Waller, T. H., 367.
Wallich, G. C., 144.
——, Condenser, 127.
——, Critical Notes on Amœbæ, 1018.
——, Pseudocyclosis in Amœba, 1019.
——, Structure of Diatoms, 286.
Walmsley, W. H., 749, 892.
Walter, A., Echinodermata of Ceylon, 462.
——, Morphology of the Lepidoptera, 635.
Walters, H. A., Net for Microscopists, 535.
——, W. H., 749.
Ward, E., 928.
——, Dry Mounting, 1101.
——, P., 144.
——, R. H., 729, 892.
——, Choice of Objectives and Oculars, 1082.
——, Iris Illuminator, 326.
——, Lens-holder, 317.
Warlomont, R., Microscopical Technique of the Eye, 895.
Warnstoff, C., European Sphagnaceæ, 281.
Wasps and Bees, Apparatus for Differentiating the Sexes in, 1.
—— ——, Receptaculum Seminis of, 1.
Water and Melted Glass Lenses, 890.
——, Ascent of, in Plants, 274.
——, Conduction of, in Plants, Importance of Dead Tubes and Living Cells for, 490.
——, ——, in the Stem of Mosses, 681.
——, Curved Bacilli in, 697.
——, Determination of the number of Living Germs in, 359.
——, Effect of Prolonged Repose and Filtration through Porcelain on the Purity of, 561.
——, Examination of, for the Development of Micro-organisms, 560.
——, Exudation of, from the Female Receptacle of Corsinia, 1035.
——, Inception of, among Mollusca, 794.
——, Influence of, on the Growth of Plants, 93.
——, Movement of, in Mosses, 493.
——, ——, in Plants, 490, 836.
—— ——, ——, Direct Observation of, 359.
——, Removal of Micro-organisms from, 923.
Water-bath, Andrews and Nachtrieb's, 1086.
Waters, A. W., On the use of the Avicularian Mandible in the determination of the Chilostomatous Bryozoa, 774.
Waters, Potable, Examination of, 923.
Watson's Camera or Lantern Microscope, 1064.
—— Swinging Substage Microscope, 1062.
Watson and Son's Slides of British Fresh-water Algæ, 928.
Watson-Wale Microscope, 860.
Wave-currents, Influence of, on Fauna of Shallow Seas, 38.
Wax Cells, 363.
——, Sheet, Cheap Punches for, 367.
Weber, C., Fungus of the Root-swellings of Juncus bufonius, 107.
——, M., Isopoda of the 'Willem Barents' Expedition, 450.
Wedding, H., 1082.
Weever-Fish, Development of the Lesser, 34.
Wegmann, H., Natural History of Haliotis, 43.
Wegscheider, R., Spectra of the Pigments of Green Leaves and their Derivatives, 670.
Weigert's (C.) Staining Method for the Central Nervous System, 158, 159.
Weisiger, W. R., Obituary of, 339.
Weismann, A., Immortality of Unicellular Organisms, 466.
Weiss, A., Soluble Yellow Pigment in the Petals of Papaver, 476.
——, Spontaneous Movements of Pigment-bodies, 476.
Wenham Disk Illuminator, Modified, 128.
West's (F. L.) Adjustable Dark-ground Illuminator, 523.
——, T., 166.
Westermaier, M., Importance of Dead Tubes and Living Cells for the Conduction of Water in Plants, 490.
Westien's (H.) Apparatus for comparing symmetrical parts of the Webs of the right and left Feet of a Frog, 879.
—— Universal Lens-holder, 316.
Wethered, E., On the Structure and Origin of Carboniferous Coal Seams, 406.
Wettstein, R. v., Laws of Growth of Vegetable Organs: Roots, 272.
——, Rhodomyces, a new Human Parasite, 1046.
Weyenbergh, H., 144.
Wharton, H. J., Fries' nomenclature of Colours in the Agaricini, 105.
Wheat, Nutritive Properties of the various portions of Grain of, 671.
White, T. C., 534.

White, T. C., Value of Photo-micrographs, 528.
White Zinc for Mounting, 163.
Whitman, C. O., 166, 749, 928, 1111.
——, Cambridge Rocking Microtome, 1091.
——, Cutting Ribbons of Sections, 158.
Whitney, J. E., 567.
——, Cheap Punches for Sheet Wax, 367.
——, Life-Box, 330.
Wichmann, A., Micro-chemical Examination of Minerals, 920.
Wielowiefski, H. v., Formation of Ova in Pyrrhocoris, 798.
——, Staining the Nucleus of the Germinal Vesicle in Arthropoda, 905.
Wienack, L., 567.
Wiesner, J., Mechanical Explanation of Spontaneous Nutations, 273.
——, Motions of Roots during Growth, 272.
Wigand, G., Development of Bacteria, 110.
Wilkie, F. B., 144.
Will, H., Anatomy of Macrocystis, 284.
Willcox, J., Spawning of Fulgur perversus, 986.
Wille, N., Physiological Anatomy of Algæ, 841.
——, Sieve-hyphæ in Algæ, 684.
'Willem Barents' Expedition, 1881, Hydroid Zoophytes of, 73.
—— —— ——, Isopoda of, 450.
—— —— ——, Sponges of, 1013.
Williams, C. F. W. T., 749.
——, G. H., The Microscope in Geology, 921.
Williston, S. W., Edible Dipterous Larvæ from Alkaline Lakes, 53.
Willow, Fungi of, 291.
Wills, L., Developmental History and Morphological Value of the Ova of Nepa cinerea and Notonecta glauca, 447.
Wilson, A. S., "Sclerotioids" of Potato, 1022.
Wings of Hymenoptera, 234.
—— of Vesicating Insects, Structure of, 992.
Winkel's Demonstration Microscope, 308.
Winogradsky, S., Influence of External Conditions on the Development of Mycoderma vini, 294.
Winter, G., Corynelia, 105.
——, Rabenhorst's Cryptogamic Flora of Germany (Fungi), 690.
——, W., 534.
Winter Habits and Hibernation of Spiders, 640.
Wire, A. P., Boro-glyceride for Mounting, 742.
Witlaczil, E., Development of Aphides, 53.
——, New Gregarine, 471.
——, Treatment of the Ova and Embryos of the Aphides, 147.
Wolffia microscopica, 834.
Wolle, F., New Fresh-water Desmids, 497.
Wollny, E., Effect of Depth of Sowing on the Germination and Growth of Plants, 93.
——, Geminella interrupta, 285.
——, Microbes in the Soil, 693.
Wood of Conifers, Anatomy of, 825.
——, Water-conducting, Air in, 679.
Wood-fibre, Sensitive Tests for, 897.
Woodhead (G. S.) and A. W. Hare's 'Pathological Mycology,' 698.
Woodward, J. J., Obituary of, 339.
Woody Tissue, Striated, 828.
Wooldridge, L. C., New Constituent of the Blood and its Physiological Import, 428.
Wormley, T. G., 567.
Worms. See Vermes, xvi.
Woronin, M., Leaves of Statice monopetala, 829.
——, Nutrition of Trees by means of Underground Fungi, 845.
Wortmann, J., Red Pigment in Flowering Plants, 670.
——, Secondary Geotropic Phenomena, 273.
——, Thermotropism of Roots, 679.
——, —— —— of Æthalium septicum, 844.
Wounds, Excretion of Healing Substances into, 476.
Wright, H. G. A., Tongue of Blow-fly, 751.
——, L., 144, 1083.
——, The Lantern Microscope, 196.
——, R. R., Free-swimming Sporocyst, 648.
——, Parasitic Copepod of the Clam, 239.
——, Suggestions as to the Preparation and Use of Series of Sections in Zootomical Instruction, 1091.
Wythe, J. H., 1083.

## Y.

Yam, Chinese, Influence of Want of Moisture on the Growth of, 1029.
Year-Book, 145.
Yeast, Cultivated Wine-, 114.
——, Degeneration of, 693.

Yolk-Blastopore, Position of, as determined by the Size of the Vitellus, 978.

Z.

Z., 145.
Zacharias, E., Structure of the Nucleolus, 821.
——, O., 145.
——, Amœboid Movements of Spermatozoa of Polyphemus pediculus, 239.
——, Experiments on Formation of Pseudopodia, 1014.
——, Fauna of the Pieces of Water of the Riesengbirge, 432.
——, Nephridia of Microstoma lineare, 813.
——, Relationship of Rotifers and Nematodes, 1006.
——, Reproduction and Development of Rotifer vulgaris, 249.
Zahlbruckner, A., Lenticels, 825.
Zawarykin, T., Study of Fat Absorption in the Small Intestine, 731.
Zeigler, E., 928.
Zeiller, R., Affinities of Laccopteris, 681.
——, Fructification of Sigillaria, 493.
——, Tracks of Insects resembling the Impressions of Plants, 635.
Zeiss, C., Dissecting Microscopes with Brücke Lens, 319.
Zenger, C. V., Double-sided Slide, 908.
——, Monobromide of Naphthalin and Tribromide of Arsenic, 909.
——, Mounting for Diatoms, to view them on both sides, 161.
——, New Mounting Medium, 377.
Zentmayer's Abbe Condenser, 710.
Ziegler, H. E., Development of Cyclas cornea, 625.
Zimmermann, A., Behaviour of the Optical Axes of Elasticity of Cell-walls under Tension, 476.
——, Causes of Anisotropy of Organic Substances, 487.
——, Spiral Cells of Nepenthes, 1023.
——, O. E. R., 534.
Zinnia, Sexual Characters in, 267.
Zoocytium of Ophrydium versatile, Chemical Composition of, 818.
Zopf's (W.) Myxomycetes, 690.
Zschokke, F., Parasites of Fresh-water Fishes, 647.
Zukal, H., Structure of Lichens, 687.
Zygnemaceæ, Bisexuality of, 1038.
——, Hibernation of, 284.
——, Sexuality in, 285.
Zygospores of Mucorini, 505.
Zymosis, Organisms Productive of, 693.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET AND CHARING CROSS.

Supplementary Number, containing Index, &c.

Ser. II.
Vol. V. Part 6a. DECEMBER, 1885. { Gratis with No. 49.

# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

## CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

## ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

## MICROSCOPY, &c.

---

*Edited by*

**FRANK CRISP, LL.B., B.A.,**

*One of the Secretaries of the Society*
*and a Vice-President and Treasurer of the Linnean Society of London;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S.,
*Lecturer on Botany at St. Thomas's Hospital,*

F. JEFFREY BELL, M.A., F.Z.S.;
*Professor of Comparative Anatomy in King's College,*

JOHN MAYALL, JUN., F.Z.S.,

FRANK E. BEDDARD, M.A., F.Z.S.,

B. B. WOODWARD, F.G.S.,
*Librarian, British Museum (Natural History),*

R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

J. ARTHUR THOMSON, M.A.,

FELLOWS OF THE SOCIETY.


WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

PRINTED BY WM. CLOWES AND SONS, LIMITED.] [STAMFORD STREET AND CHARING CROSS.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

SER. II., VOL. V. Part 6a.

# CONTENTS.

| | PAGE |
|---|---|
| TITLE-PAGES. | |
| CONTENTS .. .. .. .. .. .. .. .. | vii |
| INDEX .. .. .. .. .. .. .. .. .. | 1125 |

## DIRECTIONS TO THE BINDER.

The Presidents' Portraits should precede the Title-page, in the following order:—

1. Sir R. Owen.
2. Presidents 1842–1857.
3. Mr. Glaisher.
4. Presidents 1858–1878.

# THE ROYAL MICROSCOPICAL SOCIETY.

(Founded in 1839. Incorporated by Royal Charter in 1866.)

**The Society** was established for the communication and discussion of observations and discoveries (1) tending to improvements in the construction and mode of application of the Microscope, or (2) relating to Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows.

**Ordinary Fellows** are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time for 31*l.* 10*s.* Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-fourth of the subscription during absence.

**Honorary Fellows** (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of three Fellows and the approval of the Council.

**Ex-officio Fellows** (limited to 100) consist of the Presidents for the time being of such Societies at home and abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

**The Council,** in whom the management of the affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Fellows.

**The Meetings** are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings are devoted to the exhibition of Instruments, Apparatus, and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

**The Journal,** containing the Transactions and Proceedings of the Society, with a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c., is published bi-monthly, and is forwarded post-free to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

**The Library,** with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays), from 10 A.M. to 5 P.M., and on Wednesdays from 7 to 9.30 P.M. also. It is closed for four weeks during August and September.

*Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.*